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Examining the Technological Development of Preservice and Novice Teachers: Cross-Sectional Case Studies of Teachers in a One-to-One Laptop-Infused Teacher Preparation Program

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Dedication

To merciful Lord,

my husband, my baby Louis, my parents, my family and CRSC-SC members

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Examining the Technological Development of Preservice and Novice Teachers: Cross-Sectional Case Studies of Teachers in a One-to-One Laptop-Infused Teacher Preparation Program

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The University of Texas at Austin, 2012

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The goal of this study was to explore technology experiences from a preservice teacher preparation program that requires every preservice teachers and instructors to own a laptop. The participants were a) preservice teachers who were in the program and b) novice teachers who are the program graduates. The setting of this study was a preservice teacher preparation program that involves one-to-one computing throughout in a college of education in a large southwestern university.

The research conducted a cross sectional case study. Two preservice teachers across the first, second, and third semesters of the program and two novice teachers in the first year of teaching participated in this research. Various data sources were collected with: a) technological skills and attitude survey, b) related documents such as lesson plans, assignments and school documents, c) observation, and d) interviews.

Results of this study showed each participant's learning environment, technology experiences and technology skills, attitudes and knowledge. All preservice teachers mutually had media cart, instructors' laptops, students' laptops, and wireless internet in university classes, and had innovation station, teachers' computers, printer, telephone, students' computers, headsets and wireless internet in PK-6 school classes. Throughout

the program, university instructors mutually required Email, word processing and electronic submission of assignments to the preservice teachers. The instructors mutually modeled using PowerPoint and Learning Management System (LMS). Preservice teachers in the first semester mutually used video creation, preservice teachers in the second semester used Email and LMS, and preservice teachers in the third semester mutually used search engine, PowerPoint and innovation station. All participants' technology attitudes were overall positive. Most of the preservice teachers' technology knowledge was rated accepting level, except Neal, one of the preservice teachers in the third semester, who was rated adapting level.

Novice teachers mutually had innovation station, web conferencing devices and students' laptops in their school. Both of the novice teachers experienced barrier of technology integration due to the necessary devices were already checked out. The novice teachers mutually used innovation station, had overall positive technology attitudes and had technology knowledge at the accepting level.

The results led six discussion issues, including a) alignment of technological infrastructure, b) accessibility of technologies, c) limited exposure to technological activities, d) preservice teachers' technology skills, e) technology experiences from the program and preservice teachers' technology attitudes, and f) programmatic impact on novice teachers.

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Chapter 1: Introduction

STATEMENT OF PROBLEM

PK-6 students in the 21st century, who also can be referred to as the Millennials, tend to use various digital technologies. They communicate through SMS, IM, social networking systems and e-mail, create and share information through blogs, and use the Internet for searching information. In addition, the students show a tendency to use these media and technologies for their learning (Dede, 2005; Prensky, 2005; Tapscott, 2009). When the Millennials study, they may use a word processing to take notes, search the Internet to find information, discuss projects with other group members through instant messaging, interact through social networks, and communicate with text message (Oblinger & Oblinger, 2005; Tapscott, 2009). Technology has an important role and influence on the students' daily lives and learning (Gulek & Demitras, 2005; Silvernail & Harris, 2003; Zucker & McGhee; 2005).

Under the environment that accepts and supports technology use in schools, teachers are asked to use technology for their teaching and many of them try to integrate technology in their instruction (Christensen & Knezek, 2006; Gray, Thomas & Lewis, 2009). For example, Christensen and Knezek (2006) identified the frequency of teachers' technology use. The percentage of teachers who reported that they used technology everyday was 31%. 33% of teachers were using technology once a week. 20% of teachers were using technology just once a month. Overall 14% of teachers still were not using technology in their class at all during teaching. Gray et al. (2009) reported on the technology infrastructure in schools and teachers' technology use in the year of 2009. 97% of teachers were equipped with computers in their classrooms. 29% of teachers reported that technology is used in their classes often, and 41% of teachers reported that technology is used in their classes sometimes.

Teachers are expected to integrate technology into their classes and some teachers infuse technology in their teaching. However, there are many kinds of technologies and various ways to apply those technologies in teaching. Thus, teachers need guidance and help to learn how to integrate technology in teaching. Frank, Zhao, and Borman (2004) and NCES (2000) reported that teachers who received technology-related training perceived that they were well prepared to integrate technology into the classrooms.

By widening the target of the professional development, researchers (Frank, Zhao, & Borman, 2004; NCES, 2000) insist for preservice teachers to be prepared to use technology before they go into the field. Therefore, universities and colleges of education build preservice teacher preparation program for training preservice teachers for technology integration.

To prepare the preservice teachers to use technology for learning and teaching, various approaches, such as workshops, single courses, and technology integrated programs, have been applied in different settings. A workshop is a short-term, specific skill based activity. A single course approach is a one-semester long course to give a wide range of basic technology skills. A technology integrated program is a long-term program to prepare preservice teachers in technology integrated courses (Kay, 2006). Cradler, Freeman, Cradler, and McNabb (2002) described that preservice teachers are able to see and learn how to implement technology into classes from instructors' technology use modeling. From the idea that the instructors' modeling of technology use impacts preservice teachers' technology integration (Bin-Taleb, 2005; Resta, Abraham, Gerwels, and Tothero 2004; Scott, 2005), universities and colleges of education have developed technology integrated preservice teacher preparation programs. Some programs require instructors and preservice teachers to have laptops in courses, which expect that preservice teachers would be prepared for technology integration in PK-12

education with the combination of instructors' modeling and preservice teachers' use of laptops.

Researchers have conducted studies of the impact of preservice teacher preparation programs, which require laptop for each student, on preservice teachers' technology integration. For example, Bin-Taleb (2005) conducted research about the influence of the preservice teacher preparation program on the faculty's and preservice teachers' perception of technology integration. The results showed that the faculty perceived that the laptop-integrated preservice teacher preparation program positively influenced the teaching experience and positively supported the learning environment. But preservice teachers' perceptions of the impact of the laptop-integrated preservice teacher preparation program on teaching experience and learning environment was neutral. The more experienced preservice teachers, however, had a more positive perception on teaching experience and the learning environment than did the preservice teachers with less experience.

Peacock, Norton & Carbonaro (2009) conducted a study to examine preservice teachers' skills and technology attitudes during a laptop-integrated preservice teacher preparation program. The researchers showed that the preservice teachers felt more positive toward technology at the midpoint of the program than at the beginning point. In addition, the preservice teachers' technology skills increased more at the midpoint than at the beginning point. Bin-Taleb (2005) and Peacock et al. (2009) showed that the experience from the preservice teacher preparation program positively influence preservice teachers' technology perception, attitude and skills toward the latter part of their preparation program.

The ultimate goal of the preservice teacher preparation program for technology integration would be preparing teachers' technology use in class when the preservice

teachers get into the field. However, no research has been conducted to see the long term effect of the preservice teacher preparation program. It is necessary to see the impact of the program for the preservice teachers' future in-class technology use. The purpose of this study was, under a larger longitudinal study of the preservice teacher preparation program, to understand how the preservice teacher preparation program, which requires a laptop, prepares preservice teachers, and how the program influences the teachers when they get into the PK-6 schools after graduation.

This research explored the preservice teachers' experiences during the preservice teacher preparation program with the laptops, the technology skills they practice, the technology attitudes they have, and the technological knowledge they acquire. The understanding of how the technology skills, attitude, and knowledge that the preservice teachers acquire from the preservice teacher preparation program influence the professional teaching in PK-6 schools is necessary. In addition, the information about what environmental factors, such as technological resources, human resources and school culture impact the teachers' technology use for teaching (Zhao, Pugh, Shendon & Byers, 2002) were identified to understand the contextual support from the PK-6 schools would help the understanding of the technology use of professional teachers in PK-6 schools. Briefly, this study was aimed at understanding the preservice teachers' experiences from the preservice teacher preparation program with a laptop, to explore the impact of the preservice teacher preparation program on the novice teachers' PK-6 teaching, and to understand the infrastructural context of novice teachers.

PURPOSE OF STUDY

The purpose of this research was to explore the experiences of teachers that were in the process or have already been prepared and certified as a teacher in a preparation program that requires every preservice teacher to own a laptop. This approach of

preservice teacher preparation program is referred to as a one-to-one laptop preservice teacher preparation program. The research examined teachers at different timeframes within the program and in the first novice teaching year in PK-6 schools. More specifically, this research attempted to deeply understand the teachers' experiences during the preservice program and in their PK-6 classrooms, the technology skills they have, the technology attitudes they possess, and the technological knowledge they develop. Additionally, the research explored technological infrastructures and human resources in PK-6 schools that support or challenge the novice teachers' technology integration. A set of 8 teacher case studies was conducted in a cross-sectional format in order to explore the following research questions.

RESEARCH QUESTION

The questions that guide the study are as follows:

1. How are two preservice teachers in each level (semester) of a one-to-one laptop preservice program prepared to use technology in their future PK-6 classrooms?
    a. How do technology-related skills, attitudes, and knowledge of the six preservice teachers develop and change during the program?
    b. What kind of activities and practices prepare the six preservice teachers during the program?

2. How are two novice teachers, who are the graduates of the one-to-one laptop preservice program, enabled/disabled in using technology in their PK-6 classrooms?
    a. What technology skills, attitude, and knowledge do the novice teachers have in the first year of teaching?

b. What kind of technologies do the teachers and students access in the classroom?
c. What kind of technologies do the teachers and students use in the classroom?
d. What human, technological, and infrastructural resources exist at the novice teacher's school site that support or challenge technology integration efforts?

DEFINITIONS OF TERMS

Terms that are used in this study are the following:

Preservice teachers. University students who are enrolled in the preservice teacher preparation program, which is the last three semesters of the undergraduate PK-6 teacher certification program.

Certification Students. The preservice teachers who are in the first two semesters of the preservice teacher preparation program.

Student Teachers. The preservice teachers who are in the final semester of the preservice teacher preparation program during their PK-6 student teaching experience.

Novice teachers. PK-6 teacher certification program graduates who are currently teaching in PK-6 schools, in their first through third year of teaching.

Technology integration. Infusing technology resources into the practices and performance, such as teaching, learning and management, which occurs in schools.

Chapter 2: Literature Review

The 21st century is the society of information and knowledge (UNESCO, 2008). The Internet and ubiquitous computing devices, such as smart phones, laptop computers, iPods, and tablets help people to access information and knowledge easily. The technological environment that supports and surrounds the 21st century society influences many aspects of human life, including teaching and learning in education.

Along with the development and distribution of technologies over the past two decades, considerable federal investment has supported technology equipment of the nation's K–12 schools (McMillan Culp, Honey & Mandinach, 2005). As the results of the infrastructural support, in the year of 2009, public elementary and secondary schools were equipped with various digital devices such as LCD projects (36%) or DLP projects (48%), interactive whiteboards (57%), and digital cameras (49%), nationally (Gray et al., 2009).

Schools have technological devices that teachers can use. The next step should be using the devices. The following section describes PK-6 teachers' technology integration, including issues of expectations of teachers' technology use, teachers' actual technology use, preparation of teachers for technology use, and barriers and support for teachers' technology integration.

PK-6 Teachers and Technology Integration

Teachers are expected to integrate technology into their teaching and curriculum. However, the range and kind of technology are various; moreover, there are many ways to apply these technologies. Therefore, specific guidelines are necessary to guide teachers to use technology. The following section introduces technology standards for teachers, the National Education Technology Standards for Teachers (NETS-T).

Expectations of Teachers to use Technology

The International Society for Technology in Education (ISTE) developed NETS-T. The first version of NETS-T was released in 2000, setting guides for technology integration in teaching. NETS-T 2000 described basic concepts, knowledge, skills, and attitude for teachers to infuse technology in their teaching, including a) Technology Operations and Concepts, b) Planning and Designing Learning Environments and Experiences, c) Teaching, Learning, and the Curriculum, d) Assessment and Evaluation, e) Productivity and Professional Practice, and f) Social, Ethical, Legal, and Human Issues. NETS-T asked teachers to apply the standards when they design a lesson, implement the plan into a class, and evaluate the class, as well as give modeling of technology use to students.

ISTE updated the NETS-T in 2008, due to the enormous development in technology that reflects new expectations on teachers. The standards guide teachers "when they design, implement and assess learning experience to draw in students and enhance their learning; enrich professional practice; and offer models for students, colleagues and the community" (ISTE, 2008). NETS for teachers 2008 includes five standards: a) Facilitate and inspire student learning and creativity, b) Design and develop digital-age learning experiences, c) Model digital-age work and learning, d) Promote and model digital citizenship and responsibility, and e) Engage in professional growth and leadership (Table 1).

NETS-T gives guidelines for PK-12 teachers to use technology in their teaching. ISTE published rubrics of the NETS-T to show more specific guidelines of technology integration. It is assumed that if teachers master all the NETS-T standards, then they are able to use technology effectively for teaching and learning.

Table 1. NETS-T (ISTE, 2008)

Standard	Description
1. Facilitate and inspire student learning and creativity	Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity and innovation in face-to-face and online environment
2. Design and develop digital-age learning experiences	Teachers design, develop, and evaluate authentic learning experiences and assessments incorporating contemporary tools and resources to maximize content learning in context and to develop the knowledge, skills, and attitude
3. Model digital-age work and learning	Teachers exhibit knowledge, skills, and work processes representative of an innovative professional in a global and digital society
4. Promote and model digital citizenship and responsibility	Teachers understand local and global societal issues and responsibilities in a evolving digital culture and exhibit legal and ethical behavior in their professional practices
5. Engage in professional growth and leadership	Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community

The NETS-T sets certain expectations for teachers' technology integration. These technology standards ask and help teachers to use technology in their classroom teaching. The following section describes why teachers use and how teachers use and integrate technology for educational purposes.

Teachers' Technology Use

Teachers are expected to use and integrate technologies in their teaching (DiPietro, 2004). Teachers' technology use would support the tendency of current students to use technologies in their learning and positively influence on students' learning, which would be an important reason for teachers to integrate technology. Before discussing teachers' technology use, the following section describes current students' traits and the positive influence of technologies.

Millennials, media, and learning

The PK-12 students have close attachments and relationships with media, and this feature characterizes these students (Dede, 2005). Scholars label these young people as the "Net Generation," "Millennial," and "Digital Natives." Net Generation refers to the Internet users who were born roughly between 1977 and 1997 (Tapscott, 2009). Millennials are the youth who were born after 1982 (Dede, 2005) that are characterized by use of one-to-one computing devices and information technology (Dieterle, Dede, & Schrier, 2007; McMahon & Pospisil, 2005). Digital Natives are the students who are native speakers of the digital languages of media and technology (Prensky, 2001).

In this paper, the term Millennial will be used as it defines the young people who were born after 1982 or those who are at most 28 in the year of 2010. Scholars describe that the Millennials have accessed media such as the Internet and digital devices from a very young age (Dede, 2005; Herring, 2008; Oblinger & Oblinger, 2005; Prensky, 2001; Tapscott, 2009). The Millennials' use of digital media has affected their life style. The following sections will describe the characteristics and features of the Millennials and the impact of media on the Millennials' learning.

The role of technology in the Millennials' lifestyle. Members of the Millennials have a close relationship with media and technology. Millennials have encountered with media since their birth. Millennials have accessed the Internet from a very young age and have lived with the development of digital devices such as laptops, cell phones, smart phones, MP3 players and the iPod touch age (Dede, 2005; Herring, 2008; Oblinger & Oblinger, 2005; Prensky, 2001; Tapscott, 2009). Through their interaction with the media, the Millennials have developed specific characteristics, which distinguish them from previous generations.

Characteristics of the Millennials. The previous generations, such as the Baby Boomer generation and Generation X, had access to different technologies than the Millennials (Dede, 2004). The main technology that connected the Baby Boomers to the world was television (Dede, 2004; Tapscott, 1998, 2009). Television delivered audio-visual information, creating "a real-time alternate world" (Tapscott, 2009, p. 14).

The more developed media allowed the Generation X to be connected with the world through "cable TV, digital TV, satellite TV, VCRs, video games, fax machines, microwave, pagers, cell phones, palm Pilot and most importantly the personal computers" (Lancaster & Stillman, 2002, p. 26). Personal computers let the Generation X interact with the world reciprocally. Generation X could create information and get feedback more immediately than the Baby Boomers.

The next generation, the Millennials, have the Internet technology since their young age (Tapscott, 2009). The Millennials have developed their own characteristics that reflect their interaction with the Internet and media. Technology is an essential part of the Millennials' daily lives (Bennet, Maton, & Kervin, 2008). The Millennials have interacted with media since they were very young in age and have grown up in an environment where the Internet and media have always been present (Herring, 2008; Oblinger & Oblinger, 2005; Sankey, 2006). Prensky (2001, 2005) described the Millennials as easily able to access the mobile devices such as computers, video games and digital music players, and they use those digital devices for almost their entire lives. Moreover, the computers, which are equipped with better specifications than those of Generation X's personal computers, support super-realistic video games, e-mail, instant messaging, and online communities and allow very immediate interaction with the people and information (Tapscott, 2009). We can see that the Millennials interact with others, access information, and create knowledge with advanced technologies. The Millennials

use digital devices and technology in their daily lives, and the relationship with technology is expected to impact the users in many ways.

Recent research showed the Millennials' use of media and their device ownership. Among the American teens aged 12-17, 60% of teens own a laptop or a desktop computer, 74% teens have an mp3 player, 55% own a mobile gaming device, and 93% of teens go online (Jones & Fox, 2009; Lenhart, 2009; Lenhart, Madden, Smith, & Macgill, 2007; Lenhart, Purcell, Smith & Zickuhr, 2010). More than half of teenagers aged from 12-17 own various digital devices and almost every teen uses the Internet. By owning various devices, members of the Millennials conduct various activities simultaneously, as they are described to "listen to music, talk on the cell phone, and use the computer, all at the same time" (Brown, 2000, p. 13). 77% of teens own a game console (Lenhart, 2009).

Through owning and using digital media, the Millennials are always connected to the world (Oblinger & Oblinger, 2005; Rainie, 2007), which enables immediate interaction (Carlson, 2005; Tapscott, 2009) and allows freedom of expression (Tapscott, 2009). Easy access of media permits the Millennials to seek information and judge among various information and opinions (Dede, 2005), which allows customization and personalization of information (Tapscott, 2009). Moreover, Millennials do not stop at accessing information, but redesign and tailor the accessed information to fit their individual interests and needs (Dede, 2004). Lenhart et al. (2007) reported that 26% of teens aged 12 through 17 develop new creations based on the contents they find online. The Millennials prefer collaborative and social activities, and seek individual improvement and development, which are enhanced by using technology (McMahon & Pospisil, 2005). Instant messaging, blogging, interactive online games let members in the Millennials to interact with others more immediately and easily, which naturally leads to teamwork (Oblinger & Oblinger, 2005). The Millennials perceive collaboration and

relationships as important features (Tapscott, 2009). Tapscott (2009) describes that the Millennials try to connect themselves with others through ubiquitous devices. Researchers reported that 33% of teens create or work on Webpages or blogs for interactive purposes and 73% of teens use social networking websites to be connected with other people (Lenhart et al. 2007; 2010). In addition, 38% of teens send text messages through their cell phones every day and 36% of teens make calls on their cell phones every day (Lenhart, 2009).

This section described the characteristics of the Millennials, who prefer collaboration, and use various digital media and devices. Millennials access and process information with the support of technology. The characteristics of the Millennials may affect their approaches to learning. The following section describes how the Millennials learn in the various media supported environments.

Millennials and learning. The Millennials, who use ubiquitous media, have different ways of learning. First, the learning resources that the Millennials use are visual and dynamic information (Prensky, 2001). To be connected with information and to learn, Millennial students use media and digital gadgets (Carlson, 2005; Prensky, 2001), such as Smartphone, iPod and laptop. For example, students interact and communicate with peers and teachers through e-mail, instant messaging, and text-messages (Harwood & Asal, 2007); the Millennials exploit digital stickies, calendar applications, and concept-mapping programs for organization (Levin, 2005); the members of Millennials access the Internet to search information (Harwood & Asal, 2007; Levin, 2005); students use computer technology for their reports and school projects in and out of school (Harwood & Asal, 2007; Levin, 2005).

Second, Millennials like to learn through learning-by-doing (McNeely, 2005) because the Millennials perceive that "doing is more important than knowing" (Oblinger,

2003, p. 40). The Millennials prefer to learn from experience, discovery, and exploration, which permit learners to memorize, recall and transfer information better (Oblinger & Oblinger, 2005).

Third, the Millennials are apt to choose collaboration and group activities (Oblinger, 2003; Tapscott, 2009), which increase academic conduct better than individual study or competition (Tapscott, 2009). Teamwork and helping each other as peers are common for the students (Oblinger & Oblinger, 2005). Tapscott (2009) explained that the Millennials have grown up to collaborate, share and produce together.

Technology is an important role in supporting the Millennials's learning preferences. Interactivity of technology allows students to get feedback from other students and instructors. Moreover, technologies help students to visualize abstract and complex concepts, so that they can understand them better. In addition, technology gives more opportunities to reflect and to revise, so that students are able to construct new knowledge. Furthermore, technology helps students to learn through authentic problem-based environments, as well as learning-by-doing with real world issues (Bransford, Brown, & Cocking, 2000).

Not only the students, but also the preservice teachers are the Millennials. Therefore, not only students' learning, but also future teachers' teaching would include technology use. Some PK-6 schools attempt to integrate technology in classes, thus students and teachers can use technology for the learning and teaching. The following two sections will describe the evidence of media use in PK-6 schools for students' learning and teachers' teaching.

Evidence of technology use in PK-6 schools for students' learning

Some schools, local districts and states try to support students' learning with technology in various ways. The PK-6 schools are interested in the one-to-one laptop

initiatives, providing a laptop computer and Internet access to the students for their learning at school, as well as at home (Penuel, 2006). Laptops have certain specifications that allow the use of various applications such as word processing, Internet, e-mail, and PowerPoint. Therefore, owning a laptop is expected to increase students' use of media and their learning. Schools have tried to create ubiquitous environments for students through the one-to-one computing program.

Starting from the state of Maine, more states, districts, and schools have infused the one-to-one laptop initiatives. To find and to explore the impact of using technology for students' learning, researchers conducted studies on one-to-one laptop programs in PK-12 schools. Gulek and Demitras (2005) studied the Laptop Immersion Program situated in the Harvest Park Middle School and described the impact of the program. The Harvest Park Middle School in California established a Laptop Immersion Program in 2001, which was sponsored by a high-tech business in the district. All the students who joined in this program were required to own a laptop. Under the Laptop Immersion Program, an initial course, a computer camp, was developed. The computer camp was not mandatory, and only volunteered students participated. The computer camp instructed the students about basic information for using computers, such as the functions of a computer, navigation and operation of a laptop, and the installation of software in the computer. Moreover, the students were introduced about regulations and expectations of laptop use in classes. After this computer camp, students used the laptop everyday in their school year. Students used laptops in various ways in the classroom, including searching for information on the World Wide Web, developing PowerPoint presentations, developing website and taking notes. A comparison research was conducted with the students who joined the camp and other students who did not. Results from all of the

measurements revealed that the students who used laptops achieved higher GPAs than students who did not.

Silvernail and Harris (2003) identified the effects of the one-to-one laptop initiative with the report of the Maine Education Policy Research institute (MEPRI). MEPRI evaluated the effects of the Laptop initiative through interviews and surveys with students. In this research, nine exploration schools and seven comparison schools participated, and twenty-three classes were observed. The results showed that the laptop use gave positive impacts on students' learning. Students showed increased engagement and attendance, and decreased behavior referrals. Students' technology use in classrooms was dramatically raised. In addition to the quantitative research, a case study was conducted. The researchers compared the two groups of students; one participated in the Laptop initiative program and the other who did not. The results showed that the students who accessed laptops had a significantly more positive attitude toward school and scored higher on computer skills and self-concept than the other students who did not participate in the laptop initiative program.

Zucker and McGhee (2005) described how laptops influenced high school students' learning. Henrico County Public Schools in Virginia State implemented one-to-one computing in 2001 in the middle and high schools in the district. Since 2001, more than 25,000 teachers and students in grades 6-12 have participated in the one-to-one computing. Each teacher and student had his/her own laptop computer. Henrico County Public Schools supported laptop integration and use in classes and schools by connecting to the wireless Internet network, installing hardware and software, and providing professional technology development. Based on the assistance of various media, teachers and students utilized laptops and media for teaching and learning in classes. To identify the impacts of the one-to-one computing initiative on students' learning, Zucker and

McGhee (2005) conducted a qualitative research by interviewing students, teachers and parents, throughout 2003 and 2004. The researchers reported that there were positive impacts from laptop integration on teaching and learning with the following results; a) students had more access to external information and resources, and up-to-date instructional content as well; b) students had more motivation, curiosity and engagement for learning; c) students performed more self-directed learning; d) students interacted with teachers more; and e) students were better organized with learning resources (Zucker & McGhee, 2005).

Researchers presented evidence and examples of the positive influence of media on students' learning. Activities with the one-to-one laptop had positive influences on students' learning. Schools and districts implemented the one-to-one laptop initiative, which affected various aspects of students' learning (Zucker & McGhee, 2005). In addition, students who participated in the one-to-one laptop program scored higher on tests than the students who did not participate in the laptop program, which testified to the positive impact of technology use. This means using media for learning in classroom can be encouraged in wider PK-12 schools.

Students that current PK-12 teachers encounter are the Millennials, who prefer to use technology for their learning when available. Technologies have positive impact on learning (Gulek & Demitras, 2005; Silvernail & Harris, 2003; Zucker & McGhee, 2005). Additionally, society demands students to be prepared to use technology (P21, 2004; UNESCO, 2008). These needs influence PK-12 schools to prepare teachers to teach students to use technology, which means teachers should know about and be prepared to use technology. The next section describes previous research about teachers' technology use.

Previous research about teachers' technology use

NCES (2000) presented quantified data about teachers' technology use in PK-6 classes. According to the results, approximately 80% of inservice teachers used technology to develop instructional material. About half of teachers used computer to manage administrative records. Nearly 53% of teachers used computers for delivering instruction. Roughly 50% of teachers used e-mail for instructional purposes. Moreover, one fifth of teachers used the Internet for posting assignments.

Researchers identified teachers' use of technology in class. For example, Russell, Bebell, O'Dwyer, and O'Conner (2003) administered a survey to see what technologies were used frequently by the inservice teachers. 2,894 inservice teachers who work in PK-6 schools in Massachusetts completed the survey. Teachers' technology use from most frequent to least was listed. The research did not indicate percentage of use, but the approximate frequency table was presented. Teachers' purpose for technology use from most frequent to least is the following: a) class preparation b) e-mail use, c) teacher-directed student use, d) recording of grades, e) delivery and f) special education and accommodation.

Christensen and Knezek (2006) identified teachers' use of technology with a total of 659 teachers from four schools. The Stages of adoption survey identified the teachers' personal perceptions on levels of technology adoption in teaching. There were eight different strategies, and teachers were asked to check the frequency of the use of such strategies in class. The results showed that most of the teachers (35.9%) used the computer for small group projects or presentations once a month. In addition, most of the teachers used the computer for whole class teaching (37.1%), direct teaching/lecturing (42.2%), analyzing and interpreting information (33.3%), and organizing, summarizing, or displaying information (34.4%) once a week. The three strategies most of the teachers

used were guiding/facilitating student learning, cooperative learning, and specific TEKS (Texas Essential Knowledge and Skills) instruction every day. Teachers who participated in this research indicated the frequency of computer use in class for instructional purposes. 3.3% of the teachers never used the computer, and 11.7% of the teachers used the computer once a month. 30.0% of the teachers used the computer once a week and 55.0% of the teachers used the computer every day in their classrooms for instructional purposes.

Gray, Thomas, and Lewis (2009) reported the technology infrastructure in schools and teachers' technology use. 97% of teachers had computers in their classrooms. 93% percent of the computers had Internet access. 29% of teachers reported that they or their students often used computers during instruction time. 36% of teachers reported that they had LCD projectors in the classroom. 48% of teachers reported that they had DLP projectors in the classroom. 72% of teachers often or sometimes used LCD or DLP projectors for their instruction. 23% of teachers had interactive whiteboards in their classrooms. 57% of teachers used interactive whiteboards for their instruction. 14% of teachers had digital cameras in their classrooms. 49% of teachers used digital cameras for their instruction. Teachers reported that their school systems were available with online data such as grades (94%), attendance (93%), and students' assessments (90%). Teachers reported that they used word processing (96%), spreadsheets (61%), students' record managing applications (80%), PowerPoint (63%), and the Internet (94%) for administrative purposes.

However, researchers reported that teaching in PK-12 schools has remained unchanged even with the technology integration (Cuban, 2001; Norris, Sullivan, Poirot, & Soloway, 2003; Sandholtz & Reilly, 2004). Cuban described that high schools, which were well equipped with technology, did not use technology as much as expected

(Cuban, 2001). Some researchers reported that lack of teachers' technology use in class is highly related their technology preparation (Frank et al., 2004; NCES, 2000). Without technology experiences and preparation, we cannot expect teachers to have prepared technology skills and knowledge and to use technology in teaching. Teacher preparation is important, as how teachers are prepared with technology influences teachers' technology integration (Frank et al., 2004; NCES, 2000). The next section describes areas of teacher preparation.

Preparing Teachers to Integrate Technology

The three important areas for teachers to acquire are knowledge, skills, and attitude of teaching (Darling-Hammond & Bransford, 2005). The three areas can be applied to technology skills, attitude and knowledge, as the areas that teachers should have to integrate technology. This section describes technology attitude, technology skills, and Technological Pedagogical Content Knowledge (TPACK).

Teachers' attitude and technology integration

Attitude is defined as a "predisposition to respond positively or negatively to things, people, events or ideas" (Simpson, Koballa, Oliver & Crawley, 1994, p. 212). Attitude is an identical concept in the issue of teachers' technology integration in the history of technology use in education (Brinkerhoff, 2006; Cassidy & Eachus, 2002; Hardy, 1998; MacArthur & Malouf, 1991; Zhao & Conway, 1999). Teachers' technology attitude was identified as a key factor related with technology integration (Bitner & Bitner, 2002; Demetriadis, Molohides, Palaigeorgiou, Psillos, Vlahavas, Tsoukalas, & Pombortsis, 2003; Mumtaz, 2000; Zhao & Conway, 2003). Previous studies revealed that teachers' technology attitudes impact their technology integration in instruction.

Leis (2006) investigated teachers' technology integration in curriculum and found a significant statistical relationship between teachers' technology attitude and their use of technology in classes. This study explored the factors that affect teachers' technology adoption in teaching. A total of 179 inservice teachers participated in this study. To collect data, mixed methods were conducted, including surveys and interviews. The results showed that the teachers who had positive technology attitude used technology more frequently than the teachers who had negative attitude. In addition, teachers with positive attitude perceived that using technology in class brought positive influences on students' learning.

Demetriadis et al. (2003) explored teachers' experiences from the post-graduate professional development program. This teacher preparation program provided 300 hours of lessons based on technological knowledge and pedagogical knowledge. The teachers participated in lectures, lab-sessions, group discussions, and collaborative projects to learn technology integration. Teachers also had partnerships with mentors in which they collaborated together. Under this setting, this study focused on teachers' attitude on the acceptance/resistance of media and the relationship between attitude and technology integration. The main data was participating teachers' reports, which were submitted regularly. The results showed that the teachers who had positive attitude were more likely to integrate technology into teaching.

Cox, Preston, and Cox (1999) conducted research to explore the relationship between teachers' attitude on technology and technology integration. To collect data, a questionnaire was designed to ask teachers about their experiences of technology use, expertise and attitudes, and prior experience of training. A total of 72 teachers who use technology in their classes participated in the research. The results showed that the

teachers who had positive attitude for media use perceived technology integration in teaching as valuable.

Research shows that teachers who have positive technology attitudes use technology more frequently. Overall, technology attitude seems to influence teachers' perception on the value of technology integration and/or their inclination to actually integrate technology into their teaching. Teacher's likelihood to integrate technology seems to be possibly measured, in part, by their attitude towards technology.

Teachers' technology skills

To integrate technology, teachers have to have technological skills. Researchers describe the positive influence of technological skills on technology integration in the class. Wright and Lesisko (2008) conducted a case study in the Granite Rock School District. The survey was administered to collect data from the 410 teachers who work in the school district. The survey asked about technology proficiency levels, level of understanding technology, and technology integration in classes. The researchers conducted a correlation analysis to see the correlation between the level of skills and technology integration. The results reported that teachers' skill level was positively correlated with technology integration in class. In addition, personal use of technology was positively correlated with technology integration in class.

Rakes, Fields, and Cox (2006) administered a survey to 186 teachers who teach 4th and 8th graders from 36 schools. The survey included the level of technology implementation, personal computer use, and current instructional practice. The research found the relationship between teachers' current skills and technology integration through multiple regression analyses. The results reported that there was a significant linear relationship between teachers' current skills and technology integration. Therefore, teachers' current skills could predict the level of technology integration in teaching.

Technology knowledge: Technological Pedagogical Content Knowledge (TPACK)

Recently, there has been a strong emphasis on teachers' awareness on knowledge of decision making in the integration of technology (Angeli & Valanides, 2005; Hughes, 2005; Mishra & Koehler, 2006). The Technological Pedagogical Content Knowledge (TPACK) framework explains the knowledge that teachers use to integrate technology.

Teaching is a complex task that depends on various kinds of knowledge, and there are various knowledge systems that are fundamental for teaching. Among those, two areas of knowledge are focused as the foundation knowledge for teachers: pedagogical knowledge and content knowledge (Shulman, 1986). Based on these areas of knowledge, Shulman (1986) theorizes the Pedagogical Content Knowledge (PCK). Content (C) refers to the subject matters that teachers teach and students learn. Pedagogy (P) is the collected practices, processes, strategies, procedures, and methods of teaching and learning. PCK is not just a combination of content knowledge and pedagogical knowledge, but also a construct (Shulman, 1986). PCK represents "the blending of content and pedagogy into an understanding of how particular aspects of subject matter are organized, adapted, and represented for instruction" (Mishra & Koehler, 2006 p. 1021). Therefore, PCK goes beyond the knowledge of subject matter and knowledge for teaching (Shulman, 1986 and 1987).

The construct of PCK is extended to understand the knowledge of the educational use of technology with the continuous development of technology in schools and the active applications of digital devices, (Angeli & Valanides, 2009; Mishra & Koehler, 2006). This new form is called the Technological Pedagogical Content Knowledge, TPACK (Mishra & Koehler, 2006). Technology (T) means modern technologies, such as computers, Internet, and various applications, which include peripheral devices, such as LCD projectors and digital camcorders, and commonplace technologies that include

blackboards and books (Koehler & Mishra, 2005). In a new area, technology is identified by four different types that include technology knowledge (TK), technology pedagogical knowledge (TPK), technology content knowledge (TCK), and technology pedagogical content knowledge (TPACK) (Hughes, 2000, 2005, and 2008). TK is about both the traditional technology and the more recent technology. TK includes skills and knowledge that help to operate technology. TCK explains that technology and subject matter correspond to each other. Therefore, teachers are required to know the content as well as the conditions under which the subject matter can be changed by the technology application in class. TPK is the "knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and knowing how teaching might change as the result of using particular technologies (Mishra & Koehler, 2006). TPACK is the form of knowledge, which is anchored in the interactions between the content, pedagogy, and technology, and therefore this model is required to use technology when technology is integrated in teaching and learning (Koehler, Mishra & Yahya, 2007). Figure 1 shows the interaction of the three knowledge areas.

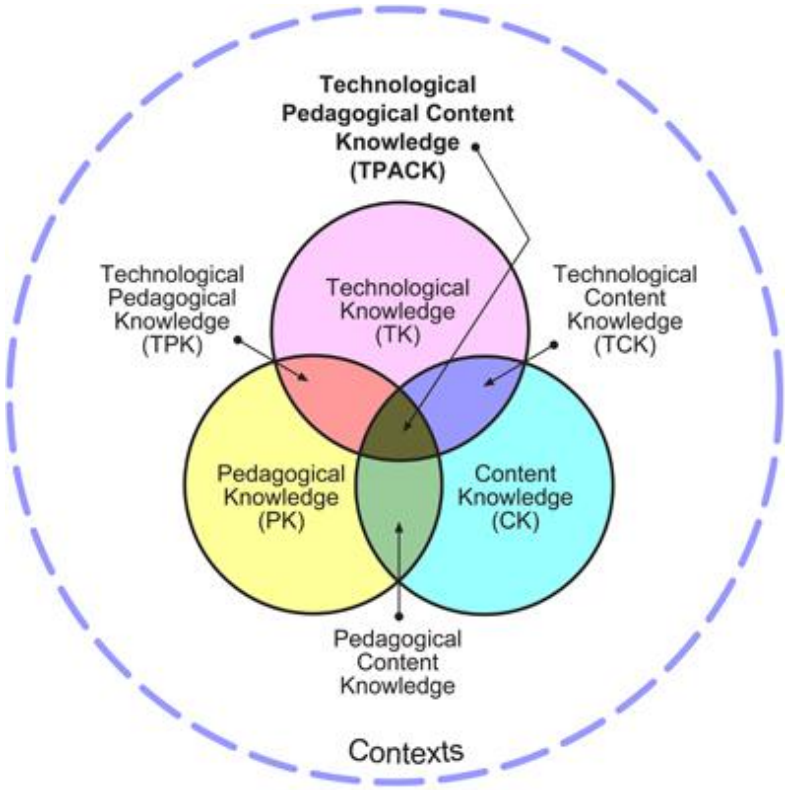

Figure 1. TPACK (tpack.org)[1]

TPACK explains how the sums and components of knowledge support the teachers' decision–making when teachers start to consider innovative ways of technology use for instruction (Cavin & Fernandez, 2007; Hughes, 2004, 2005; Niess, Suharwoto, Lee, & Sadri, 2006). Researchers showed that teachers' TPACK development was followed by their reflection, belief, attitude and application of technology (Hughes, 2005; Koehler et al., 2007; Neiss et al, 2006).

Researchers have tried to assess the development of TPACK. Angeli and Valanides (2009) have created five criteria to assess preservice teachers' TPACK with

[1] The TPACK framework is the result of an on-going design experiment being conducted by Matt Koehler & Punya Mishra and has involved many other people as well (co-conspirators include Kathryn Hershey, Lisa Peruski, Aman Yadav, Kurnia Yahya, and Yong Zhao). The users are free to use and reproduce this version of the image in your own non-profit works, including dissertations.

their lesson plans. Each criterion in the rubric is scored from 0 to 5, and the score of the TPACK of preservice teachers can range from 0 to 25.

Schmidt, Baran, Thompson, Mishra, Koehler, and Shin (2009) conducted a study to understand how preservice teachers develop TPACK through an introductory technology course. The course used the TPACK as a theoretical frame. A total 100 preservice teachers submitted TPACK survey for pre-test and post-test. Results indicated that the preservice teachers statistically significant gained in all seven TPACK components. Technology Knowledge (TK), technological content knowledge (TCK) and technological pedagogical knowledge (TPACK) were the largest developed areas.

Researchers have tried to develop a measurement for TPACK (Angeli & Valanides, 2009; Archambault, & Crippen, 2009; Schmidt, Baran Sahin, Thompson, & Seymour, 2008) and TPACK standards (Niess, Ronau, Shafer, Driskell, Harper, Johnston, Browning, Özgün-Koca, & Kersaint, 2009). However, there is still no standardized TPACK measurement tool that can be universally used or is statistically and theoretically valid. For more accurate evaluation of teachers' TPACK, developing TPACK assessment instrument is necessary.

Barriers and Supports to Technology Integration

Even if the teacher possesses positive technology attitude, technology skills, and deep TPACK, teachers still work within a school context that has conditions that may impact their technology integration efforts. Zhao et al. (2002) identified that teachers felt they needed more external support from school. The conditions such as technology resources, the current culture of schooling, reliability of technology, and quality of educational software impact teachers' efforts. Abate (2006) discovered that access to technology and organizational support of technology use were the main barriers that the teachers encountered.

To help teachers to maximize their technology integration, external factors should be equipped. Zhao et al. (2002) identified that the school context surrounding teachers is one of the core factors for classroom technology innovation. To build encouraging context for teachers' technology infusion, three factors should be satisfied: technological infrastructure, social support, and human infrastructure. Technology infrastructure consists of arranged devices and hard/software that could be accessed remotely from existing technological resources by teachers. Mumtaz (2000) supported the importance of technology infrastructure in technology integration, reporting that teachers reflected that the lack of device availability prevented the technology integration. Social support means peers' support of teachers' innovation. Teachers need systematic human infrastructure. Demetriadis et al. (2003) reported that the role and attitude of the principal influenced teachers' technology integration in classes. That is, a principal's positive attitude increases teachers' technology use in class, but if a principal has a negative attitude that prevents teachers' technology integration. Human infrastructure comprises an adaptable and reactive technical staff, knowledgeable and communicative staffs that help the teacher understand and use technologies based on their classrooms' needs, supportive and informed administrative staff, and institutionalized policies and procedures related to technological issues (Zhao et al. 2002). In order to support teachers' technology integration, technological infrastructure, social support and human infrastructure should be provided. Lack of resources around teachers and in schools would impede teachers' technology integration. It is necessary to identify the teachers' external conditions and provide support for missing parts.

TECHNOLOGY INTEGRATED PRESERVICE TEACHER PREPARATION

Society requires more teachers who are capable of integrating technology in classes. To produce more capable teachers who can infuse technology in instruction,

colleges of education have developed preservice teacher preparation programs to include technology integration preparation. The preservice teacher preparation program includes technology integration in the courses, as well as technological support, so that preservice teachers are able to follow a model of how instructors use technology.

The preservice teacher preparation program tries to prepare preservice teachers with technological attitude, skills, and knowledge. To teach technology integration, the preservice teacher preparation program uses various approaches, such as workshops, single-courses, and modeling. A workshop is a short-term, specific skill based activity. A single-course approach is one-semester long course to give a wide range of basic technology skills. Modeling is teaching technology integration from instructors' technology integration in classes (Kay, 2006). Some preservice teacher preparation programs are technology integrated to prepare preservice teachers with technology. The next part describes how the preservice teacher preparation programs prepare preservice teachers with technology.

Many novice teachers teach as they learn (Lortie, 1975; Pierson, 2001). Therefore, it is important for preservice teachers to be shown examples of how to infuse technology in teaching and learning while they are learning to teach in a preservice teacher preparation program. For example, Duran, Fossum and Luera (2006) introduced the Michigan Teachers' Technology Education Network, MITTEN. MITTEN is three-year long teacher preparation program with technology integration. Teacher candidates learn subject matter knowledge, technology integration and pedagogical knowledge from coursework, as well as their instructors' modeling in class. The knowledge is elaborated with field experience in local schools. Throughout the MITTEN program, the preservice teachers are able to use advanced technology tools in the local schools. Preservice teachers who participated in MITTEN showed positive performances. First, preservice

teachers had more confidence in using technology. Second, the participants' competence to use advanced technology increased. Third, preservice teachers integrated more technology into the lesson plans. Moreover, the participants exchanged more ideas, interacted more with other people, and developed sense of community.

The technology integrated approach emphasizes the impact of instructors' modeling and guide for preservice teachers' technology integration, but this may be achieved more effectively when the students are equipped with technology (Resta et al., 2004). One-to-one laptop integrated preservice teacher preparation program endeavors to better preparation of preservice teachers with technology. For example, preservice teachers in The University of Texas at Austin engage in the teacher preparation program, Laptop Initiative for Future Educators (LIFE). This program is based on the theory that teachers will not be prepared well without proper modeling of how to integrate technology into teaching. Therefore, the LIFE program focuses on faculty's demonstration of infusing laptops into their courses (Tothero, 2005) while students are required to have individual laptops. Instructors show how to use technology in classes, and preservice teachers observe the instructors use and learn how to use technology in their future teaching. The preservice teachers participate in the student teaching in the local PK-6 schools. While they teach, various aspects of teaching are assessed by their faculty, and technology use is one of the important factors that are assessed. However, even though the program has quite a long history, few research studies exist (Bin-Taleb, 2005; Rowland, 2008; Scott, 2005).

Technology-integrated preservice teacher preparation programs try to support preservice teachers with a technology-rich environment and certify preservice teachers to have the competence to integrate new technologies (Bin-Taleb, 2005; Resta et al., 2004; Scott, 2005). When technology is integrated across a program, faculty can model

technology integration. Therefore, preservice teachers can observe technology integration closely. A technology-integrated approach is helpful for the experts of the subject matter to focus on the pedagogical content knowledge and technology together (Gillingham & Topper, 1999). Furthermore, the technology-integrated preservice teacher preparation program is able to give realistic and meaningful experiences and problem solving insights for preservice teachers (Doering et al., 2003). However, technology-integrated preservice teacher preparation programs have issues. First, limited faculty expertise and time (Eifler et al., 2001; Whetstone & Carr-Chellman, 2001) influences the effectiveness of the program. Though faculty's technology use and technology skill have increased (Friedman, Bolick, Berson, & Porfeli; 2009), we still observe that faculty's adoption of technology is somewhat slow (Friel, Britten, Compton, Peak, Schoch, & VanTyle, 2009). In addition, the difficulty of transferring what is learned at the university to field experience in the PK-6 classroom is another issue (Brush, Glazewski, Rutowski, Berg, Stromfors, Van-Nest, Stock, & Sutton, 2003; Eifler et al., 2001).

This section depicted some examples of technology-integrated preservice teacher preparation programs. Usually, the preservice teacher preparation program takes several semesters. Therefore, to see the effectiveness of the program, longitudinal research is necessary. However, no longitudinal studies of preservice into inservice teaching have been conducted regarding technology integration. Moreover, the impact of the preservice teacher preparation program with technology in the PK-6 teaching has not been studied extensively. Research about the effectiveness of the technology-integrated preservice teacher preparation program and the longitudinal impact of the program on the PK-6 teaching is necessary.

RESEARCH QUESTIONS

This research was conducted to understand the effectiveness and the impact of one technology-integrated preservice teacher preparation program. The research questions that guided this study are:

1. How are two preservice teachers in each level (semester) of a one-to-one laptop preservice program prepared to use technology in their future PK-6 classrooms?
    a. How do technology-related skills, attitudes, and knowledge of the six preservice teachers develop and change during the program?
    b. What kind of activities and practices prepare the six preservice teachers during the program?

2. How are two novice teachers, who are the graduates of the one-to-one laptop preservice program, enabled/disabled in using technology in their PK-6 classrooms?
    a. What technology skills, attitude, and knowledge do the novice teachers have in the first year of teaching?
    b. What kind of technologies do the teachers and students access in the classroom?
    c. What kind of technologies do the teachers and students use in the classroom?
    d. What human, technological, and infrastructural resources exist at the novice teacher's school site that support or challenge technology integration efforts?

POTENTIAL SIGNIFICANCE OF THE STUDY

The setting of this study was a technology-integrated preservice teacher preparation program with one-to-one computing required throughout. The one-to-one computing preservice programs are still rare in the preservice teacher preparation programs in U.S. Therefore, more research is necessary to understand these programs. In addition, there is research about preservice teachers' technology preparation and inservice teachers' technology use. Moreover, there is longitudinal research about the technology-integrated preservice teacher preparation program (Harrell & Harris, 2006; Rutledge, Duran & Carroll-Miranda, 2007). However, there are a few longitudinal studies of preservice development to see how novice teachers apply their knowledge (Abate, 2006). Therefore, this study examined a technology-integrated preservice teacher preparation program with one-to-one computing to understand what happened throughout the program and beyond using a cross-sectional study in the year of 2010.

This research discovered how the preservice teacher preparation program, which requires laptop prepares preservice teachers to use technology. In addition, the findings of this study may help change the current program, if needed. Moreover, this research would help other preservice teacher programs to develop similar programs.

Chapter 3. Methods

SETTING

The setting of this study was a preservice teacher preparation program that involves one-to-one computing throughout in a college of education in a large southwestern university. The preservice teacher preparation program is a special period for the preservice teachers to be prepared more professionally for future teaching. This university's one-to-one laptop program was established in 2002. The period of the preservice teacher preparation is from two to five semesters, varying for each field of certification. The certification area that participated in this study was early childhood through 6th grade, a three-semester long program.

This program requires each student to have his or her own laptop during the preservice teacher preparation program for use in learning and teaching in the university and for use in field experiences and student teaching in PK-6 classes. All students who are engaged in this program have been required to have a laptop computer, such as an Apple iBook, PowerBook, MacBook or MacBook Pro, with specific hardware and software, such as MS Office 2004 or 2008, iLife '06, '08 or '09 and anti-virus software.

This preservice teacher program that involves one-to-one computing offers instructions and opportunities to the future teachers to develop proficiency in the use of technology to teach students in the future classes. The program is based on the theory that teachers will not be prepared well without the modeling of how to integrate technology in teaching. Therefore, this preservice teacher preparation program requiring one-to-one laptop focuses on the faculty's demonstration of infusing the laptop into their classes. During the preservice teacher preparation program, preservice teachers enroll in courses that are closely related to professional instruction and subject matter.

In addition, this preparation program includes experiences in PK-6 classrooms for preservice teachers. The certification students, the preservice teachers who are in their first and second semester of the preparation program, and the student teachers, the preservice teachers in the last semester of the program, are required to participate in field experience and in student teaching at local PK-6 schools

To support preservice teachers' technology use and learning, a technology learning center in the college of education helps preservice teachers with technological difficulties and issues and lends digital devices that the preservice teachers need to use for their learning, such as digital camcorders and digital cameras. Moreover, the preservice teachers can receive orientations about the laptop they use during the preservice teacher preparation program and about the new technologies for teaching and learning from the staff of technology center.

CROSS SECTIONAL CASE STUDY

Case Study

The study used a case study design. A case is a "single instance of a bounded system" (Cohen, Manion & Morrison, 2006, p. 253) and a "specific, complex, functioning thing" (Stake, 1995, p.2). A case can be a person, a classroom, a school or an educational system. A case is selected as it reveals attributes of the phenomena in which the researcher is interested (Merriam, 2002).

Hancock and Algozzine (2006) defined a case study as "a detailed analysis of a person or group, especially as a model of medical, psychiatric, psychological, or social phenomena " (p. 85). According to Yin (2003), a case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (p.13). A case

study examines a case, which is an active and ongoing phenomenon, in order to understand it deeper. Therefore, a case study was proper for this research. I wanted to investigate how the preservice teacher preparation program prepares the preservice teachers and how the graduates of the program use technology in the PK-6 classes. Therefore, as reflected in research question shows, the research pursued the complex phenomena of preservice teacher preparation, the impact of the phenomena on novice teachers' technology integration in PK-6 classes. A case study helped me to investigate various experiences of each participant in the real context.

Cross Sectional Study

A cross sectional study examines a snapshot of phenomena, data sources or participants at a certain point of time (Cohen et al., 2006). Even though the cross sectional study is conducted at a particular point of time, this study proposed to understand what happens over time (Babbie, 2009). A cross sectional study can select parallel groups or participants that are categorized from the population at the same time, so that this study has the hallmarks of a longitudinal study (Cohen et al, 2006).

In this study, cross-sectional and case study methodology were combined to enact a cross sectional case study, targeting participants at different points in time in technological preparation and application/integration. Therefore, in this study, the same number of preservice teachers was selected by each academic semester of the program and the same number of novice teachers in their first year of professional teaching experience participated in this research.

PARTICIPANTS

The participants of this cross sectional case study included preservice teachers in the preparation program and novice teachers who had graduated from the same program.

This research was related to a larger longitudinal research study of the preservice teacher preparation program with the one-to-one laptop initiatives. Therefore, the preservice teacher participants for this cross sectional case study were selected from the participant pool of the longitudinal study of preservice teacher preparation.

Since Fall 2008, the larger longitudinal research study conducted by Dr. Joan E. Hughes (e.g., Hughes, Accepted; Hughes, Gonzales, Wen, & Yoon, 2012) has invited preservice teachers to participate in various research activities. To recruit the participants, Hughes and co-researchers visited orientations for the preservice teachers who started the first semester of the preservice teacher preparation program and gave a short explanation about the research. After the description of the research, the researcher distributed consent forms to ask for all the preservice teachers in the orientation to consider participating in a range of research activities for longitudinal study. Some participants for this cross sectional study emerged from those who had already consented for the longitudinal research study.

All the participants for this study enrolled in the certificate area Early Childhood to Sixth Grade Certification, EC-6. EC-6 is the largest certification area in the preservice teacher preparation program. EC-6 administers a three-semester-long preservice teacher preparation program. All the preservice teachers are required to enroll in different credit hours of classes that are related to preservice teacher preparation programs each semester and to partake in different hours of experiences in PK-6 schools. The certification students in the first semester of the program need to take 15 credit hours of coursework that are required for the program and 12-14 hours of field experience. The certification students in the second semester of the program are required to take 12 hours of coursework and 16 hours of field experience. The student teachers take 12 hours of coursework and 40 hours of student teaching experience in their last semester of the

program. The following table shows the specific hours of classes and PK-6 school experiences.

Table 2. EC-6 Preservice Teachers' University Course and Field Experience Hours

	Total Credit hours of coursework	**PK-6 Experience (hours/type)**
First semester	15	12-14/ Field Experience
Second Semester	12	16/ Field Experience
Third Semester	12	40/Student Teaching

To recruit participants, I contacted preservice teachers who consented to participate in the larger research study. From each semester, only two preservice teachers replied back to me, saying they could participate in the research, joining all the data collection activities I requested.

I recruited the novice teachers in the first professional teaching year. First year novice teachers had already consented to continue in the research after graduation. I contacted the novice teachers who had agreed to continue participating after their graduation. Among those novice teachers who I contacted, two replied to participate in the research. Therefore, a total of eight teacher (preservice and novice) cases participated in this cross sectional study (See Table 3).

Table 3. Number of Participants

Certificate Area	**EC-6**			
Status of teachers	**Preservice**			**Novice**
Level	**1st Semester**	**2nd Semester**	**3rd Semester**	**1st Year**
Number of Participant cases	2	2	2	2

DATA SOURCES AND DATA COLLECTION

Various data sources were collected: a) technological skills and attitude survey, b) related documents such as lesson plans, assignments and school documents, c) observation, and d) interviews. The following table provides short description about the

instruments (See Table 4). Additionally, the specific data collection schedule and timeline is presented in Appendix I. Data collection occurred between September, 2010 and January, 2011.

Table 4. Necessary data and the data collection instruments

Participants / Instruments		Preservice teachers			Novice Teachers
		1st semester	2nd semester	3rd semester	
Preservice Teacher Survey		√		√	
Novice teacher Survey					√
TPACK Survey		√	√	√	√
Documents	Instructors' Syllabi	√	√	√	
	Lesson Plan	√	√	√	√
Observation		√	√	√	
Interview		√	√	√	√

Note: "√" indicates the instrument was used to collect data from the marked participants.

Surveys

Preservice teachers and novice teachers shared their data through a Technology Skills and Attitude survey and a TPACK survey.

The technology skills and attitude survey

The first-semester preservice teachers and student teachers took the survey. The first semester preservice teachers took the survey in the first two weeks of the first semester of the program. The student teachers took the survey in the last two weeks of the end of the semester, as is planned with the longitudinal study. Novice teachers took the survey in the end of the semester in which this study was conducted.

The preservice teacher participants and novice teacher participants took slightly different Technology Skills and Attitude survey. The preservice teacher survey (Appendix A) includes the following parts: Digital technology self-efficacy, learning technology attitude, and technology skills. The survey for the novice teachers (Appendix

B) includes the same three parts and has an extra section for technological resources from the school. Table 5 shows the sections that the preservice teacher survey and novice teacher survey have.

Table 5. Preservice teacher survey and novice teacher survey sections

	Preservice Teacher Survey	Novice Teacher Survey
Digital Technology Self Efficacy	√	√
Learning Technology Attitude	√	√
Technology Skills	√	√
Technological Resources from School		√

Note: "√" indicates the survey includes marked sections.

Digital technology self-efficacy. The digital technology self-efficacy is a modified version of Holcomb, King, & Brown (2004). The term "computers" was changed to "digital technologies." Digital technology refers to electronic computers, computer software, and handheld computing devices that convert, store, protect, process, transmit, and securely retrieve information. Internal reliability, as measured by Cronbach's alpha, was .96, which is high.

Learning technology attitude. The learning technology attitude section asks about participants' perception of learning technology. Learning technology is becoming fluent with an array of electronic computers, computer software, and handheld computing devices tools that might assist in student learning. The learning technology attitude section is from Brinkerhoff (2006). Internal reliability, as measured by Cronbach's alpha, was .82, which is high.

Technological skills. The technological skills section includes communication activities, web activities, productivity activities, creation activities, and education-specific activities. This section consists of collecting data about frequency, purpose (personal or educational), and skill level of technology use based on the technology activities.

In the novice teacher survey, the skills questions are also categorized as communication activities, web activities, productivity activities, creation activities and education-specific activities, which have lists of certain activities that are related with each of the categories of technology. This section consists of collecting data about frequency, purpose (personal or educational), and skill level of technology use based on the technology activities. The novice teacher survey skills section additionally asks students' performance of technology activities, projected by the novice teachers.

Technological resources from school. Only the novice teacher survey included this section. This section explores the resources that exist at the novice teachers' schools. The resources from school section asks about the support or challenges that the novice teachers encounter from PK-6 schools such as issues with technological infrastructure (facility, equipment, and Internet network), human infrastructure (support staff and institutionalize policies and procedures about technology access), and organizational support (peer support) (Zhao et al. 2002). Survey items were created based on the context part of individualized inventory for integrating instructional innovation that Groff and Mouza (2008) created. This individualized inventory for integrating instructional innovation is developed from the framework of barriers of technology integration that has been studied by Zhao et al. (2002). The original inventory includes school context, teachers, projects, and students, but in this survey, only school context is included to collect information about infrastructural support from PK-6 schools.

TPACK Survey

The TPACK survey (Appendix C) collected preservice and novice teachers' TPACK data. This survey asks the preservice and novice teachers to reflect their lesson plan experience, to describe issues of pedagogy, content/subject matter and technology that they thought about while they developed the lesson plan as well as to describe how

well the lesson plan was enacted. The TPACK survey was administered in the end of the semester.

Documents

The second data source was documents, which includes lesson plans from preservice teachers and novice teachers, and instructors' syllabi from classes in which preservice teachers were enrolled. Preservice teachers and novice teachers submitted a technology-supported lesson plan when they completed the TPACK survey. The lesson plan was expected to provide a view of how the preservice teachers and novice teachers integrate technology into their lessons, which would provide an understanding about TPACK of preservice and novice teachers.

The syllabi of applicable preservice courses were collected. Instructors' syllabi include the information about how the instructors teach content and how they integrate technology in preparing preservice teachers professionally. The syllabi showed the preservice teachers experience within the class and described the performance during the preservice teacher preparation program. By law, all undergraduate syllabi should be publically available on the department website on the first class day of each semester.

Observation

The third type of data was observation. I observed preservice teachers in university classes and student teachers' PK-6 teaching experiences, once, respectively. I used an observation protocol (Appendix D) during the observation.

During the observation, I wrote observation notes. I sat at an appropriate distance from the participant to observe the activities and performance of each participating preservice teachers. The appendix E is the example of the observation note.

Interview

I conducted a face-to-face interview with each preservice teacher at the end of the semester to collect data from the preservice participants to hear their experiences from the program.

I conducted email and phone interview with the novice teachers about their experiences from the PK-6 schools. I interviewed the novice teachers twice, in the middle of the semester and in the end of semester. I used the interview protocol (Appendix F and G) during the interview with all of the participants.

IRB

Briefly, the data collection methods that were used in this study were a) preservice teacher survey, b) preservice teacher interview, c) preservice teacher classroom observation both in university classes and PK-6 classes as chosen by participants, d) novice teacher survey, e) novice teacher interview, f) TPACK survey for preservice and novice teachers, and g) documents such as syllabi from preservice teachers, novice teachers and university class instructors', and technology related documents from PK-6 schools. All of the processes and instruments were approved by the Institutional Review Board at The University of Texas at Austin.

DATA ANALYSIS

Each teacher participant case's data was analyzed in the following ways. I analyzed data (see below) and developed each participant case report. After all individual case reports were completed, I analyzed cross-cases for meaningful patterns that address the case: technology preparation and application/integration in this one-to-one computing setting.

Technology skills

The technology skills data were drawn from the technology skill section in the survey, the observation, and the interview. The technology skills section of the survey includes communication, web, productivity, creation and education-specific activities. Each of these areas comprises frequency, purpose, and skill level of technology use. The technologies that preservice and novice teachers used were analyzed by cross-tabulation with frequency of technology use. The technologies that participants used were analyzed by cross-tabulation with the purpose of technology use, comparing the percentages of use of technology for personal and educational purposes. Each participant indicated their overall skill level of each technology activities. The scales of overall skill level of technology are expert, very skilled, fairly skilled, not very skilled, and not at all skilled.

In addition, data from class observations of preservice teachers were analyzed qualitatively. The observation data include technology experiences from university classes, PK-6 classes in which the preservice teachers participate and teach and/or other environments, the technology use and the purpose of use of preservice teachers. The observed data were analyzed with using the open, axial and selective coding (Strauss & Corbin, 1998). Strauss and Corbin (1998) described the definition, purpose and the related activity with the open coding, axial coding, and selective coding. The open coding is the process of analysis to identify the concepts that are revealed in the data. The purpose of open coding is for discovering, naming, and categorizing phenomena by considering the properties and dimensions of the concepts. Open coding allows the researcher to break down the data through examination and look for similarities and differences by comparing the broken down data.

The axial coding is the analytic process of creating the relationship of categories to the sub categories created from the open coding. The purpose of axial coding is to

reassemble the broken down data and define concepts. During the axial coding, categories and subcategories are identified. A category means a phenomenon such as a problem, issue, or event that are defined as being significant to participants. A subcategory is descriptive information about a phenomenon. The researcher relates the category, the defined concepts, to their subcategories, which allows the explanation of the phenomenon to be more precise and complete.

The last step of the process is selective coding, which is the analytic process of integrating and refining the theory based on the developed relationship among categories. The purpose of selective coding is to integrate categories at the dimensional level. Through the selective coding, researchers can discover a theory, certify the relationship between concepts, and identify categories that are in need of further refinement.

The interview data was analyzed qualitatively. The recorded interview data was transcribed in the document file. The interview script was coded by taking open, axial and selective coding steps. Through open, axial and selective coding and analytic memo, interview data was analyzed to understand preservice and novice teachers' technology skills.

I supported the qualitative data analysis procedure with analytic memo writing. In this research, my analytic memo was used as an analytic method. The analytic memo helps researchers to discuss and to debate the meanings of codes and created categories. Moreover, the analytic memo supports researchers as an audit trail tool that helps in the evaluation of conceptualization (Glaser & Strauss, 1999). During the coding procedure, whenever I had analytic ideas, I stopped coding and created an analytic memo.

Technology attitudes

Data helps us to understand participants' technology attitudes include the digital technology self-efficacy and learning technology attitude sections of the survey and

interview. Some survey data items were reverse coded. Among the 17 items of digital technology self-efficacy section, 12 items are reverse-worded. 5 out of 12 items of learning technology attitude are also reverse-worded. The scales are listed in the order of a) strongly agree, b) agree, c) disagree, and d) strongly disagree. Each scale was scored 4, 3, 2, and 1. In case of the items which need reverse codes, 4 was scored 1, 3 was scored 2, 2 was scored 3, and 1 was scored 4. After the reverse code, I calculated the mean value of digital technology self-efficacy and learning technology attitude of each participant case. The higher score means the participant has a more positive digital self-efficacy or learning technology attitude.

Technology knowledge

The TPACK survey and lesson plans were analyzed to understand each participant's technology knowledge. To analyze technology knowledge, the criteria for assessing TPACK rubric (see Appendix H), which was created by Lyublinskaya and Tournaki (2011), was used. The criteria for assessing TPACK rubric four components; a) An overarching conception about the purposes for incorporating technology in teaching subject matter topics; b) Knowledge of students' understandings, thinking, and learning in subject matter topics with technology; c) Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics; and d) Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies. Each component rates preservice teachers' TPACK level: Recognizing, Accepting, Adapting, Exploring or Advancing. Under each level, criteria are listed to evaluate technology use.

Participants' technology uses mentioned in lesson plans were evaluated based on the criteria and checked to determine which TPACK level it met.

Trustworthiness

Lincoln and Guba (1985) stated that the research's trustworthiness is significant. The trustworthiness includes confirming credibility, transferability, dependability and confirmability. Credibility means that the truth of the research results is confident; transferability means that the results can be applied in different contexts; dependability means that the results are consistent with repetition; and confirmability means that the results are from the participants' respondents, not from researchers' bias or motivations.

For this research, I used triangulation, member checks, thick description and an audit trail. Triangulation helps to reduce bias that may result from depending on only one method, source, researcher, and theory (Lincoln & Guba, 1985). Triangulation is the key to doing a case study with using multiple data sources and data gathering techniques (Tellis, 1997). To triangulate the data, I used multiple sources and data collection methods such as survey, interview, observation and documents. The second technique was member checks. Member checking is a process of taking data and tentative interpretations back to the participants and asking if the data and researchers' interpretation are reasonable (Lincoln & Guba, 1985). I interviewed the participants to ask if the collected data from the participants were correct and if my interpretation was plausible. The last technique was thick description. In the case study, I collected data, described sufficiently from the collected data, and reported the description with adequate detail and preciseness (Lincoln & Guba, 1985). The last strategy for trustworthiness was the audit trail. The audit trail is a detailed account of the methods, procedure, and decision points in performing the research (Lincoln & Guba, 1985). In this study, I wrote reflective journal to develop a detailed account of the methods, procedures, and decision points for the analysis of the study.

Research matrix

A research matrix (Appendix J) was created. The research matrix guided me researcher to use specific data collection method and analysis method for each research question.

Chapter 4. Results

This research was conducted to understand and explore how the technology integrated preservice teacher preparation program prepares preservice teachers in developing technology skills, attitude, and knowledge and how the preservice teachers' experiences from the program influenced their technology integration preparedness. Two research questions guided and led this research: a) How are two preservice teachers in each level (semester) of a one-to-one laptop preservice program prepared to use technology in their future PK-6 classrooms?; and b) How are two novice teachers, who are the graduates of the one-to-one laptop preservice program, enabled/disabled in using technology in their PK-6 classrooms?

Each section will present the case study results of each group of participants' (first semester, second semester, and third semester preservice teachers, and novice teachers) technology experiences.

FIRST-SEMESTER PRESERVICE TEACHER CASES

This section describes the technology skills, attitudes, and knowledge of Isaac and Tony during their first semester of the program.

Isaac

Isaac is a European male. Overall, Isaac had basic skills of using technologies, but he did not have chances to think actively about technology integration in teaching.

Technological experience upon entry to program

This section shares the technology skills and attitude of Isaac, when he had just begun the program.

Technology skills. Isaac used technology for communication, web, productivity, creation, and education-specific activities. Table 6 shows Isaac's use of technology for

communication activities. He read online discussion boards/forums and posted/sent messages to online discussion boards/forums for totally educational purposes. Isaac used reading and sending email more for educational purposes. The most frequently performed communication activities were reading email and participating in text messaging via phone.

The mean score of purpose of Isaac's use of communication activities is 3.7, which indicates that he used communication activities more for personal rather than educational purposes. The mean score frequency of communication activities is 2.7, which indicates that Isaac used communication activities at an almost daily frequency.

Table 6. Isaac's communication activities upon entry to the program

Communication Activities	**Use***	**Purpose****	**Frequency*****
Read online discussion boards/forums	Y	9	2
Post/send messages to online discussion boards/forums	Y	9	2
Read email	Y	6	4
Send email	Y	6	3
Read Blog	Y	2	3
Participate in text messaging via phone	Y	1	4
Write/Comments on Blog(s)	Y	1	3
Participate in text-based instant messaging	Y	1	3
Read Wiki	Y	1	2
Participate in Online Audio/Video interactions	Y	1	1
Send messages to an email listserv	N	n/a	n/a
Write/Edit Wiki(s)	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 7 shows Isaac's technology use for web activities. Isaac used the university library website mostly for educational purposes. Isaac used the web from cell/smart phone and accessed music or videos for both personal and educational purposes. The

most frequently performed web activities were using the university library website and using the Web from a cell/smart phone.

Isaac's mean score of purpose of use of web activities is 4, which indicates that Isaac used web activities almost equally for personal and educational purposes (slightly more for personal use). The mean score of Isaac's use of web activities is 3.2, which indicates he used web activities about daily.

Table 7. Isaac's Web activities upon entry to the program

Web Activities	**Use***	**Purpose****	**Frequency*****
Use the university library website	Y	8	4
Use the Web from a cell/smart phone	Y	5	4
Access music or videos	Y	5	3
Participate in social networking websites	Y	1	3
Download music, videos or podcasts	Y	1	2
Participate in online Multiuser computer games	N	n/a	n/a
Participate in online Virtual worlds	N	n/a	n/a
Build and tag bookmarks socially	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 8 shows Isaac's use of technology for productivity activities. Isaac used presentation software and desktop publishing totally for educational purposes. Word processing was used slightly more for educational purposes. The spreadsheets were used both for educational and personal purposes.

Isaac's mean score of purpose of use of productivity activities is about 7.3, which reflects Isaac used productivity activities more for educational purposes. The mean score of productivity activities is about 1.3, which reflects Isaac used productivity activities monthly or less.

Table 8. Isaac's Productivity activities upon entry to the program

Productivity Activities	**Use***	**Purpose****	**Frequency*****
Use Presentation software	Y	9	1
Use Desktop Publishing	Y	9	1
Use Word Processing (MSWord)	Y	6	2
Use Spreadsheets (Excel, etc.)	Y	5	1
Use Online productivity suite (Zoho, GoogleApps)	N	n/a	n/a
Use Concept Maps (Inspiration, Visio, cmap)	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 9 shows Isaac's use of technology use for creation activities. Isaac created or modified digital video totally for educational purposes. Overall, Isaac did not use creation activities frequently.

Isaac's mean score of purpose of creation activities is about 4.7, which means Isaac used creation activities almost equally for personal and educational purposes (slightly more for educational purposes). Isaac appears to use Creation activities infrequently, monthly or less.

Table 9. Isaac's Creation activities upon entry to the program

Creation Activities	**Use***	**Purpose****	**Frequency*****
Create or modify digital video	Y	9	*m*****
Create or modify digital pictures or art	Y	4	1
Create digital photo galleries or albums	Y	1	1
Create or modify digital audio	N	n/a	n/a
Produce podcasts	N	n/a	n/a
Produce vodcasts or screencasts	N	n/a	n/a
Create or modify web pages	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day
**** *m*: Missing Data

Table 10 shows Isaac's use of technology for education-specific activities. Isaac participated in course management system (also known as: learning management system) and utilized subject-specific software or technology for discipline. However, he used it scarcely, about once a month.

Isaac's mean score of the frequency of use of education specific activities is 2.5, which indicates Isaac used them between weekly and daily.

Table 10. Isaac's Education Specific activities upon entry to the program

Education Specific Activities	**Use***	**Frequency****
Participate in Course Management Systems	Y	4
Utilize subject-specific software or technology for your discipline	Y	1
Build an electronic portfolio of my coursework	N	n/a

* Y: Yes, N: No
* 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Isaac had technological experiences with various activities, such as communication, web, productivity, creation, and education-specific activities. Among them, the survey data reveals that Isaac used productivity activities mostly for educational purposes, except education-specific activities. Yet, he did not use productivity activities frequently. Isaac used web activities most frequently, which were used more for personal purposes. From this result we can see that on average Isaac did not use many technology activities for educational purposes and did not use technologies frequently (See Table 11).

Table 11. Summary of Isaac's technology use upon entry to the program

Technology Activities	**Mean Score Across All Activities**	
	Purpose*	**Frequency****
Communication	3.7	2.7
Web	4	3.2
Productivity	7.3	1.3

Creation	4.7	1.2
Education Specific	n/a	2.5

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Technology attitudes. The mean score of Isaac's digital technology self-efficacy was 2.65, which reflects slightly positive self-efficacy. Isaac's survey results also show that the mean score of his learning technology attitude was 3.08, which reflects a moderately positive attitude.

Also, Isaac shared his perception of expertise of technology activities (See Table 12). Isaac thought that his expertise levels of technology activities were all moderate, fairly skilled.

Table 12. Isaac's perception of his expertise of technology activities

Technology Activities	**Perception***
Communication	Fairly skilled
Web	Fairly skilled
Productivity	Fairly skilled
Creation	Fairly skilled
Education Specific	Fairly skilled

At the program starting point, Isaac's digital technology self-efficacy was slightly positive, his learning technology attitude was moderately positive, and perception of his digital technology expertise was fair.

University context

This section describes Isaac's technology experiences in the university, including infrastructural information and his instructors' technology expectations, and their technology modeling during the first semester of his preservice teacher education program.

Infrastructure. In the university classes Isaac was enrolled in, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet. The media cart allows instructors to project information from the instructor computer to students through a projector and on a screen.

University instructors' technology expectations. Isaac was enrolled in five courses. Table 13 presents the list of the instructors and course names.

Table 13. First Semester Coursework for Isaac

Instructor	Course Name
A	Teaching English as a Second Language Methods
B	Elementary Social Studies Methods
C	Reading Assessment & Development
D	Guiding Young Children in Groups
E	Applied Human Learning

The five instructors required certain technology activities from preservice teachers. Table 14 summarizes instructors' technology expectations, as evidenced in the course syllabi.

Table 14. Technologies that instructors expected for preservice teachers to use

Expected Technologies	Instructors
Email	A, B, C, D, E
Learning Management System (LMS)	A, B, C, D
Word processing	A, B, D
Electronic submission of assignment	A, D
Laptop	C, D
Phone contact	B, D
PowerPoint	B, D
Audio and video data creation	C
iMovie	B
iPhoto	B
Online chat	E

First, instructor C and D, introduced their expectations for daily use of laptops and other technologies, saying, "You will use your laptop extensively for this course as

we think together about various tools for assessment and instruction, as well as how new technologies influence our own reading lives. We will rely on your flexibility and creativity in thinking about how different modes (i.e., Sound, Video, Text, Images) and new technologies are useful in assessment. Please bring your laptop to class every day, and check for updates throughout the week" (Instructor C's syllabus), "During class, we invite you to use your laptop in ways that enhance our face-to-face conversations" (Instructor C's syllabus), "Class Participation includes coming to class with your laptop" (Instructor D's syllabus), "All students are required to purchase an iBook laptop computer as part of the SCOE initiative. Your computer will be an integral part of the course sequence and will be used in a range of ways in this class, in your placement classrooms, and in the completion of our assignments. Please bring your laptop to class each week" (Instructor D's syllabus), and "Several of your assignments are designed to build upon and develop your technological skills. The skills required for this course involve tools and software applications that are regularly used by early childhood Teachers" (Instructor D's syllabus). Instructors used laptops in their classes, as observed at the university class observations. Instructor C and D used laptops to present a lesson using PowerPoint slides (Interview), to search web to find pictures, to find information from regional ISD, and to play music to motivate students.

Second, instructors A, D, and E required preservice teachers to use certain communication activities. One of the communication methods that the instructors used was email. All of the instructors marked their email address on the syllabi. Instructor A suggested using and checking email frequently, saying, "You are responsible for checking your email regularly" (Instructor A's syllabus). Instructor D also indicated "Please email, call or schedule a time to talk with me if you have any questions regarding the course policies and/or assignments" (Instructor D's syllabus). The other method was

phone. Instructor B and D marked their phone numbers in their syllabi. Instructor E required preservice teachers to use online chatting system during the class, twice in the semester, which is indicated in the syllabus, "In-class online chat" (Instructor E's syllabus).

Third, the instructor B required preservice teachers to use web resources to support their learning. The instructor explained the web activity in the syllabus, "Completing the Atomic Learning modules in these programs. Print out the certificate that indicates that you have completed the module(s)" (Instructor B's syllabus). The instructor did not indicate which parts of the Atomic Learning modules were to be completed in the syllabus. The Instructor B used web resources during the class. During university class observation of Isaac and Tony, the instructor used web to search for relevant class information. He searched the teachers' guide information from a regional ISD website to support preservice teachers' lesson plan development and pictures through Google.

Fourth, instructor A, B and D specified student use of productivity activities in their syllabi. Instructors required productivity software most. Instructors wanted preservice teachers to use word processing for their paper composition, indicating, "All assignments must be typed, include the student's name, and turned in on time" (Instructor A's syllabus), "Keep a journal record in your computer for each of your viewings" (Instructor A's syllabus), "Your final write up should follow APA style, double spaced, 1-inch margins" (Instructor A's syllabus), "You will demonstrate competency in iPhoto, iMovie, Microsoft Word, PowerPoint and one other software tool of your choice" (Instructor B's syllabus) and "All assignments should be typed unless otherwise specified by the professor" (Instructor D's syllabus). Instructors used productivity application, and generally, they used PowerPoint. Isaac said that instructor D used PowerPoint

(Interview). During the university class observation, instructor B used PowerPoint to present content information to the students. In instructor B's class, PowerPoint slides were the main content information presentation tool (University class observation).

Fifth, instructor B, C, and D required preservice teachers to do creation activities. Creation activities included using and editing picture, video, and audio resources. Instructors asked preservice teachers to perform: "You will demonstrate competency in iPhoto, iMovie, Microsoft Word, PowerPoint and one other software tool of your choice" (Instructor B's syllabus), "Your reflections will also take advantage of the affordances of technologies accessible through your laptop to capture image, sound, video, etc" (Instructor C's syllabus), "Using the body of evidence from your assessments over the semester, you will create a multimodal report that uses some combination of print, images, audio, or video" (Instructor C's syllabus), and "learning photographs - students working in groups/centers/projects/learning video - students working in groups/centers/projects (iMovie)" (Instructor D's syllabus). According to Tony, instructor B taught how to use iMovie to the preservice teachers, saying, "In a social studies class, [Instructor B] taught us about iMovie" (Interview).

Sixth, instructor A and D required preservice teachers to submit their assignments electronically. Instructor A asked preservice teachers to submit their assignment through a LMS, saying, "Submit your paper electronically through Blackboard" (Instructor A's syllabus). Instructor D required submitting assignments through email, saying, "Introduction Letter due via email" (Instructor D's syllabus) and "EC Guidance Strategy Activity due via email" (Instructor D's syllabus). During observing Tony's class in university, instructor D commented to submit preservice teachers' assignments through email. In addition, Tony explained his experience of electronic submission, saying, "Instructor sent questions to students to respond to, and asked students to send the reply

to the instructor through email" (Interview). Similarly, one instructor out of five asked preservice teachers to submit their assignments stored onto CD, saying, "Digital media, which includes your learning videos and learning photos, burned onto one CD" (Instructor D's syllabus).

Seventh, instructors A, B, C, and D required preservice teachers to use LMS. Across these five classes, students were accessing three different LMSs, including Firstclass[2], Elgg[3], and Blackboard. Instructor A required students to use Elgg and Blackboard, instructor B required students to use First class, and instructor D required students to use Blackboard. Instructor C did not specify the name of the LMS in her syllabus, but she used Elgg during her class (University class observation). Tony shared his experience of using LMS for his class, saying, "This year, we transferred to special learning management system on Elgg, the new educational system. We had discussions on that, we post and reply to other students, our classmates. Every week, we had reading reflections, and comment on other people, like Online Discussion through that" (Interview). LMSs were used for two different activities, posting discussion and/or reading responses, and sharing resources such as reading assignments, lecture notes, and class-related templates. The instructors announced the information about using LMSs for posting discussion and/or sharing in their syllabi, saying, "You are responsible for checking your email regularly and utilize Blackboard for weekly discussion forums, announcements, and course documents: You are also encouraged to utilize Elgg for networking with colleagues and sharing information" (Instructor A's syllabus), "Participation in a weekly Forum is required" (Instructor A's syllabus), "Our class will

[2]"Firstclass is a full-featured Group Ware system run by the College of Education utilizing Open Text's FirstClass client and server software package. (Firstclass Info, 2012)"

[3]Elgg is an open source social network engine. Based on the Elgg service, the college of education, where this study was held, developed supportive learning management system.

develop a reading response system that will allow students to demonstrate a clear understanding and thoughtful response to the reading in ways that encourage rich classroom discussion" (Instructor B's syllabus), "You will respond electronically to our course readings and to each other. You will alternate between posting either an extended Reading Response, or a Peer Response to several of your classmates" (Instructor C's syllabus), "You will post your plans electronically prior to the start of class on Wednesday. This electronic space will allow for ongoing professional conversation with peers as well as regular feedback from us" (Instructor C's syllabus), and "You will write a brief reflection on some aspect of the tutorial session that captures your attention each week" (Instructor C's syllabus). Additionally, class resources were posted on another older LMS technology, FirstClass, "(reading resources were) also posted on Firstclass" (Instructor B's syllabus, and Instructor C's syllabus), "Additional course readings will be available through Blackboard" (Instructor D's syllabus), "Lectures will be posted after class on Blackboard" (Instructor D's syllabus), "The summary sheet template will be provided on Blackboard under the course documents folder" (Instructor D's syllabus), "Complete your portions of the Project2 Rubric, which again will be made available on Blackboard under Course documents" (Instructor D's syllabus), and "Periodically, additional readings will be assigned and will be made available on Blackboard" (Instructor D's syllabus). Tony said that LMS was main resource that used in class, saying, "I think that was the main things most teachers use. And also discussion boards on blackboard" (Interview). The instructor D's use of LMS also observed during the university class observation. The instructor signed in the Elgg once during the research observation to check the class schedule.

University instructors required preservice teachers to use technology; however, instructor A and D regulated or limited technology use in class. Instructor A and D

explained required laptop etiquette to the preservice teachers in their syllabi, “Laptops are not allowed in class. I will let you know in advance if a laptop will be necessary for specific in-class activities. During those activities, laptops must be used in appropriate ways” (Instructor A’s syllabus), and “Because you are a committed learner, I expect that you will use your laptop in appropriate ways and at appropriate times” (Instructor D’s syllabus). In addition, instructor A and D regulated specific digital devices and off tasks in classes, “Please refrain from surfing the net, IM-ing, checking email, shopping, doing research, downloading pictures or videos, or completing assignments for other classes at times when you need to be participating in class and taking responsibility for your learning and professional development” (Instructor A’s syllabus), “Cell phones must be silenced while in class. Refrain from text messaging in class” (Instructor A’s syllabus), “we expect that you will exhibit professionalism by avoiding material that is unrelated to our immediate discussion (i.e., email). Because our course goals include thoughtful use of technology in classroom spaces, and because your participation in class impacts the child you tutor, we take this requirement seriously” (Instructor A’s syllabus), and “Because you are a committed learner, I expect that you will use your laptop in appropriate ways and at appropriate times, and I expect that you will not be using your PDA, iPod/MP3 player, or cell-phone in class. Thus, committed learners should not be surfing the net, IM-ing each other, texting others outside class, checking email/myspace/facebook, shopping, doing research, downloading pictures or videos, listening to music, or completing assignments for other classes at times when you need to be participating in class and taking responsibility for your learning and professional development” (Instructor D’s syllabus).

Field-based PK-5 context

Isaac completed fieldwork in a first-grade classroom of Jacklin Elementary School. Jacklin Elementary School is PK-5 school, which was built in 1955. There were 323 students in total, 49.5% of female and 50.5% of male. Students represented five different ethnicities, Hispanic (73.4%), Caucasian (15.5%), African American (9.0%), Asian (1.9%), and Native American (0.3%). The school population also was categorized as: Economic disadvantaged (81.4%), At-Risk (44.6%), Limited English Proficiency (37.2%), Bilingual (31.9%), Special Education (11.1%), first-year US enrollment (8.7%), Gifted/Talented (4.3%), and English as a Second Language (3.1%). More than 80% students of Jacklin Elementary School were in the economic disadvantaged category, and almost half of all students were at risk. Almost 40% students had limited English proficiency.

In the classroom where Isaac was assigned, there were an innovation station, a teacher's computer, a printer, a timer, a telephone, an iPad, three student computers, a headset attached, and wireless Internet.

Cooperating teacher's technology use. Isaac's cooperating teacher used a microphone when she taught, and Isaac reported in his interview "she uses microphone a lot." In addition, she used a document camera. During the observation, she used document camera to show the textbook page on the screen to the class and read the textbook content. From the interview, Isaac confirmed her use of document camera. Last, the instructor used a timer. During the observation, the cooperating teacher assigned an activity to the class students and set up the timer for the time limitation, and this is all the use that I observed, and Isaac did not report any other uses of timer. The cooperating teacher had an iPad, but she worried about breaking the device, so she wrapped it with a cloth and did not use it.

Here, we can see that Isaac had been assigned into a classroom that was equipped with various technologies, but he reported observing limited and simple technologies. Technologies were used mainly to present information. Moreover, new device was not used because the cooperating teacher was scared to use it. Isaac said during the interview that "I want to see more examples using technology." to be prepared with technology as a future teacher.

Isaac's technology activities

Across the university classes and field-based activities in the first semester of the program, Isaac used search engines, regional ISD website, video creation with digital camera, iMovie, LMS, microphone, and timer. Isaac's use of those technologies can be categorized as Web, Creation, and Education-specific activities.

Web activities. He opened search engine to search information about a photographer about whom his instructor commented during the class. Isaac checked a regional ISD website to search skills and knowledge information that the state requires for teachers, following his instructor's direction (University class observation).

Creation activities. Isaac created video by using his digital camera in PK-6 class, and he recorded students' activities. He reported, "I use my digital camera to take students' learning video" (Interview). He modified his recorded movie using a movie making app, iMovie. During the interview, he reported, "We had chance to edit video on iMovie," "That was the class that we had iMovie project," and "(I used the iMovie) for the social studies class" (Interview). Isaac used his digital camera to create pictures. He took pictures of the weather and of students in the PK-6 class (PK-6 school class Observation and Interview).

Education-specific activities. Isaac used LMS to "write reflection and respond to other's reflections" (Interview). In addition, for teaching purposes, he used educational

websites. He mentioned two websites that were used for language arts: Tumble books, an online library, and starfall.com, which he reported, “It's a literacy website has literacy games and stories to listen to.” In addition, he said that he used websites “for social studies lessons sometimes” (Interview), that he did not report exact names of websites.

Isaac also used technologies for class management purposes in the PK-6 classroom during his teaching experience, such as microphone and timer. He used microphone to explain content to the students (PK-6 school class observation). He reported, “I really enjoyed using microphone and I think took it granted almost” during interview (Interview). In addition, Isaac used a timer to set alarm for in class activity (PK-6 school class observation).

Isaac learned new technology skills, using iMovie, LMS, and microphone from the program. Out of all the technology skills, most influential skill for Isaac was using microphone. Laptop related activities were using iMovie, LMS, educational websites and regional ISD website.

Isaac’s technology attitudes

Isaac expressed his attitudes toward technology’s role in education, laptop computer, and specific technologies. First, he was not confident in using technology for education, saying, “Not very confident” (Interview). He explained that it is because he did not observe enough technology integration modeling from his instructors, saying, “I didn't have really good models” (Interview). However, Isaac had positive attitude toward using technology for education. He said, “I like the idea using technology for teaching” (Interview).

Second, Isaac thought laptop did not play a big role in his preparation. He said, “It hasn’t played any big role, it was like just with the iMovie projects and other thing (pause) just really it didn’t play big role (for my preparation)” (Interview).

Third, Isaac showed his attitude toward specific technologies, including document camera, iMovie, LMS, Microphone, and Smartboard. Isaac thought a document camera was useful (Interview). He also used iMovie, which he felt "frustrating sometimes" (Interview), but he thought, "Overall I enjoyed playing with it, seeing the final product was kinda cool" (Interview). Isaac used LMSs, Blackboard and Elgg, and he preferred Elgg to the Blackboard, saying, "I really enjoyed the Elgg, it's much better than the blackboard" (Interview). Isaac used Microphone, which he "really enjoyed using (it)" (Interview). Isaac's favorite technology was Smartboard. He said, "I especially like, my favorite is the Smartboard, we didn't have it in the classroom, but I really like the idea of Smartboard" (Interview).

Even though Isaac had positive attitude in technology integration, he did not have chances to enhance his confidence of technology integration during the program. Isaac preferred technologies such as Smartboard and microphone, which are related with information presentation and class management.

Isaac's technology knowledge

Isaac prepared a mathematics lesson plan about subtraction for 1st grade students. In his lesson plan, no technology was integrated. The lesson plan was developed based on a lesson plan template and the lesson plan template had no requirement for preservice teachers to infuse technology within it.

Even though Isaac did not include technology use in his lesson plan, Isaac described his potential practice of teaching and integrating technology in his teaching from his TPACK survey in the reflective questions. He wrote, "I thought I could use the document camera to demonstrate concepts that students were having difficulty with" (TPACK Survey). Isaac's use of document camera can be rated with the TPACK rubric. The document camera shows lesson information to the students. The use of document

camera is for demonstration of information and teacher-centered activity. In addition, students are recipients and listeners of information. Table 15 reflects Isaac's TPACK level, which was overall 2/5 (Accepting) level.

Table 15. TPACK Components and levels of Isaac's potential use of Document Camera

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Main purpose of technology use is for demonstrations, which include presenting new knowledge. • Technology integrated activities procedures concentrate on teacher demonstration and practice.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student follow work with technology, it is rarely used for students' independent explorations.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Teacher uses didactic (teacher-directed) approach to teaching with technology to maintain control of the progression of the activities.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Recognizing** • Technology integrated activity provides students only with opportunities for drill and practice, or for listening, receiving information.

To Isaac, teaching seemed to involve delivering information. Isaac's lesson plan reflected his technology use for information delivery centered and teacher centered instructional strategy.

Tony

Tony is an Asian American male student. He reported that he was technologically active since high school. He actively engaged in technology use and technology integration in teaching.

Technological experience upon entry to program

This section presents Tony's technology skills and attitude at the beginning of the preservice program.

Technology Skills. Tony used communication, web, productivity, creation and education specific activities. Table 16 shows Tony's use of technology for communication activities. The only activity that Tony did more for educational purposes is reading wiki. Tony used reading and sending email for both personal and educational purposes. Tony used reading email, reading online discussion boards/forums, posting/sending messages to online discussion boards/forums, participating in text-based instant messaging and participating in text messaging via phone most frequently.

Tony's mean score of purpose of use of communication activities was 3.3, which reflects a more personal use orientation, and the frequency of his use of communication activities was 3.2, which reflects daily use of these activities.

Table 16. Tony's communication activities upon entry to the program

Communication Activities	**Use***	**Purpose****	**Frequency*****
Read Wiki	Y	6	2
Read email	Y	5	4
Send email	Y	5	3
Read online discussion boards/forums	Y	3	4
Post/send messages to online discussion boards/forums	Y	3	4
Read Blog	Y	3	3
Write/Comments on Blog(s)	Y	3	3
Participate in text-based instant messaging	Y	2	4
Participate in text messaging via phone	Y	2	4

Participate in Online Audio/Video interactions	Y	1	1
Write/Edit Wiki(s)	N	n/a	n/a
Send messages to an email listserv	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 17 shows that Tony's technology use for web activities. Tony only used university library website totally for educational purposes. The most frequently performed web activities were using the web from a cell/smart phone and participating in social networking websites.

Tony's mean score of purpose of web use was 2.8, which reflects a more personal use orientation, and the mean score of frequency of Tony's web use was 2.4, which reflects weekly use of these activities.

Table 17. Tony's Web activities upon entry to the program

Web Activities	**Use***	**Purpose****	**Frequency*****
Use the university library website	Y	9	1
Use the Web from a cell/smart phone	Y	2	4
Participate in social networking websites	Y	1	4
Access music or videos	Y	1	2
Download music, videos or podcasts	Y	1	1
Participate in online Multiuser computer games	N	n/a	n/a
Participate in online Virtual worlds	N	n/a	n/a
Build and tag bookmarks socially	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 18 shows Tony's use of productivity activities. Presentation software was used all for educational purposes. He used spreadsheets more for educational than

personal purposes. Word processing was used evenly for educational and personal purposes. The most frequently used productivity activity was using word processing, which was used daily.

Tony's mean score of purpose of productivity activities is 6, which reflects a more educational use orientation, and the mean score of frequency of Tony's productivity activities is 2.5, which indicates that Tony used them between weekly and daily.

Table 18.Tony's Productivity activities upon entry to the program

Productive Activities	**Use***	**Purpose****	**Frequency*****
Use Presentation software	Y	9	1
Use Spreadsheets	Y	7	1
Use Word Processing	Y	5	3
Use Desktop Publishing	Y	3	1
Use Online productivity suite	N	n/a	n/a
Use Concept Maps	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 19 shows Tony's use of creation activities. Tony's missing data obscures our understanding of his purpose of these technology activities. He did not use creation activities frequently. The mean score of frequency of Tony's creation activities is 1.3, indicates that Tony used them monthly or less.

Table 19. Tony's Creation activities upon entry to the program

Creation Activities	**Use***	**Purpose****	**Frequency*****
Create or modify digital pictures or arts	Y	*m*****	2
Create or modify digital video	Y	*m*	1
Produce podcasts	Y	*m*	1
Create digital photo galleries or albums	Y	*m*	*m*
Create or modify digital audio	N	n/a	n/a
Produce vodcasts or screencasts	N	n/a	n/a

Create or modify web pages	N	n/a	n/a

* Y: Yes, N: No
** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose
*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day
**** *m*: Missing Data

Table 20 shows Tony's use of technology for education specific activities. He participated in LMS and utilized subject-specific software or technology for discipline. He used LMS daily, and used subject specific software or technology weekly. Overall, mean score of frequency of Tony's use of education specific activities is 2.5, which indicates that Tony used them between weekly and daily.

Table 20. Tony's Education Specific activities upon entry to the program

Education Specific Activities	**Use***	**Frequency****
Participate in Course Management Systems	Y	3
Utilize subject-specific software or technology for your discipline	Y	2
Build an electronic portfolio of my coursework	N	n/a

* Y: Yes, N: No
** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Tony used laptop and other technologies for various activities, such as communication, web, productivity, creation, and education-specific activities. Among them, the survey data reveals that Isaac used productivity activities most for educational purposes, except education-specific activities that were totally for educational purposes and creation activities, about which Tony did not complete information about purpose. Tony used communication activities most frequently (See Table 21).

Table 21. Summary of Tony's technology use upon entry to the program

Technology Activities	**Mean Score Across All Activities**	
	Purpose*	**Frequency****
Communication	3.3	3.2
Web	2.8	2.4

Productivity	6	1.5
Creation	*m*[***]	1.3
Education Specific	n/a	2.5

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose
** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day
*** *m*: Missing data

Tony reported that he was experienced with technology already. He reported that he could use various computers in his high school. He reported "I used Macs in high school," "I've used iMovie in the past, in the high school for making films, just kind of getting used to the software and how to take videos, transfer from camera to the computer and edit," and "When I was a high school sophomore, I had computer at home, so downloaded music, and create CDs," and "I created high school yearbook, so I used MS office and could have advanced skill" (Interview).

Technology Attitudes. Tony's survey results show that his digital technology self-efficacy score was 3.88, which shows a very highly positive self-efficacy. In addition, the score of Tony's attitude toward learning technology was 3.92, which also reflects a very strong positive attitude towards learning technologies.

Tony shared his perception of his expertise of digital technology activities. Table 22 shows Tony's perception of his expertise of technology activities. Tony thought his expertise level of communication, web and productivity activities are expert level, which shows his strong confidence. Tony perceived his expertise level of creation and education specific activities are very skilled, which reflects his confidence.

Table 22. Tony's perception of his expertise of technology activities

Technology Activities	**Perception**
Communication	Expert
Web	Expert
Productivity	Expert

Creation	Very skilled
Education Specific	Very skilled

Tony shows strong confidence and positive attitude toward technology activities, which might be due to his previous technology experiences.

University context

Tony was in the same preservice teacher cohort with Isaac, thus they were enrolled in all the same five classes. Therefore, Tony's learning context was the same as Isaac's, which is summarized briefly here for reader convenience. There were a media cart, an instructor's laptop, students' laptops, and wireless Internet.

Infrastructure. In the university classroom, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet.

University instructors' technology expectations. Instructors who taught Tony required daily use of laptops (Instructor C and D), communication activities (Instructor A, D, and E), web resource use (Instructor B), productivity activities (Instructor A, B and D), Creation activities (Instructor B, C, and D), electronic submission of assignments (Instructor A and D), and using LMS (Instructor A, B, C, and D).

Different from Isaac, Tony reported that he observed technology modeling from his instructor. Tony reported that he observed good technology modeling in instructor D's class. From instructor D, Tony could see technology integration modeling that instructed him to learn about technology integration. Not only from her own technology use of video and presentation, but also from the technology integration examples that instructor D introduced during the class.

Field-based PK-5 context.

Tony completed fieldwork in a kindergarten classroom of Jollyville Elementary School. Jollyville Elementary School is PK-5 school, which built in 1985. There were

623 students in total, 51% of female and 49% of male. Students were grouped in four different ethnicities, Hispanic (82.7%), African American (10%), Caucasian (6.4%), and Asian (0.2%). The school population was also categorized as: Economic disadvantage (91.3%), At-Risk (53.8%), Limited English Proficiency (41.9%), Bilingual (36%), Special Education (8.7%), English as a Second Language (5.1%), First year US enrollment (3.7%), and Gifted/Talented (1.6%). More than 90% students of Jollyville Elementary School were in the economic disadvantage category, and more than half of all students were at risk. Almost 40% students had limited English proficiency.

The school was equipped with a computer lab in the library. There were 27 desktops in total, each attached with a headset. Internet was connected with each computer so that teachers and students can access Internet. The computer lab was equipped with document camera, digital projector, and a set of speakers. In the classrooms, there were an innovation station, a teacher's laptop, a DVD player, an iPad, a printer, a telephone, a tape recorder and player, a boom box, a digital camera, digital video camera, GoTalk20+ (an augmentative communication device), two student computers with one headset, and wireless Internet.

Cooperating teacher's technology use. Tony's cooperating teacher used document camera to show students assignments and class relevant web information to the students. During observation, I observed a "fun" day students earned through good behavior and good academic accomplishment. Therefore, Tony's cooperating teacher took all the students to the computer lab and let them play learning games. Students played Carve a pumpkin game, which is a seasonal game for Halloween, and a color matching game.

The teacher had received iPad certificate from regional ISD and had an iPad in her class. She shared the iPad with her students. During the observation, she let the

students use iPad, a pattern app, which asks student to match right number, and the number of blocks. With this app, student could practice and learn about pattern.

The cooperating teacher allowed students to use and to practice various technologies. During the observation, she handed over digital camera and digital video camera to take pictures and to record the day. The recorded movies and pictures were planned to be edited to create a movie by the students.

Moreover, she allowed students to use students' computer during class and break. Sometimes, including the observation day, the cooperating teacher gave a chance for the students to enjoy online learning games about an hour at the computer lab, the Carving a pumpkin and a color matching game. According to Tony, most of the students in his class were from economically disadvantaged families. Therefore, they had little chance to access technologies outside of school. Tony's cooperating teacher wanted and allowed her students to use technologies, therefore, at mid-term, the students could use technology far easier and better than the early of the semester (Interview).

In addition, according to Tony, to develop her teaching, his cooperating teacher recorded her teaching with the projector and reviewed the recorded teaching, "There are so much there that innovation station, what they call, so much more to that, it has a camera on ceiling of the classroom, and in a way she could record her lessons and something that can have a lot of potential for improving curriculum the way you teach, you can review yourself, I think that was cool" (Interview). From this PK-6 school experience, Tony could learn various aspects of technology integration, including presentation of information, using web resources, and self-professional development.

Tony's class was the class in which the most various types of technologies were integrated. It is due to the Cooperative teacher's interest to integrate technologies in teaching, and her practice of technology integration. During observation and interview,

Tony complimented his cooperating teachers, saying, “My cooperating teacher is very keen to technology. She got certified about using an iPad from ISD last semester, so she got one in this semester from ISD,” and “She got certified in different programs called techno-scientist of something” (Interview). Moreover, he could also learn that giving chances to use and to practice technologies to the students who cannot access those devices at their homes.

Interestingly, Tony who was technology experienced and had positive technology attitudes met a cooperating teacher who was keen to technology integration. The cooperating teachers’ technology modeling and the interaction with her were influential to Tony, which shows the importance of the experience from the fieldwork.

Tony’s technology activities.

Across the courses and the field-based experiences, Tony used word processing, digital camera to take pictures and video, iMovie, an innovation station, and educational websites and Smartphone. His use of those technologies can be categorized as Productivity, Creation and Education-specific activities.

Web activities. Tony used his own Smart phone to search educational apps. Tony was the only preservice teacher who used the Smartphone and searched educational apps.

Productivity activities. Tony used word processing at the PK-6 school classroom. He connected the class computer and hooked it up with projector. Then he opened word processing, which was projected through the digital projector. On the blank page, he wrote title, date and name to model what the students were supposed to write on their paper (PK-6 school class Observation).

Tony described his use of word processing, saying, “[I use the word processing for] taking notes. I think it's a lot easier and faster for people for taking notes. Record more information than typing,” “Also for interviews, some of our assignments were

interview different people, pull up Microsoft word and you can record up in the Microsoft word," and "I used Microsoft Word recording function for my instructor's class for the tutor" (Interview).

Creation activities. Tony used a digital camera and a digital video camera. On the way to go to the gym, Tony took one digital video camera and one digital camera from the homeroom and took pictures of students. Later in his homeroom, he recorded the CT's teaching with a student with learning disorder about creating patterns with the blocks with a small video camera. Afterwards, he interviewed another student about the pattern and recorded how another student created a pattern with blocks (PK-6 school class observation).

Tony described his experience of using creation activities during the program, saying, "In different classes, in a social studies class, he taught us about iMovie. I've used it in the past, in the high school for making films, just kind of getting used to the software and how to take videos, transfer from camera to the computer and edit, so that was one of the big project that we had this year," and "you get iMovie and iPhoto, those programs during the PDS I know we're using them a lot more and more. Because we already using them a lot this semester and I know we just keep using it more and more" (Interview).

Education-specific activities. He used the innovation station for information presentation during his teaching at the PK-6 school (PK-6 school class observation). He used educational websites (PK-6 school class observation). He said, "I used to use the discovery education website, they have a lot of videos of social studies and science" (Interview). Tony accessed the regional ISD website and pearsonsuccessnet.com to show content-related animations to the students (PK-6 school class observation).

Tony integrated various technologies in his teaching and also allowed students to use them. He seemed to be trying to integrate technology that he knew and learned in his

teaching as much as he could. In addition, he kept search for educational apps on his Smartphone when he had free time. Moreover, he also offered opportunities for students to use technologies as his cooperating teacher allowed the kids to use technologies, which shows the importance of the experience from the fieldwork.

Tony's technology attitudes

Tony showed very positive attitude toward technology. He said, "Technology is awesome," "I think it is the coolest thing," "I love technology, I always want to keep up today, I think it is the biggest part of my personality," "This has a lot of potential. I know there's a lot of potential technology," "I am a big technology person myself," "I feel like it has a lot of benefits for education," and "I see a lot of potential on that (technology)" (Interview). He showed a slight concern of depending on technology too much, saying, "It is scary to rely on technology," but still he viewed technology positively, saying, "but at the same time that's how life changes" (Interview).

Second, Tony showed his positive attitude to technology integration for education. He said, "It is very good thing to engage the students," "It grasp the attention, and (has) so much information and so many things that you can use," "(technology is the thing) making beneficial to your curriculum," "It can give you more information and newer cool stuff, such as videos, YouTube, a lot of things that kids can learn from using technology," "Possibly, in the future classes integrating and involving more technologies," "Technology is getting more important, I feel like, pretty soon, every classroom in (this university) has computer and overhead projector, and I see that is happening in middle schools and high school, definitely in middle school and high school, most likely in the elementary school, it's really beneficial," "So I think it's important, I think teachers should definitely look into integrating technology, it could be very beneficial," "Iif you integrate technology, they (kids) will love it," "A lot of

advantage that teachers can take advantages of, educators really can take advantages of technologies," "I think technology has potential that teachers should keep up or try to learn more cause I feel it will be very beneficial," and "There's a lot of potential, a lot of potential" (Interview).

Third, Tony had strong confidence in using technology and future technology integration. He said, "I feel really confident about it. Because I use a lot of technology daily basis and so comfortable I am already," "How many hours do I use laptop every day, it's a little bit scary at the same time, it's built a lot of confidence, I can use all the programs," and "I help my classmates, too, which makes me more confidence" (Interview).

Lastly, Tony expressed his positive attitude toward specific technologies, including online chatting, computers, iPad, word processing, and Smartboard. First, he talked about using online chatting, which he did in the computer lab in the SCOE building for reading assignment discussion (Interview). He shared his thought of the benefit of using online chatting, saying, "People talk more in the chat. I think people feel more comfortable talking on the chat rather than speaking orally." Second, Tony has very positive attitude on computer. He said, "Computers always has been good," "Computers are big, everywhere in colleges, everybody needs laptop. It's basically required material just like school supplies. It's becoming more and more important," and "Computer these days are always hooked up with Internet that you can get to anything" (Interview). Third, Tony observed his cooperating teachers' use of iPad. He saw positive possibility of iPad as educational technology. He said, "My teacher had an iPad. I hadn't any experience with iPad until now but so many applications that are very specific to different education and different subject," and "To them it is almost like a toy, it's more fun at the same time their learning iPads and those kinds of touch systems might be helpful in the future.

There are so many things you can do" (Interview). Fourth, he used recording function in word processing. He did not learn about this function from the program, but he personally knew this function already. He benefited the function, saying, "That was very beneficial for the project" (Interview). Fifth, he observed using Smartboard from a class out of the program, and he valued the technology (Interview). And last, Tony benefited using projector, saying, "You really get their attention whenever I use the overhead and document camera, they are always attentive" (Interview).

Tony had positive technology attitudes. From his program experiences and his students' reaction, he was positive influence of technology on students' learning. Tony's experiences from the program enhanced his positive technology attitude.

Tony's technology knowledge

Tony prepared a mathematics lesson plan about shape for kindergarten students. In his lesson plan, no technology was integrated. The lesson plan was developed based on a lesson plan template and the lesson plan template had no request for preservice teachers to infuse technology into it.

Even though Tony did not mark technology use in his lesson plan, Tony described his practice of teaching and integrating technology in his teaching from his TPACK survey. He wrote, "I like the document camera as a way to model to students the different assignments" (TPACK Survey). Tony used document camera to show assignment information to the students. The use of document camera is for demonstration of information and teacher-centered activity. In addition, students are recipients and listeners of information. Table 23 reflects Tony's TPACK level, which was overall 2/5 (Accepting) level.

Table 23. TPACK Components and levels of Tony's potential use of Document Camera

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Main purpose of technology use is for demonstrations, which include presenting new knowledge. • Technology integrated activities procedures concentrate on teacher demonstration and practice.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student follow work with technology, it is rarely used for students' independent explorations.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Teacher uses didactic (teacher-directed) approach to teaching with technology to maintain control of the progression of the activities.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Recognizing** • Technology integrated activity provides students only with opportunities for drill and practice, or for listening, receiving information.

Tony's technology skills and attitudes might have positioned him to integrate technology into his lesson plan, but Tony focused on information delivery centered and teacher-centered technology, similar to Isaac.

Distinctions in the first-semester preservice teacher cases

At the program starting point, Isaac and Tony both used productivity activities for educational purposes more than any other technology activities. However, Isaac and Tony showed slightly different trends in their technology skills and attitudes. Isaac used web activities most frequently, and Tony used communication activities most frequently (See Table 24).

Table 24. Summary of Isaac's and Tony's mean technology use upon entry to the program

Technology Activities	Isaac		Tony	
	Purpose*	Frequency**	Purpose*	Frequency**
Communication	3.7	2.7	3.3	3.2
Web	4	3.2	2.8	2.4
Productivity	7.3	1.3	6	1.5
Creation	4.7	1.2	*m***	1.3
Education Specific		2.5	-	2.5

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

****m:* Missing data

In addition, the technology attitude and self-efficacy scores showed that Tony had more positive technology attitude and self-efficacy. Tony had already developed his own ideas and perceptions about technology and technology integration. Tony, even before he entered the certification program, used various technologies and enjoyed technology's advantages, conducted various technology activities, such as developing a yearbook and creating videos. On the other hand, Isaac did not have specific ideas about technology and did not seem to actively use technologies. This indicates that even at the starting point of the program, preservice teachers have different technology experience and attitudes.

Table 25. Summary of Isaac's and Tony's technology attitudes

Preservice Teacher	Technology Attitudes	Score
Isaac	Digital Technology Self-efficacy	2.65
	Attitude toward Learning Technology	3.08
Tony	Digital Technology Self-efficacy	3.88
	Attitude toward Learning Technology	3.92

During the first semester of the certification program, Isaac and Tony learned in the same university classes. The university classes were equipped with a media cart, an instructor's laptop, students' laptops, and wireless Internet. Under this technological environment, instructors required preservice teachers to use specific technologies. The

same five instructors taught Isaac and Tony. The instructors required preservice teachers to use email (all instructors), phone contact (instructor B and D), online chat (instructor E), word processing (instructor A, B, and D), PowerPoint (instructor B and D), iPhoto (instructor B), iMovie (instructor B), audio and video data creation (instructor C), electronic submission of assignment (instructor A and D), and LMS (instructor A, B, C and D). Instructors required first semester preservice teachers to use and to be exposed various technologies. However, instructors A and D limited technology use to avoid off-task technology behaviors in class. The technologies that most of the instructors expected for preservice teachers to use were the LMS and word processing. Interestingly, in their first semester of learning to become a teacher, Tony and Isaac were expected to use the same productivity technologies for educational purposes as they reported using prior to the certification program. The program seemed to be reinforcing the use of productivity activities among these first-semester preservice teachers.

While the university classwork exposed Isaac and Tony to the same technologies, Isaac and Tony had different experiences in the fieldwork. In the PK-6 school classrooms where Isaac and Tony participated, they both had an innovation station, teacher's computer, printer, telephone, iPad, students' computer, headsets and wireless Internet. Isaac's class had a timer. However, interestingly, Tony was in a classroom equipped with more technologies. In Tony's class, there were a DVD player, tape recorder, boom box, digital camera, and digital video camera.

In Isaac's class, not many technologies were used, and Isaac also said that he did not see a lot of examples of technology integration. Isaac's cooperating teacher had iPad, but the cooperating teacher was scared to use the device, so the cooperating teacher wrapped the device with a cloth and did not use it during the class. Compared to Isaac, Tony observed his cooperating teacher use various technologies during the class, such as

an iPad, an innovation station, a digital camera and a digital video camera. Moreover, Tony's cooperating teacher was very eager to try integrating various technologies in her teaching. Tony's cooperating teacher thought giving technology use experiences to the students in the low social economic status was very important, as they don't have chances to use technology in their own home. Therefore, the cooperating teacher gave as many chances to the students to use technologies, including computers, a digital camera, a digital video camera, an innovation station and an iPad.

In the teaching experiences, Isaac and Tony showed differences. The only technology that Isaac used during teaching was the timer. However, Tony integrated word processing, digital camera to take pictures and video, an innovation station, and educational websites into his teaching.

During the program, technology experiences for Isaac and Tony from the university classes were same. However, interestingly, the two preservice teachers' technology experiences from fieldwork and with the cooperating teachers were very different. In Isaac's case, he did not have very many technology experiences. Isaac was not very confident in integrating technologies. His cooperating teacher did not integrate technology in teaching. In addition, experiences from the program did not develop Isaac's technology integration. On the other hand, in Tony's case, he already was technology experienced, had very positive technology attitudes and even had an influential cooperating teacher, which may contribute to further developing Tony's technology integration. Isaac and Tony had distinctively different experiences from PK-6 school, which shows the importance of the PK-6 school experiences during the program.

After the end of their first semester of the program, both Isaac and Tony reported positive attitudes toward technology and technology integration. However, Tony expressed stronger confidence and positive attitude toward technologies and technology

integration than Isaac did. Isaac reported that he did not observe many cases of technology integration during the program, which he wished he had. On the other hand, Tony observed the cooperating teacher integrating various technologies in teaching, which was very influential on Tony's technology experiences during the program. From the first semester of the program, the distinctive experience was the PK-6 school experience that seemed bringing difference between the two preservice teachers, which shows the importance of the modeling of the cooperating teachers from the PK-6 school field.

Isaac and Tony had different technology skills, attitudes and experiences; however, both Isaac and Tony had similar technology knowledge level, which was overall rated 2/5 (Accepting) level. They all used technology only for delivering information to students, using a document camera or an innovation station. As novice preservice teachers, it seems difficult for them to have deep technological pedagogical contents knowledge.

SECOND-SEMESTER PRESERVICE TEACHER CASES

Courtney and Sally, who were second-semester preservice teachers, were in different cohort groups who had different instructors for courses and different field-based placements.

Courtney

Courtney is a Hispanic female, who was in the English as a Second Language group of EC-6 certification.

University context

This section describes Courtney's technology experiences in the university, including infrastructural information and instructors' technology expectation, and their technology modeling.

Infrastructure. In the university classes, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet. Additionally, in the classroom that I observed, there was an overhead projector, which was not used during the class.

University instructors' technology expectations. Courtney enrolled in five classes. Table 26 presents the instructors and their course names. Instructor H taught two different courses, so one class is marked a, and the other class is marked b.

Table 26. Second Semester Coursework for Courtney

Instructor	Course Name
F	Guiding Young Children in Groups
G	Applied Learning & Development
H-a	Teaching English as a Second Language Methods
H-b	Métodos de la enseñanza en español en el aula bilingüe-Escritura
I	Reading/Language Arts (Spanish)

The four instructors expected certain technology activities from preservice teachers. Table 27 summarizes Courtney's instructors' technology expectation.

Table 27. Technologies that Courtney's instructors expected preservice teachers to use

Expected Technologies	Instructors
Email	F, G, I
Electronic submission of assignment	F, G, I
LMS	F, G, I
Word processing	F, G, I
Laptop	F
PowerPoint	G
Video Edition	F

First, instructor F described the role of laptop during the course and the importance of technology experiences, describing "Your laptop will be an integral part of

this course and should be brought to class each week; it will be used to support your learning in a range of ways in our classroom, in your placement classrooms, and in the completion of our assignments. Several of your course assignments are designed to build your skill in working with the tools and software applications most useful to pre-k, K, or 1st grade teachers. If you do not have technical proficiency necessary to use these tools and applications, the expectation for this course is that you will take advantage of one of the many resources available to support you in developing these skills" (Instructor F′s syllabus). Instructors used laptop during the classes. Courtney said, "Several of them use PowerPoint lectures" (Interview). In addition, during her university class observation, instructors used laptop to present class information.

Second, instructor F, G, and I expected preservice teachers to use certain communication activities. Three instructors explained about using email in the syllabi, saying, "E-mail is recognized as an official mode of university correspondence; therefore, you are responsible for reading your e-mail for university and course-related information and announcements" (Instructor F′s syllabus), "You are expected to check your email on a daily basis and to respond to any inquiries from [instructor's and TAs' names] within 24 hours" (Instructor G′s syllabus), and "E-mail is recognized as an official mode of university correspondence; therefore, you are responsible for reading your e-mail for university and course-related information and announcements. You are responsible to keep the university informed about changes to your e-mail address. You should check your e-mail regularly and frequently—I recommend daily, but at minimum twice a week—to stay current with university-related communications, some of which may be time-critical" (Instructor I′s syllabus).

In addition, the instructor F expected using LMS for communication purpose, saying, "It is your responsibility to check the Blackboard course site regularly for class

work and announcements" (Instructor F′s syllabus). In practice, instructors used email for the communication with preservice teachers. All of the instructors shared their email address on syllabi to allow preservice teachers to communicate with the instructors. Additionally, instructor H shared her fax number for preservice teachers to communicate with the instructor (Instructor H's syllabus-a). Moreover, instructor F, H, and I shared their phone numbers for the last method of their communication method with preservice teachers.

Third, instructor F, G and I specified using productivity activities for students in their syllabi. Instructors required preservice teachers to use word processing application and PowerPoint. The instructor F specifically explained the format of written assignments in their syllabi, saying, "All papers must be word processed, double spaced, 12 point font, with numbered pages" (Instructor F′s syllabus), "5 Reading Responses of approximately 250 words (about 1/2 page, single-spaced, INSIDE AN EMAIL MESSAGE TO TA) " (Instructor G′s syllabus), and "Assignments (with the exception of Discussion Boards and Reading Logs) should be double-spaced, 1-inch margins and typed in a Times New Roman 12-size font" (Instructor I's syllabus). In addition, one instructor required preservice teachers to use PowerPoint, saying, "Group Presentations. You will be expected to work with a team of classmates to prepare and present one PowerPoint presentation" (Instructor G′s syllabus). During Courtney's university classroom, instructors' use of using PowerPoint was observed. Moreover, Courtney introduced that one of her instructor used an online PowerPoint, saying, "My teacher uses a lot of Glogster[4]" (Interview).

[4]Glogster is a "social network based on the creation and sharing of Glogs - interactive posters loaded with text, graphics, music, videos, and more." (Glogster, 2012)

Fourth, instructor F expected preservice teachers to use creation activities. The instructor asked to use video edition application, explaining "learning video (students working in groups/centers/projects) iMovie" (Instructor F's syllabus, Guiding Young Children in Groups).

Fifth, instructors F, G and I required preservice teachers to submit their assignment electronically. The instructor F and G required submitting assignment through email, saying, "These reading responses should be between 250-300 words in length and submitted to the TA via email with a heading indicating what Reading Response this is (see weekly topics table)" (Instructor F′s syllabus), "5 Reading Responses of approximately 250 words (about 1/2 page, single-spaced, INSIDE AN EMAIL MESSAGE TO TA)" (Instructor G′s syllabus), and "Note that you are required to submit an electronic draft of this paper one week in advance to your assigned peer reviewer" (Instructor G′s syllabus). Instructor I required preservice teachers to submit their assignments through LMS, explained, "Submitting: All assignments will be submitted through Blackboard and not through the instructor's e-mail" (Instructor I′s syllabus), "Each week, prior to class complete a minimum of two pages of a Double Entry Critical Summary Form with your responses to the readings and your thoughts about how can you connect the readings with your child's learning. The purpose of this reading and student learning log or journal is to make connections between the readings and your LCM child's learning. You will submit it through Blackboard three times," "Upload the handout on Blackboard (Assignments) and in the Discussion Forum so that your classmates have access to your Handout," and "Upload your Lesson Plans on Blackboard (Assignments) and in the Discussion Forum so that your classmates have access to your Plans" (Instructor I′s syllabus). Courtney reported her experience of

submitting her assignments through LMS, saying, “Submitted assignments Blackboard” (Interview).

A different way of electronic submission of assignment is submitting students’ assignment stored onto CD. Instructor F asked preservice teachers to submit their assignments stored onto CD, saying, “digital media, which includes your learning videos and learning photos, burned onto one CD. Please be sure that your iMovie will open and play in a computer other than your own” (Instructor F′s syllabus).

Sixth, instructor F, G, and I required preservice teachers to use a certain LMS, the Blackboard. The instructors described about the class requirement of LMS, saying, “A major component of the class will be the use of Blackboard, a Web-based course management system with password-protected access. It is your responsibility to check the Blackboard course site regularly for class work and announcements” (Instructor F′s syllabus), and “Use of Blackboard: A major component of the class will be the use of Blackboard, a Web-based course management system with password-protected access. It is your responsibility to check the Blackboard course site regularly for class work and announcements” (Instructor I′s syllabus). One of the purposes of using LMS was to share class resources, such as sharing course reading, lecture note, class related template and handout. Instructors explain in their syllabi as follow; “Course readings are available through Blackboard” (Instructor F′s syllabus), “Lectures will be posted after class on Blackboard” (Instructor F′s syllabus), “A summary sheet template is provided on Blackboard under the course documents folder” (Instructor F′s syllabus), “A set of readings available in Blackboard” (Instructor I’s syllabus), “Upload the handout on Blackboard (Assignments) and in the Discussion Forum so that your classmates have access to your Handout” (Instructor I′s syllabus), and “Please consult the Guidelines for Class Discussions’ handout made available on Blackboard” (Instructor G′s syllabus). The

other purpose of the use of LMS is posting reflection and reading responses. Instructor F, G, and I explained about the activities in their syllabi, saying, "Posting reflections and other mini-assignments linked to in-class activities and/or to work in your placement classroom" (Instructor F′s syllabus), "Reading Responses: Questions for each week's reading are available on the blackboard site, within Course Documents, entitled Questions for Readings" (Instructor G′s syllabus), and "Each week, prior to class complete a minimum of two pages of a Double Entry Critical Summary Form with your responses to the readings and your thoughts about how can you connect the readings with your child's learning" (Instructor I′s syllabus). Courtney reported her experience that her instructors required using "discussion board for us to share information" (Interview).

Although instructors required preservice teachers to use technology, all four instructors restricted technology use, as well. All instructors specifically notified laptop etiquette in their syllabi, "laptops must only be used in appropriate ways and at appropriate times" (Instructor F′s syllabus), "Laptops should NOT be open and operational during class, unless the instructor specifically requests you to use them during class" (Instructor G's syllabus; emphasis in original), "Laptops must only be used in appropriate ways and at appropriate times" (Instructor H's syllabus-b), and "Laptop etiquette is expected during lectures, discussions, etc. As with any course, your use of laptops and other electronic devices within class should focus exclusively on maximizing your learning of course material" (Instructor I′s syllabus). Additionally, all four instructors regulated using other digital devices and off tasks in classes, "Cell phones, smart phones, PDAs must all be silenced during class and left in your backpack or handbag" (Instructor G′s syllabus), "Classroom etiquette, another form of professionalism expected in this class, involves making a commitment to using your electronic devices only in appropriate ways and at appropriate times" (Instructor G′s

syllabus), “You should not be surfing the net, texting, twittering, checking email, shopping online, doing research, downloading pictures or videos, or completing assignments for other classes at times when you need to be participating in class and taking responsibility for your learning and professional development. Failure to display appropriate etiquette will be reflected in your course grade” (Instructor G′s syllabus), “Because you are a committed learner, I expect that you will use your laptop in appropriate ways and at appropriate times, and I expect that you will not be using your PDA, iPod/MP3 player, or cell-phone in class. Thus, committed learners should not be surfing the net, IM-ing each other, texting others outside class, checking email/my space/facebook, shopping, doing research, downloading pictures or videos, listening to music, or completing assignments for other classes at times when you need to be participating in class and taking responsibility for your learning and professional development” (Instructor F′s syllabus), “Please refrain from surfing the net, IM-ing, checking e-mail, shopping, doing research, downloading pictures or videos, or completing assignments for other classes at times when you need to be participating in class and taking responsibility for your learning and professional development” (Instructor F′s syllabus), “Cell phones must be silenced while in class. Pre-service teachers must refrain from text messaging while in class” (Instructor F′s syllabus), “Please, put any electronic device on vibrate mode. This should be done automatically as a courtesy to others. Answering of cell phones during class will not be accepted. I reserve the right to ask you to leave the class in such situations” (Instructor I′s syllabus), and “You are expected to refrain from personal Internet searching, instant messaging, e-mailing, and completing other assignments for this or other courses during our class time” (Instructor I′s syllabus).

Courtney's instructors required basic technologies, which were focused on assignment completion and submission. In addition, all of Courtney's instructors restricted technology use in classes.

Field-based PK-6 context

Courtney completed fieldwork in the Maplewood Elementary School, which was built in 1950. Courtney was placed in a first grade, bilingual class. In the school, there were 478 students in total, 45.4% of female and 54.6% of male. Students were grouped in five different ethnicities, Caucasian (48.7%), Hispanic (45.0%), African American (6.9%), Asian (1.3%), and Native American (0.2%). The school population also was categorized as: Economic disadvantage (53.1%), At-Risk (23.4%), Special Education (16.3%), Bilingual (11.3%), Limited English Proficiency (14.2%), Gifted/Talented (7.1%), English as a Second Language (1.9%), and First year US enrollment (1.7%). About 50% students of Maplewood Elementary School were in the economic disadvantage category, and less than 30% of students were at risk.

This school was equipped with technologies. There was a computer lab in the school library, and technology skills activities and practices were offered for students. In addition, the school started to pilot using iPods. In the classroom where Courtney was assigned, there were an innovation station, a DVD player, a video player, a television, a telephone, teacher's laptop, seven students' computer, and seven headsets, and wireless Internet.

Cooperating teacher's technology use. During Courtney's PK-6 classroom observation, her cooperating teacher used a microphone, document camera and projector. According to Courtney, the instructor used the microphone quite frequently and a projector (Interview). Courtney's PK-6 experiences seemed to focus on the use of technology for classroom management and information delivery.

Courtney's technology activities

Courtney used email, Word processing, PowerPoint, search engine, regional ISD website, a microphone, an innovation station, and LMS. Her use of technologies can be categorized as communication, productivity, web, and education specific activities during her program.

Communication activities. She used email for her communication activity. She was observed opening her email system during her university class (University class observation).

Productivity activities. Courtney used Word processing and PowerPoint for productivity activities. She used a lesson plan format, which was created with Word processing, and writing notes on Word processing (University class observation). She also described her use of productivity applications, saying, "I'm very visual person that I have to type everything. Easier for me to organize things in charts and a lot of handouts," "we can look through teacher book but it's better to type them up and modify them," "I need to create PowerPoint and Word processing handout," and "(I use my laptop for) typing and organizing documents" (Interview).

Web activities. Courtney used web search engine to search books, and she said, "I search Internet to research books or to reserve books that I'm gonna use in my lessons" (Interview). In addition, she reported that she looked at the regional ISD website to check the State mandated subject area information in her lesson plan (Interview).

Education-specific activities. During her teaching in the PK-6 class, she used a microphone and an innovation station to show information to students. Courtney wore a necklace-type wireless microphone during her teaching. She put the "My math problem book," which was part of the class activities, on the document camera and wrote a mathematical problem on the paper, which was shown on the screen to the students. In

addition, Courtney also used the innovation station to share students' assignments to all the students. She put students' assignments on the document camera and shared them with students (PK-School classroom observation).

Another education specific technology that Courtney used is LMS. She had to access the LMS to finish her assignment because her instructor posted lesson plan format in the LMS (University class observation).

At the university level, Courtney's technology use focused on assignment completion and delivery. In addition, for her teaching, she used technologies in the same way as her cooperating teacher. Courtney used a microphone and an innovation station, which focused on class management and information delivery.

Courtney's technology attitudes

Courtney expressed her attitude toward technology integration, confidence on technology integration and specific technologies. First, Courtney shared her positive thoughts about technology, saying, "Kids are very visual, too, and I consider myself is a visual learner, so it's easier to see the different formats. I think it's more engaging" (Interview).

Second, Courtney showed her confidence on technology integration. She said, "I feel confident that I am able to use it," and "I am pretty confident and familiar with technology" (Interview). Courtney said that the program did not amplify her confidence of integration technology very much, saying, "I've always been big on computer before the program, so I think either way I would have confidence without the program. It helps to do a lot of assignments on our computer, but I think it's just add-on, as I already have background" (Interview).

Last, Courtney shared her thoughts of specific technologies, such as laptop computer, LMS, microphone and an online game. First, she benefited using laptop

computer, saying “Very efficient to do activities like typing things up, pulling up information from [the school district], recording,” and “I don't have to go to the computer lab” (Interview). Second, Courtney valued using LMS for sharing files online. She said, “The reliability that every person can open the same file. Sometimes one file can be opened on somebody's computer but not opened on other's computer” (Interview). Third, she liked the advantage of using microphone, saying, “It helps because you don't have to raise your voice” (Interview). Fourth, Courtney favored online games, saying, “Classroom management is more effective, what if I don't have all the materials for kids to actually touch” (Interview).

Courtney already had positive attitudes and confidence about using technology and integrating technologies in teaching. She valued efficiency and effectiveness of technologies. However, she felt the experiences from the program did not enhance her confidence as the activities were already familiar with her.

Courtney’s technology knowledge

Courtney prepared an English Language Art and Science subject lesson plan titled The Wind Blew for 1st grade students. In her lesson plan, no technology was integrated. The lesson plan was developed based on a lesson plan template and the lesson plan template had no request for preservice teachers to infuse.

Sally

Sally is one of the second semester preservice teachers. She is a Hispanic female.

University context

This section describes Sally’s technology experiences in the university, including infrastructural information and instructors’ technology expectation, and their technology modeling.

Infrastructure. In the university classes, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet.

University instructors' technology expectations. Sally enrolled in four courses. Her instructors required preservice teachers to use the following technology activities. Table 28 shows the courses that Sally enrolled.

Table 28. Sally's instructors and courses

Instructor	Course name
J-a	School Organization and Classroom Management
J-b	Introduction to Teaching: Applied Learning and Development
K	Elementary Mathematics Methods
L	Reading Methods

Instructor J taught two different courses. For the later reference, School Organization and Classroom Management will be marked as a, and Introduction to Teaching: Applied Learning and Development will be marked as b.

Sally's instructors expected preservice teachers to use certain technologies. Table 29 summarizes the instructors' technology expectations.

Table 29. Technologies that Sally's instructors expected preservice teachers to use

Expected Technologies	**Instructors**
Email	J-a, J-b, K, L
Phone	J-a, J-b, K, L
LMS	J-a, J-b
Video Edition	J, L
Blogs	L
Electronic submission of assignment	L
PowerPoint	L
Web Page Creation	J-a
Word processing	L

First, Sally's instructors required preservice teachers to use communication technologies. Instructors used technologies for communication purposes, including email and phone. All three instructors shared their email address and phone numbers to allow

preservice teachers to communicate with their instructors. In addition, Instructor L required preservice teachers to use blogs. The instructor L was the only instructor who marked using blogs in their syllabi, explaining, “You will be blogging about these articles AFTER class is over,” “Reading Log: Your own journey as a reader is something you will document using the blog as well,” “As you are conducting the research in your classroom, you will post photos to the blog to document the types of texts in the classroom,” and “Along the way, continue to blog about the discussions that come up in your classroom and your reflections on these sessions” (Instructor L′s syllabus; emphasis in original). Using blogs was observed during Sally’s university class observation. In the TA’s presentation sheet, there was information about what to post in the blog, such as "Interesting things that you want to talk to your group about” and “1 question to pose to your group” (University class observation). During the class the TA recommended to write a reading reflection on their blog and the instructor recommended to groups about blogging about the class activity, as well. In the interview, Sally explained her instructors’ requirement of using blog, saying, “She's always having us have our computers open and ready to type, because we have our blogs as a part of our class” (Interview).

Second, the instructor K required preservice teachers to use productivity application in the syllabus. During observation, the instructor L explained that all the assignments should be written on the laptop by using word processing application and be sent through email (University class observation). Instructors also used the productivity application, PowerPoint (University class observation). During Sally’s university classroom observation, instructor L mainly used PowerPoint to show information. In the presentation, there was information about topics for blogging posts, activity description,

and agenda for next week. Sally said, “They use a lot of PowerPoint and projectors. That's all I've seen from them” (Interview) about her instructors’ technology use.

Third, instructor J required preservice teachers to do creation activities. The instructor J required recording and editing video in the syllabus b. Instructor J first required the second-semester preservice teachers record video, describing, “Plan and teach in a more indirect instructional environment. Video-tape at least part of this lesson. Transcribe a portion. Critique your lesson -- two pages. Video-tape at least a part of one of your tutorial lesson” (Instructor J’s syllabus-b). In addition, instructor J required preservice teachers to use picture resources “We will provide guidance for you to complete this assignment in class, but along the way, feel free to snap pictures of texts that are used and created in the early days of the school year” (Instructor J’s syllabus-b).

Fourth, instructor L required preservice teachers to submit their assignment electronically. There was no information about submitting assignments electronically, but during Sally’s university class observation, her instructor notified that the assignments should be submitted through email (University class observation).

Fifth, instructor J (a, b) required preservice teachers to use LMS, the Firstclass. Instructor J required preservice teachers to write reading posts on LMS, explaining, “You are required to respond to all assigned readings on Firstclass. Responses must be posted by 9:00 the night before class. You will also have responsibility, at least once in the semester, to respond to other students. You will have this opportunity all of the time” (Instructor J’s syllabus-a), and “Read and respond on Firstclass to all assignments” (Instructor J’s syllabus-b). During observation, instructor L’s use of LMS was observed. The instructor projected small group information, which was in the LMS (University class observation).

Sixth, instructor J-a required preservice teachers to develop web page. He described the assignments as follows, “We expect this model to become part of your professional website” (Instructor J’s syllabus-a), and “Website: You will prepare a professional website. This will be both a “cohort” and an individual project and will be linked to a project next semester where you build a classroom website” (Instructor J’s syllabus-b). According to Sally’s interview, the purpose of developing a website is to have their “website portfolio for future employment” (Interview).

Sally’s instructors supported technology use; however, some instructors also limited preservice teachers’ technology use in class. One of the four instructors notified digital device regulation in the syllabus, explaining, “Silence your cell phone, of course, and please resist the urge to check your personal online accounts or carry out your personal business on the computer during class. It’ll help you to stay present” (Instructor K’s syllabus). Moreover, Sally said during the interview, “Still there are instructors who say close the computer. Because they think if computers are open then you'll be distracted” (Interview).

There were technologies that instructors used but not described in the syllabi. During the observation, the TA used web search function twice to search proper information. Once, she used online dictionary website to search vocabulary, and next, she used Google to search class relevant information.

Sally experienced two new technologies from two university classes, blogging and webpage creation. Out of all participants’ technology experiences throughout the program, these two technology activities were the only new technologies for Sally.

Field-based PK-6 context

Sally completed fieldwork in the same PK-6 school with Courtney, Maplewood Elementary School. Sally was placed a multiage classroom, including third and fourth grade students.

In the classroom where Sally was placed, there were an innovation station, a CD player, a CD/CDV/LD players, a DVD player, a special microphone for a student who has a hearing impairment, an overhead projector, a printer, 7 desktops and 15 laptops for students, teachers' laptops, a telephone, a television, a video player, wireless Internet.

Cooperating teachers' technology use. Sally had two cooperating teachers. First, one of the teachers used a microphone. There was a student who had hearing impairment; therefore the teacher used a wireless microphone that sends her voice to the student's special earphones to support his hearing. Second, the same teacher used a document camera and projector. During the class observation, a teacher used a document camera to show how to solve mathematics problems to the students. The teacher put mathematics problem sheet on the document camera and projected the problem solving process. Sally confirmed the cooperating teachers' document camera use during the interview, saying, "[The cooperating teachers used] Elmo (document camera) and projector for pretty much every lesson in order to show them (the students) documents and stuff" and "They always were using computers and overheads and Elmo, websites, used in every class" (Interview). Third, the teachers also used overhead projector to visualize information, which was observed during the language art class. The teacher showed textbook contents to the students with the overhead projector. Fourth, the teachers used a word processing application to organize textbook lists. Fifth, the teachers used Internet. Sally described her cooperating teachers using Internet resources and applications frequently, saying, "They always were using computers and overheads and Elmo, websites, used in every

class," and "My teachers use a web site which has a lot of videos, and games of the students can play. There were quite a few websites" (Interview). Data collected from Sally showed that she observes technology used for information presentation and visualizing information for students. Last, the teachers let the students develop PowerPoint presentation about Maplewood Elementary School teachers. The PowerPoint development activity was totally student-centered collaborative activity. The student-centered PowerPoint development activity confirmed that young students learn technology very fast and technology integration in teaching and learning is important (Interview).

Sally's Technology activities

Sally used email, blog, Google document, electronic portfolio, DVD, and LMS. Her use of technologies is categorized as communication, productivity, and education specific activities.

Communication activities. Sally used email and blog. She used email during her university class (University class observation). In addition, blogging was one of the assignments. She said that "I should take pictures and see all the text in the classroom and analyze, which should be posted on my blog for my preservice teacher preparation program class," and "I use blog for my classes" (Interview). Sally's use of blog was observed during her class. She wrote a blog post after she finished her reading assignment and after she finished her class activity (University class observation).

Productivity activities. Sally used word processing. She used the word processing and Google document. Sally used Word processing to take a note. She said, "My computers are useful. That's the way I take notes" (Interview). In addition, Sally used Google document. She explained her experience using Google document saying, "I need to interview two of the students from time to time about reading texts in the classroom

and write the interview content on Google doc to share with cooperating teachers and instructor," and "Resource that I constantly use to take notes, to write papers, to write teacher's journal with Google docs. I use Google docs for taking notes and when something comes up to talk about" (Interview).

Web activities. Sally used electronic portfolio. She said, "I recently started the e-portfolio for my future resume" (Interview).

Education-specific activities. She used DVD to present information. She said about her experience, "For lessons I used laptop to show a DVD for language art. I use it a lot" (Interview). Another technology that Sally used for education specific purpose was LMS. She should share her reading reflection with her instructor and classmates through the class LMS. She shortly explained her experience, "Write reflection and responses to other's reflections" (Interview).

Sally's technology attitudes

Sally shared her confidence in technology integration, saying, "I really feel confident. I feel really appreciated that I am in the classroom that uses so much technology, being able to see integrating technology in our class. It's really helpful. It makes me feel comfortable. When I make students to use PowerPoint and website, it's not a big deal as I am familiar with it. I will feel more comfortable about me and my students because it's not a novel experience" (Interview).

Second, Sally shared her positive thoughts about technology integration in education, saying, "It's good for teachers to be knowledgeable and to begin using these resources," and "When I have interview, I will ask what resources are available to me as the first year teacher. I am so interested in the technologies" (Interview).

Third, Sally shared her positive attitude on students' technology use and experience, saying, "Students in the world surrounded with technology, introducing them

every type of technology like PowerPoint, Word, which were developed on their laptops, it's beneficial to them as they will gonna use them," "it is good to use tech in young age, as that is what they will do in their high school and college. They need to be expert before that," "It is amazing they pick it up very fast and how enthusiastically engage they are whenever they have the opportunity to use the technology," and "Give them the opportunity" (Interview).

Last, Sally expressed her attitude toward specific technologies, such as computer, document camera, PowerPoint, developing a portfolio website, and Smartpen. First, Sally talked about the usefulness of computers, saying, "My computers are useful" (Interview). Second, Sally benefited document camera, saying, "[Document camera is] important technology for education," "Accustomed with projector and Elmo. Easier for the students to see, easier for teachers to visualize, which is important for students," "I am definitely planning using it. I am already pretty much decided of the school doesn't have the resources, projector and Elmo then I will get donation or buy one by myself. I find it is very useful" (Interview). Third, Sally valued using PowerPoint to visualize information for students, saying, "They work. We used PPT for some of our lessons. It is just one way to visually show what we're teaching. Kids get engaged because they love technology" (Interview). Fourth, Sally positively thought of her experience of developing portfolio website, saying, "In this semester, I've really gotten it because of portfolio website, because we're using it in multiple classes, which wasn't done last semester" (Interview). Last, Sally explained her positive attitude in using Smartpen, saying, "Smart pen, I used it for tutoring. I recorded students' reading. I will use it in my own classroom for short interviews, guided reading," and "One of my cohort students (preservice teacher) has one. I was pretty amazed, so I just got it. It is pretty interesting. There are lots of things that you can do with it in the classroom" (Interview).

PK-6 school classroom experiences enhanced Sally's confidence and technology attitudes. Sally saw technology integration examples from her cooperating teachers and students' technology use in classes, which were familiar technology activities to her. The familiarity enhanced Sally's confidence and technology attitudes, as she realized that her technology knowledge and skills were applicable in real teaching and learning environment.

Sally's technology knowledge

Sally prepared a Language Art lesson plan for multi grade students, including third and fourth grade students. In her lesson plan, Sally integrated using supportive DVD of a book, named Click Clack Moo: Cows That Type. Instead of reading the book itself, Sally planned to show the DVD movie that was developed based on the book story. The use of DVD movie was rated in all of the TPACK components (See Table 30). The DVD animation was used for subject matter development, as well as for motivating students. And the DVD was the main resource of presenting information to the students. Therefore, in the first component, an overarching conception about the purposes for incorporating technology in teaching subject matter topic, Sally's technology knowledge was rated in the Accepting level. The DVD motivated students' learning and was the learning resource for students, therefore, in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology, use of the DVD movie was rated in the Accepting level. This DVD was one-way information presentation tool, which just replaced textbook information into animated information. And the information was closely related with instructor's curriculum goal, thus the third component, Knowledge of curriculum and curricular materials that integrated technology in learning and teaching subject matter topics, was rated in the Adapting level. The instruction was totally teacher-led, so, the last component, Knowledge of instructional

strategies and representations for teaching and learning subject matter topics with technologies, was rated in the Accepting level.

Table 30. TPACK Components and levels of Sally's lesson plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Technology is used for either or both motivation and actual subject matter development. • Main purpose of technology use is for demonstrations, which include presenting new knowledge.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Teacher sees the technology as either or both a motivational and learning tool.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • The technology is used as a replacement for non-technology based tasks in a traditional curriculum approach. • Technology is aligned with one or more curriculum goals.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Accepting** • The instructions are teacher-led. Teacher structures lesson plan with limited student explorations with technology.

Distinctions in the second-semester preservice teacher cases

Courtney and Sally were in different cohorts but had fieldwork at the same PK-6 school but with different cooperating teachers in different classes. Courtney and Sally had different technological experiences in both university classes and fieldwork.

Some of the instructors of Courtney and Sally expected the same technologies for the preservice teachers to use during the second semester of the program. Four instructors (Instructor F, G, H and I) taught Courtney, and three instructors (Instructor J, K, and L)

taught Sally. Instructors required preservice teachers to use email (Instructor F, G, I, J, K, and L), word processing (Instructor F, G, I and L), presentation (Instructor G, and L), video edition (Instructor F, J and L), electronic submission of assignments (Instructor F, G, I, and L), and LMS (Instructor F, G, I, and J).

Compared to Courtney, Sally's instructors expected more technology use. Instructor L and J expected the preservice teachers in the second semester of the program to use blogs and web page development, respectively. Blog was a communication tool to share information with other preservice teachers and the instructor. And the purpose of web page development was to build an e-portfolio for future job search. Sally enjoyed the new technology experiences from the university classes and expected to use those technologies in her future teaching. Instructors required second semester preservice teachers to use and to be exposed various technologies. However, instructors F, G, H, I (all of Courtney's instructors) and K (one of Sally's instructors) limited technology use to avoid off-task technology behaviors in class.

Courtney and Sally had different technology experiences in their field work. In the PK-6 school classes, they both had innovation stations, DVD player, video player, TV, telephone, teacher's computer, students' computers, headsets, and wireless Internet. In Sally's classroom, there were CD/DVD/LD player and overhead projector, additionally. The cooperating teachers of Courtney and Sally both used a microphone, a document camera, and a projector. Sally's cooperating teacher additionally used an overhead projector. The cooperating teachers mainly used technology for information delivery and presentation.

Only Courtney did teaching in the PK-6 school class. Courtney used information delivery technologies, including document camera and digital projector, and class

management technology, a microphone, which were all activities that Courtney observed her cooperating teacher use.

Sally also observed her cooperating teachers mainly used information delivery technologies and class management technology. Additionally, Sally observed that her cooperating teachers allowed students to use computers during a class session. Sally's cooperating teachers let students create a presentation by using PowerPoint. At this time, students were the leader of technology experience. Even the cooperating teachers confessed that students were the experts of using technology during this project time. Thus, Sally observed a student-centered technology experience.

At the end of the second semester, Courtney and Sally had positive attitudes toward technology and technology integration. However, Courtney said that her confidence had not changed because she already had confidence, and technology activities from the program were already familiar. On the other hand, Sally said that she could apply her technology skills in her teaching, which was a good experience for her and strengthened her confidence.

Between Courtney and Sally, only Sally showed her technology knowledge evidence in the lesson plan. Courtney did not include technology in her teaching (lesson plan). Even though she used an innovation station during her teaching, for her lesson plan, she did not integrate the device. Sally added DVD in her lesson plan. She integrated DVD to present main content information. Sally's use of DVD was focused on information presentation, and teacher-centered. Therefore, based on the TPACK rubric, her technology use rated at the 2/5 (Accepting) level.

THIRD-SEMESTER (STUDENT TEACHING) PRESERVICE TEACHER CASES

This section reports technology experiences of Arden and Neal, who are in their third semester of the program, which culminates with their graduation and teacher certification.

Arden

Arden is a Caucasian female. She is cautious about integrating technology in education for technology's sake.

University context

This section describes Arden's technology experiences in the university, including infrastructural information and instructors' technology expectation, and their technology modeling.

Infrastructure. In the university classes, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet.

University instructors' technology expectations. Arden enrolled in one course, Elementary Science Methods (See Table 31). The instructor M required the student teachers to use technology for their class activities in the syllabus. First, the instructor required preservice teachers to use certain communication activities, especially, using Email. The instructor emphasized the importance of using email for class, saying, "Email is recognized as an official mode of university correspondence; therefore, you are responsible for reading your email for university and course-related information and announcements. You are responsible to keep the university informed about changes to your e-mail address," And "You should check your e-mail regularly and frequently—I recommend daily, but at minimum twice a week—to stay current with university-related communications, some of which may be time-critical" in the syllabus (Instructor M's syllabus).

Table 31. First Semester Coursework for Isaac

Instructor	Course Name
M	Elementary Science Methods

Second, the instructor M specified using word processing for student teachers in the syllabus. The instructor required "All assignments should be typed," specifically describing the format of the writing assignments "All written work must be word-processed using single-spacing and a 12 pt font size. Margins should be one inch" (Instructor M's syllabus). In practice, the instructor used PowerPoint for her class. Arden shared her experience observing her instructor's technology use, saying, "(I saw the instructors) put things on PowerPoint, but that's the only technology that I saw them using" (Interview).

Third, the instructor M required student teachers to submit their assignments electronically. The instructor described in the syllabus of the course named Elementary Science Methods, "Students are expected to email me all assignments with no typographical or grammatical errors," and "All assignments should be typed and emailed to me." During the university class observation, her announcement about sending the final assignments to her through email was observed (University class observation).

Fourth, the instructor M required the students to use LMS, the Blackboard. Except introducing that the class is required to use the Blackboard, there was no other data about LMS use in her syllabus.

The instructor M's technology requirement reinforced using productivity technology activities. In addition, the instructor M's technology requirement focused on assignment completion and delivery.

Field-based PK-6 context

Arden completed field work, student teaching, in the 5th grade classroom of Beacon Elementary School, which was built 1986. There were total 508 students, 47.0% of female and 53.0% of male. Students were grouped in five different ethnicities, Hispanic (45.7%), Caucasian (40.7%), African American (9.8%), Asian (3.0%), and Native American (0.8%). The school population also was categorized as: Economic disadvantage (52.2%), At-Risk (19.1%),Special Education (17.9%), Limited English Proficiency (9.6%), English as a Second Language (5.1%), Bilingual (3.9%), Gifted/Talented (2.8%), and First year US enrollment (0.6%). About 50% students of Maplewood Elementary School were in the economic disadvantage category, and less than 20% of students were at risk.

The school was equipped with technologies. In Arden's classroom, there were an innovation station, calculators, an overhead projector, six students' computer, teacher's computer, a telephone, a timer, a television, a video player, and wireless Internet.

Cooperating teacher's technology use. Arden was a focal teacher, therefore, she might have more time to teach rather than observing cooperating teachers' teaching. From Arden, no information was collected about cooperating teachers' use of technology as Arden taught the class on her own.

Arden's technology activities

This section describes Arden's technology activities during the last semester of the program.

Communication activities. The survey results showed that Arden used all the communication activities, except writing/editing wiki and participating in text messaging via phone. Among the activities that Arden did, only sending email was used more for

educational purposes and the rest of the activities were used more or totally for personal purposes.

Arden's mean score of purpose of use of communication activities is 1.8, which indicates that she used communication activities more for personal rather than educational purposes. The mean score frequency of communication activities is 2.4, which indicates that Arden used communication activities at an almost daily frequency (See Table 32).

Table 32. Arden's communication activities

Communication Activities	**Use***	**Purpose****	**Frequency*****
Send email	Y	6	4
Read email	Y	4	4
Read Blog	Y	1	3
Read online discussion boards/forums	Y	1	3
Read Wiki	Y	1	2
Participate in text-based instant messaging	Y	1	2
Send messages to an email listserv	Y	1	2
Participate in Online Audio/Video interactions	Y	1	2
Write/Comments on Blog(s)	Y	1	1
Post/send messages to online discussion boards/forums	Y	1	1
Write/Edit Wiki(s)	N	-	-
Participate in text messaging via phone	N	-	-

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Web activities. Table 33 shows Arden's use of technologies for web activities. Arden accessed music or videos, used the Web from her cell/smart phone, participated in social networking websites, and downloaded music, video or podcasts. Out of the used web activities, Arden used the university library website for both educational and personal purposes, but rest of the activities were used more or totally personal purposes.

The mean score of purpose of Arden's use of web activities is 2.5, which indicates that she used web activities more for personal rather than educational purposes. The mean score frequency of web activities is 1.5, which indicates that Arden used web activities between monthly or less and weekly.

Table 33. Arden's Web Activities

Web Activities	**Use***	**Purpose****	**Frequency*****
Use the university library website	Y	5	1
Download music, videos or podcasts	Y	2	1
Access music or videos	Y	2	1
Participate in social networking websites	Y	1	3
Use the Web from a cell/smart phone	N	n/a	n/a
Participate in online Multiuser computer games	N	n/a	n/a
Participate in online Virtual worlds	N	n/a	n/a
Build and tag bookmarks socially	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Arden explained her use of web during the interview, saying, "Document camera and projector and Internet, those are the technologies that I used only" (Interview). Arden's access of web resources was observed in her university class. During university class, she opened search engine, Google map and job search website (University class observation).

Productivity activities. Table 34 shows Arden's use of technologies for productivity activities. Arden used presentation software, word processing and spreadsheets. Presentation and word processing were used more for educational purposes and Spreadsheets were used more for personal. Word processing was used very frequently, but the other two applications were used less than weekly.

Arden's mean score of purpose of use of productivity activities is 5, which indicates that she used productivity activities for both personal and educational purposes. The mean score frequency of productivity activities is 2.4, which reflects Arden used productivity activities at an almost daily frequency.

Table 34. Arden's Productivity activities

Productivity Activities	**Use***	**Purpose****	**Frequency*****
Use Presentation software	Y	7	1
Use Word Processing	Y	6	4
Use Spreadsheets	Y	2	2
Use Online productivity suite	N	n/a	n/a
Use Concept Maps	N	n/a	n/a
Use Desktop Publishing	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Arden described her use of productivity activities. "Other than that, the only technology I used was a word processor to type up the directions for each station" (Lesson Plan). "I really do anything with my laptop. I use my laptop for everything. I take notes on papers, everything is on the computer. I think that's just my generation. That does things a lot easier to categorize things, everything's neat, scrolling, I have fly pen, if I draw on a paper it will automatically transfer it to my computer" (Interview). Arden's use of word processing was observed during her student teaching at the PK-6 school class. Arden opened a word file written "The position, direction, and motion of an object changes when a force is applied" and projected it through the projector (PK-6 classroom observation).

Arden also shared her experience using PowerPoint at the interview. She said, "So I wanted to make a PowerPoint presentation that showed pictures from all of the world, showing geographic features, fjords, mountains" (Interview).

Creation activities. Table 35 shows Arden's use of technology for creation activities. She produced podcasts, created or modified digital pictures or arts, and digital video, and produced vodcasts or screencasts. However, the purpose of the activities Arden did was either more or totally personal. Arden's mean score of purpose of use of creation activities is 2, which indicates that she used creation activities more for personal rather than educational purposes. The mean score frequency of creation activities is 1, which indicates that Arden used creation activities at a monthly or less frequency.

Table 35. Arden's Creation activities

Creation Activities	**Use***	**Purpose****	**Frequency*****
Produce podcasts	Y	4	1
Create or modify digital pictures or arts	Y	2	1
Create or modify digital video	Y	1	1
Produce vodcasts or screencasts	Y	1	1
Create digital photo galleries or albums	N	n/a	n/a
Create or modify digital audio	N	n/a	n/a
Create or modify web pages	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Education-specific activities. Table 36 shows Arden's technology use for education specific activities. Table shows that she used only utilizing subject-specific software or technology for discipline, which she used daily.

Table 36. Arden's Education Specific activities

Education Specific Activities	**Use***	**Frequency****

Utilize subject-specific software or technology for your discipline	Y	3
Participate in Course Management Systems	N	n/a
Build an electronic portfolio of my coursework	N	n/a

* Y: Yes, N: No
** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Arden used various technologies for education specific activities. Arden used an innovation station for presenting information to her students. During an interview, Arden described her use of document camera and projector, which are parts of the innovation station, saying, "Document camera and projector, Internet. Those are the technologies that I used only" (Interview). During her PK-class teaching, Arden connected her laptop to the innovation station to show online movie clips from Google movies, Brain POP, discovery education website (PK-6 school class observation). In addition, she used overhead projector to show her students. She described her experience of using overhead projector in her lesson plan, explaining, "I used the overhead for the warm-up and direct teach portion, so that all students could see what I had been doing" (Interview).

Arden used laptop and other technologies for various activities, such as communication, web, productivity, creation and education specific activities. Among them, the survey data reveals that Arden used productivity activities most for educational purposes, except education-specific activities, and she used them more for both educational and personal purposes. Arden used Communication and Productivity activities most frequently. From the results, on average, Arden did not use many technology activities for educational purposes or very frequently. Table 37 summarizes Arden's technology activities.

Table 37. Summary of Arden's technology use before they entered program

Technology Activities	**Mean Score Across All Activities**	
	Purpose*	**Frequency****
Communication	1.8	2.4
Web	2.5	1.5

Productivity	5	2.4
Creation	2	1
Education Specific	n/a	3

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Arden's technology attitudes

Arden's survey results showed that the mean score of her digital technology self-efficacy was 2.94. The digital technology self-efficacy ranges from 1.0, which means low/very negative, to 4.0, which means high/very positive. Therefore, her mean score shows her moderately positive attitude to digital technology.

Also, Arden shared her perception of her expertise of digital technology activities. Arden thought her expertise levels of technology activities are all medium, fairly skilled (See Table 38).

Table 38. Arden's perception of her expertise of technology activities

Technology Activities	**Perception***
Communication	Fairly skilled
Web	Fairly skilled
Productivity	Fairly skilled
Creation	Fairly skilled
Education Specific	Fairly skilled

In addition, the mean score of Arden's learning technology attitude was 2.83. The learning technology attitude ranges from 1.0, which means low/very negative, to 4.0, which means high/very positive. Therefore, Arden's mean score of the learning technology attitude shows her moderately positive attitude.

Arden showed her attitude toward technology, confidence with technology integration in education, laptop requirement, and a specific technology, document camera. First, Arden shared her opinion that schools force teachers to use technology for

the sake of technology use, not for enhancing teaching and learning, saying, “Also technology is something that people and school brag about sometimes, it's just sometimes it's just you have to do because the principal wants you to use technology. So you can just usually talk about something it might be more engaging but you're forced to make technological presentation so I think it's got two sides,” “I think that people try to find one solution to fix a whole problems and sometimes they think technologies the way you'll solve the problems, and I don't think it's that easy,” and “If it doesn't help improve anything then why do you use it? PowerPoint was just kind to show things, using something more technological wouldn't improve the process” (Interview). In addition, Arden thought that technology is a small part among many aspects that teachers need to have, saying, “There are 500 more important things than using technology in classroom that I have to deal with. Some are better for integrating technologies but some of them are so focused 499 things we had to learn. So there was no big emphasis on technology [in my teaching]” (Interview). Arden was wary of using technologies without purpose, but she claimed she benefited from using technologies, as well, saying “to some extent, technologies used to help me bringing things to kids wouldn't already see, for example, geographic pictures, I was confident that my students hadn't seen mountains before, so I want to make a PowerPoint presentation that showed pictures from all over the world, showing geographic features, fjords, mountains, and kids were really liked them, so that's technologies role that benefit me” (Interview).

Second, Arden showed confidence with technology integration in education, saying, “I feel capable of doing it,” and “I've known a teacher I've worked with who struggled everyday with using a computer which is very sad to me because it seems too intuitive to me. I feel confident right now” (Interview).

Third, Arden valued using document camera, explaining, “I think I've had a lot of success in using document cameras, projectors, because you don't have to run down for transparencies (go to the copy room), you can write on things and you can show students work in progress. I really like the document cameras and I hope they get installed in more schools. Computer projectors that can project from computers are just great. Then you can watch out the videos of the Internet which are free and fast,” and, “I think the document camera transforms the way I teach radically,” “the document camera filled the void where I couldn't before with overhead that couldn't display student work, I had to make transparency for everything, you couldn't have things in color, I couldn't put a book under on an overhead and show the test from the book and stuff, but this document camera fill that problem, which is being able to show the books, student work without transparency” (Interview).

Arden was confident in using and integrating technologies in her teaching. However, she was cautious about integrating technology in teaching just for technology’s sake. In addition, she thought that technology integration was an additional burden to teachers who should have multiple knowledge and skills.

Arden’s technology knowledge

Arden prepared a mathematics subject lesson plan about fraction for 5st grade students. In her lesson plan, she integrated an online game for students to practice what they learned at the class. The game allowed students to practice fractions. Using an online game motivates the student, as well as develops subject matter understanding. Therefore, the first component of the TPACK rubric, an overarching conception about the purposes for incorporating technology in teaching subject matter topic, Arden’s technology knowledge is rated in the Accepting level. The online game helps students to practice to understand what slide, flip and turn means, repeatedly. Rather than getting new

knowledge, it is practicing learned knowledge. Therefore, in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology, use of the online games is also rated in the Recognizing level. This online game used as an add-on to practice what students learned from their textbook aligned with curriculum goal. Therefore, in the third component, Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, Arden's use of technology is rated in the Accepting level. This activity of using an online game to learn mathematics vocabulary is closely related with subject-matter objectives. Therefore, in the last component, Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, Arden's technology use is rated in the Adapting level. For more specific description of each component and levels (See Table 39).

Table 39. TPACK Components and levels of Arden's use of an online game

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Main purpose of technology use is for demonstrations, which include presenting new knowledge.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Recognizing** • Technology is used primarily for student practice. • Technology integrated activities do not present any new material, and only provides space for applications and drills.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Accepting** • Teacher uses textbook-based approach to the curriculum topics with technology being used as add-on. • Technology is partially aligned with one or more curriculum goals.
Knowledge of instructional strategies	**Adapting**

and representations for teaching and learning subject matter topics with technologies	• Technology integrated activities are focused primarily around subject-matter objectives.

Arden described her practice of teaching and integrating other technologies in her teaching from her TPACK survey. She used an overhead projector. She wrote, "I used the overhead for the warm-up and direct teach portion" (Lesson Plan). Table 40 shows TPACK components and level of Arden's use of Overhead projector.

Table 40. TPACK Components and levels of Arden's use of Overhead projector

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Main purpose of technology use is for demonstrations, which include presenting new knowledge. • Technology integrated activities procedures concentrate on teacher demonstration and practice.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student follow work with technology, it is rarely used for students' independent explorations.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Teacher uses didactic (teacher-directed) approach to teaching with technology to maintain control of the progression of the activities.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Recognizing** • Technology integrated activity provides students only with opportunities for drill and practice, or for listening, receiving information.

Neal

Neal, the other student teacher, is a Caucasian male. He used work at a computer related company. He got interested in technology integration in education from this work

experience. Therefore, in his mid-30s, he entered in the preservice teacher preparation program.

University context

Neal was in the same cohort and class with Arden. Therefore, I will simply summarize the university context information, which is the same as reported for Arden.

Infrastructure. In the university classes, there were a media cart, an instructor's laptop, students' laptops, and wireless Internet.

University instructors' technology expectations. The student teachers took only one course during the semester, and Instructor M taught the class. Instructor M expected preservice teachers to use email, word processing, electronic submission of assignments, and LMS, which focused on assignment completion and delivery.

Field-based PK-6 context

Neal was placed in the 5th grade classroom of Silver Creek Elementary School, which was built in 1971. There were 464 students in total, 48.5% of female and 51.5% of male. Students were grouped in five different ethnicities, Hispanic (80.4%), Caucasian (14.2%), African American (2.6%), Asian (2.2%), and Native American (0.6%). The school population also was categorized as: Economic disadvantage (82.1%), At-Risk (48.5%), Limited English Proficiency (44.2%), Bilingual (41.2%), Special Education (15.3%), First year US enrollment (8.4%), English as a Second Language (2.8%), and Gifted/Talented (0.6%). More than 80% students of Silver creek Elementary School were in the economic disadvantage category, and almost 50% of students were at risk. More than 40% of students had limited English proficiency and were bilingual.

The school was equipped with technologies. Neal taught in two different classes. In the first classroom, there were 5 student computers, headsets, screen, 2 overhead

projectors, a telephone, a teacher's laptop, and calculators. In the second classroom, which was his homeroom, there were four student computers, an innovation station, calculators, a telephone, a teacher's laptop, four headsets with students' computers, and wireless Internet.

Cooperating teacher's technology use. Neal also was the focal teacher in his placement classroom. During his class, he led the class teaching. However, his cooperating teacher was ready to help his teaching and technology integration during his teaching. Once, the cooperating teacher supported his teaching and used her laptop and projector to show Internet resources to the students.

Neal's technology activities

Neal used email, search engine, online videos, online games, Google Earth, digital photos, PowerPoint, an innovation station, and an overhead projector. His use of technologies can be categorized with communication, web, productivity, creation, and education-specific activities.

Neal did not complete the survey; therefore, I could not get the information about his technology activities from the survey.

Communication activities. Neal used email. Neal's use of email was observed during his university class. Neal read and sent emails during his university class (University class observation).

Web activities. Neal used technology for web activities, such as search engine, online videos, online games, and Google earth. During interview, Neal explained about an example of using search engine, saying, "In a third grade teaching, language arts, reading, story about family from Korea, and the student was reading his grand parents' letter who are still in Korea, and he talked about persimmon, none of the kids in the class ever heard of it. I looked up the persimmons and hooked it up with an innovation station"

(Interview). Neal shared his experience accessing online videos to show relevant information to students, saying, “I found the Discovery streaming videos online, I used my laptop to show the videos. After students' activities, I played the videos afterward to support what they learned and remind scientific name,” and “[my students] watched some videos” (Interview). In addition, Neal also accessed the web to allow students to learn from online games, which he explained as follows, “(I used) interactive online games to teach the topic (voyage from Europe to America)” (Interview). He included using web activities in his students’ class activity. In his lesson plan, Neal described an activity, which needed Google Earth, “The activities allow students to explore Google Earth to find endangered species, engaging students as they learn” (Lesson Plan).

Creation activities. Neal used pictures to visualize information. Neal used PowerPoint to show lesson information about a coral reef to the students, and in the presentation, he used pictures, which were taken by him. He explained his use of creation activity during the interview, saying, “The Power Point that accompanies the lesson adds a technology and visual aspect to the audio aspect of what I say throughout,” and “Many of the pictures featured in the presentation were taken by me while scuba diving on coral reefs in Mexico and the students really get into it if they know I have been there” (Interview).

Productivity activities. Neal used PowerPoint. His use of PowerPoint was observed in the university class. He presented about his scientific experiment to the classmates. Neal used PowerPoint in his PK-6 classroom to show lesson information about coral reefs to his students. He explained about his experience during interview, saying, “The Power Point that accompanies the lesson adds a technology and visual aspect to the audio aspect of what I say throughout” (Interview).

Education-specific activities. Neal used an innovation station. During the interview, Neal described his experiences of using the innovation station at the PK-6 school, saying, “In a third grade teaching, language arts, reading, story about family from Korea, and the student was reading his grand parents' letter who are still in Korea, and he talked about persimmon, none of the kids in the class ever heard of it. I looked up the persimmons and hooked it up with the innovation station” (Interview). Neal also connected the innovation station with his laptop to show web resources to the students. During the interview, he said, “I found discovery streaming videos online, I used my laptop to show the videos. After students' activities, I played the videos afterward to support what they learned and remind scientific name” (Interview). His use of the innovation station and laptop to show online learning movie was observed in his PK-6 school. Neal opened his laptop and connected it with the innovation station. And access to the discovery education website to show a movie about Puritans' transfer to America (PK-6 school class observation). He also accessed the Optical Research Association website and showed text information about light (PK-6 school class observation).

Neal used a document camera, which is a part of the innovation station, to show information about how to use solar calculator. During the PK-6 school class teaching, he made students use a solar calculator. To instruct how to use the solar calculator, Neal used document camera and projected the demonstration of how to use it (PK-6 school class observation). To show information, Neal also used Overhead projector (OHP) to show how to solve a mathematics problem in the classroom that did not have the innovation station. The OHP was used during a mathematics class. Neal put the mathematics problem sheet on the OHP to show the questions to the students (PK-6 school class observation). In addition, he showed how to solve those mathematics

problems (PK-6 school class observation). During the problem solving process, students asked how to solve 3¾, thus he showed how to solve it (PK-6 school class observation).

Neal integrated technologies as much as he could in his teaching. Neal used technology for delivering information to students. Also, he let students use technologies to construct and to build knowledge on their own.

Neal's technology attitudes

Neal expressed his positive attitudes toward technology integration in education, students' technology use, confidence, and specific technologies. First, Neal had positive attitude toward technology integration in education, saying, "I feel good about where I am about based on completing my education. But also I realize that I am gonna be learning. My real education begins when I get my own classroom. I will always gonna watching for, I feel good about where I am right now, but I am not satisfied. I want to continue to evolve and learn new technologies. I know there are a lot out there right now and I don't know about, but I am always open to, ready to learn new things, not for the sake of using technology but because there's a lot of stuff out there that can be used to really enrich learning. I am very confident but I am also, part of my confidence is I will never stop learning," "I've always understood value and power in technology in our world today. I know how important technology can be in education," and "I always felt like, I always has opinion that technology can and should be used in education" (Interview).

Second, Neal thought allowing students to use technology was important. He said he allowed students' computer use and said, "They've got to use computers" (Interview).

Third, Neal was confident in integration technology in education, saying, "I am very confident but I am also, part of my confidence is I will never stop learning," and "Still I feel very confident and passionately that technology should be used" (Interview).

Last, Neal valued using specific technologies, such as an innovation station and Google Earth. First, Neal used an innovation station. He said, "I've been working in the classroom with an innovation station which has a projector, document camera, really great tool, we use it a lot," and "projector in every classroom is very important, projector with sound and document camera. Document camera makes things to go over with kids. In the past, when kids develop science questions, it was other people read and students write down, but with document camera, we give them spaces that they can write it all out. And instructor takes their ideas and develops a question, when student cannot find the right words, and students watch it." Last, Neal liked using Google Earth, saying, "I love Google Earth and can mess around with it for hours" (Interview).

Neal started his educational career based on abundant previous technology experiences. In addition, when he started the program, he already had strong belief that technology is very important in education. His strongly positive technology attitudes seemed to powerfully affect his teaching experiences at the PK-6 school classes. He considered various technologies that could enhance students' learning.

Neal did not complete the survey, therefore, I could not get the information about his technology attitudes from the survey.

Neal's technology knowledge

Neal prepared a science subject lesson plan about fractions for 5st grade students. Neal integrated PowerPoint "to illustrate points" (Lesson Plan), online video, Google Earth for students' exploration of coral reefs, and Microsoft Excel for managing data collected from Google Earth Exploration. The TPACK components of each technology that Neal infused are presented in the Table 41.

Table 41. Overall TPACK components and levels of Neal's Lesson Plan

	PowerPoint	Online Video	Google Earth and Microsoft Excel
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	Recognizing Accepting	Accepting	Exploring
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	Accepting	Accepting	Exploring
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	Adapting	Adapting	Adapting Exploring
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	Accepting Exploring	Accepting Exploring	Advancing

In case of integrating PowerPoint, as presented in the table, is rated Recognizing and Accepting level in the first component of TPACK rubric, an overarching conception about the purposes for incorporating technology in teaching subject matter topics. PowerPoint is rated in Accepting level in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology. For the third component, Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, PowerPoint is rated in Adapting level. For the fourth component, Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, PowerPoint is rated in Accepting and Exploring level. For more description about each component and level is following in the Table 42.

Table 42. TPACK components and levels of using PowerPoint in Neal's Lesson Plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Recognizing** • Technology is used for motivation, rather than actual subject matter development.

	Accepting • Technology is used for either or both motivation and actual subject matter development. • Main purpose of technology use is for demonstrations, which include presenting new knowledge.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student-follow work with technology, it is rarely used for students' independent explorations. • Technology integrated activities mirror the structure of the textbook presentation of subject matter without active explorations.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Technology is aligned with one or more curriculum goals. • Teacher chooses topics from school subject matter curricula; however, technology use does not provide any advantage for the chosen curriculum topics.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Accepting** • The instructions are teacher-led. Teacher structures lesson plan with limited student explorations with technology. **Exploring** • Technology integrated activities explicitly promote student reflection – especially the posing of questions for sense-making.

Neal integrated online videos in his lesson plan. His use of online video is rated Accepting level in the first component of TPACK rubric, an overarching conception about the purposes for incorporating technology in teaching subject matter topics. In the second component, knowledge of students' understandings, thinking, and learning in

subject matter topics with technology, online video using is rated in Accepting level. In the third TPACK component, knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, Neal's use of online video is rated in Adapting level. For the last component, knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, online video integration is rated in Accepting and Exploring. For more description of each component and level, see the table 43.

Table 43.TPACK components and levels of using Online Video in Neal's Lesson Plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Technology is used for either or both motivation and actual subject matter development. • Main purpose of technology use is for demonstrations, which include presenting new knowledge.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student-follow work with technology, it is rarely used for students' independent explorations. • Technology integrated activities mirror the structure of the textbook presentation of subject matter without active explorations
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Technology is aligned with one or more curriculum goals. • Teacher chooses topics from school subject matter curricula; however, technology use does not provide any advantage for the chosen curriculum topics.
Knowledge of instructional strategies and	**Accepting**

representations for teaching and learning subject matter topics with technologies	• The instructions are teacher-led. Teacher structures lesson plan with limited student explorations with technology. **Exploring** • Technology integrated activities explicitly promote student reflection – especially the posing of questions for sense-making.

Neal integrated Google Earth and Microsoft Excel in his lesson plan for students' activity. His use of Google Earth and Microsoft Excel is rated Exploring level in the first component of TPACK rubric, an overarching conception about the purposes for incorporating technology in teaching subject matter topics. In the second component, knowledge of students' understandings, thinking, and learning in subject matter topics with technology, Google Earth and Microsoft Excel using is rated in Exploring level. In the third TPACK component, knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, Neal's use of Google Earth and Microsoft Excel is rated in Adapting and Exploring level. For the last component, knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, Google Earth, and Microsoft Excel integration is rated in Advancing and Exploring. For more description of each component and level, see the table 44.

Table 44. TPACK components and levels of using Google Earth and Excel in Neal's Lesson Plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Exploring** • Main purpose of technology use is for students' exploration and experiment with it of new knowledge and practice with it.
Knowledge of students' understandings, thinking, and learning	**Exploring** • Teacher sees the technology as either or

in subject matter topics with technology	both a motivational and learning tool.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • The technology is used as a replacement for non-technology based tasks in a traditional curriculum approach. • Technology is aligned with one or more curriculum goals. **Exploring** • Teacher chooses important topics of school subject matter curricula and technology use adds curricular advantage for the chosen curriculum topics.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Advancing** • Teacher focuses on students' hands-on and experimentation of new subject matter ideas with technology, and focuses on conceptual development.

Neal was the participant who had the highest technology knowledge level. Neal integrated technologies not only for information delivery, but also for students' knowledge building with student-centered activities. His technology skills and positive technology attitudes would synchronously develop his developed technology knowledge, even though he did not have technology related instruction which exceed his technology knowledge and skills.

Distinctions in the third-semester preservice teacher cases

Arden and Neal were in the same cohort, in similar PK-6 classrooms, but distinctively, they had different technology attitudes. Arden and Neal were in the same cohort; they were enrolled in one course because the program required only one course enrollment for the student teachers. The instructor who taught the course expected preservice teachers to use email, word processing, electronic submission of assignments, and LMS. At the last semester of the program, the instructor's technology use expectation still focused on productivity activities.

Arden and Neal were in similar infrastructural environments in their PK-6 classrooms. The PK-6 classroom that Arden completed her fieldwork had an innovation station, calculators, an overhead projector, students' computer, teacher's computer, a telephone, a timer, a television, a video player, and wireless Internet. Neal taught in two different classrooms. In the first classroom, there were students' computers, headsets, screen, overhead projectors, a telephone, a teacher's laptop, and calculators. In the second classroom, which was his homeroom, there were four students' computers, an innovation station, calculators, a telephone, a teacher's laptop, headsets, students' computers, and wireless Internet. Interestingly, Neal came to believe that technology equipment was important by teaching in the two different classrooms, which were equipped with different technologies. He reported that he could not do as much as what he wanted to do during teaching in the classroom without an innovation station.

Arden reported that she was confident in technology integration. However, she was cautious and had skeptical attitude toward integrating technology. She said technology integration is just for technology's sake rather than improving teaching and learning. Arden thought technology integration was just a small part of much more important other skills that teachers should have. The only technology she said beneficial was the innovation station.

On the other hand, Neal had strongly positive attitude and strong confidence toward technology and technology integration. Neal thought technology was a very important resource for teaching and learning. Moreover, he tried to integrate various technologies in teaching and tried to integrate technology in students' learning. Neal used Internet, innovation station, online games, and Google Earth. Neal included students' technology use activities in his teaching plan.

Compared to Arden, Neal had higher technology knowledge. Actually, Neal was the person who had the highest level of technology knowledge out of all the participants. Arden integrated an online game to give repetitive practice for students and overhead projector to present information. The technology use was rated in 2/5 based on the TPACK rubric.

Neal integrated PowerPoint, online video, Google Earth, and Excel. PowerPoint use was rated 2.5/5, online video was rated 2.6/5, and Google Earth and Excel use was rated 4/5 based on the TPACK rubric. Neal had strong background of technology experience, even before he entered the program. Overall, he was confident in using technologies and integrating technology in his teaching, and was willing to learn technology integration more. It appears that his experience and positive attitudes may have contributed to his active technology integration.

FIRST-YEAR NOVICE TEACHER CASES

The first part of this section will describe Bella's technology experiences during her first year teaching, including the technological environment that supports or hinders her technology integration. The second part of this section will describe Valerie's technological environment and her technology experiences during her first year teaching.

Bella

Bella is a female novice teacher who was in her first year of in-service teaching. She graduated in August 2010 and started teaching immediately in August 2010.

School and classroom technology infrastructure

In Bella's school and classroom, there were a document camera, laptops, digital projector, devices for web conferencing, and handheld device. In addition, digital camera and digital video camera were available as needed.

Bella used laptop, digital projector, web conferencing devices, document camera and hand held devices many time per day, which is very frequent. She used digital camera and digital video camera monthly or less.

Bella's students used specific technologies in the class for class activities. For communication activities, Bella's students participated in online audio/video interactions. For web activities, Bella's students used the web from a cell/smart phone, downloaded music, video or podcasts, accessed music or videos, used the online library website, and participated in social networking websites. For productivity activities, students used word processing.

Human-technology infrastructure

Not only the technological infrastructure but also human infrastructure might be important for technology integration in classroom. Table 45 describes Bella's perception of her school's human infrastructure that supports Bella's technology integration effort. The mean score of her school's infrastructural support is 4, which reflects that Bella had very supportive human infrastructure at her school.

Table 45. Bella's perception of her school's human infrastructural support

School's infrastructural support	**Rating***
I have fellow teachers who can help me when I face technological problems or difficulties.	4
There are technical staff in the school who I can request help for technical problems or difficulties.	4
The administration of the school is supportive of me using technologies for teaching.	4
There are school policies relating to technology.	*m***

* 1. Strongly disagree, 2. Disagree, 3. Agree, 4. Strongly agree
** *m*: Missing data

Bella described that her school has a technology team among teachers, so that the members can help each other with technology integration, saying, "The school has

available supplies that we can use. We have a technology vertical team which I am a part of and we are able to help anyone that has questions" (Novice Teacher Survey).

Bella also shared technological barriers that she experienced at the school. She said that "Sometimes the materials are all checked out and if we have a something we want to show the kids then we have to wait until the next day or not show it at all" (Novice Teacher Survey).

Bella's technology activities

Table 46 shows Bella's use of communication activities. Bella used communication activities more or totally for personal purposes, rather than educational purposes. Bella used reading, writing/editing wikis, reading, writing and commenting on Blogs, reading online discussion boards/forums, and sending messages to an email listserv most frequently.

The mean score of purpose of Bella's use of communication activities is 2.1, which indicates that she used communication activities more for personal rather than educational purposes. The mean score frequency of communication activities is 3.0, which indicates that Bella used communication activities at a daily frequency.

Table 46. Bella's communication activities

Communication Activities	**Use***	**Purpose****	**Frequency*****
Read email	Y	4	1
Send email	Y	4	2
Read Wiki	Y	4	4
Write/Edit Wiki(s)	Y	4	4
Read Blog	Y	1	4
Write/Comments on Blog(s)	Y	1	4
Read online discussion boards/forums	Y	1	4
Send messages to an email listserv	Y	1	4
Participate in Online Audio/Video interactions	Y	1	3
Participate in text-based instant messaging	Y	1	2
Participate in text messaging via phone	Y	1	1

Post/send messages to online discussion boards/forums	N	n/a	n/a

* Y: Yes, N: No
** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose
*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 47 shows Bella's use of web activities. Bella only used the university library website for more educational purposes. She used downloading music, video or podcasts most frequently.

The mean score of purpose of Bella's use of web activities is 2.3, which indicates she used web activities more for personal rather than educational purposes. The mean score frequency of web activities is 2.4, which indicates that Bella used web activities at a more than weekly frequency.

Table 47. Bella's web activities

Web Activities	**Use***	**Purpose****	**Frequency*****
Use the university library website	Y	6	3
Download music, videos or podcasts	Y	1	4
Use the Web from a cell/smart phone	Y	1	1
Participate in social networking websites	Y	1	1
Access music or videos	Y	*m*****	3
Participate in online Multiuser computer game	N	n/a	n/a
Participate in online Virtual worlds	N	n/a	n/a
Build and tag bookmarks socially	N	n/a	n/a

* Y: Yes, N: No
** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose
*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day
**** *m*: Missing data

Table 48 shows Bella's use of productivity activities. Bella used word processing and presentation software more for educational purposes. Bella used presentation software daily and use word processing monthly or less (See Table 48).

The mean score of purpose of Bella's use of productivity activities is 7.0, which indicates that she used productivity activities more for educational purposes. The mean score frequency of productivity activities is 2.0, which indicates that Bella used productivity activities at a weekly frequency.

Table 48. Bella's productivity activities

Productivity Activities	**Use***	**Purpose****	**Frequency*****
Use Word Processing	Y	7	1
Use Presentation software	Y	7	3
Use Spreadsheets	N	n/a	n/a
Use Online productivity suite	N	n/a	n/a
Use Concept Maps	N	n/a	n/a
Use Desktop Publishing	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 49 shows Bella's use of creation activities. Bella used the creation activities more for educational purposes. Bella used creation activities frequently, many times per day (See Table 49).

The mean score of purpose of Bella's use of creation activities is 6.0, which indicates that she used creation activities more for educational purposes. The mean score frequency of creation activities is 4.0, which indicates that Bella used creation activities at an almost daily frequency.

Table 49. Bella's creation activities

Creation Activities	Use*	Purpose**	Frequency***
Create or modify digital pictures or art	Y	6	4
Create or modify digital video	Y	6	4
Create digital photo galleries or albums	Y	6	4
Create or modify digital audio	N	n/a	n/a
Produce podcasts	N	n/a	n/a
Produce vodcasts or screencasts	N	n/a	n/a
Create or modify web pages	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 50 summarizes Bella's technology activities. Bella used productivity activities most for educational purposes. And she used creation activities most frequently.

Table 50. Summary of Bella's technology use

Technology Activities	Mean Score Across All Activities	
	Purpose*	Frequency**
Communication	2.1	3
Web	2.5	2.4
Productivity	7	2
Creation	6	4

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Bella's technology attitudes

Bella's survey results showed that the mean score of her digital technology self-efficacy was 3.19, which means positive. The mean score of Bella's attitudes towards learning technology was 3.58, which means very positive.

Bella rated herself as "expert" across all communication, web, productivity, creation, and education specific activities (See Table 51), which may contribute to higher digital technology self-efficacy.

Table 51. Bella's perception of her expertise of technology activities

Technology Activities	**Perception***
Communication	Expert
Web	Expert
Productivity	Expert
Creation	Expert
Education Specific	Expert

Bella thought that integrating technology in her class is helpful. She said, "[I use technologies to] show science videos and online books. When I didn't have them, I had to read and find all the resources" (Interview). She also thought that using technology motivates students (Interview). The technology that she most benefited from was an innovation station. Bella was confident at integrating technology in her class even before she started her teaching, but using the innovation station enhanced her confidence (Interview). She used the innovation station to show videos and lesson related information, which was helpful for her teaching. Therefore, Bella expressed positive thoughts about the innovation station during the interview.

Bella had positive attitude to technologies, technology integration in teaching, and technology use. The existence of the innovation station, which supports presenting information to students, especially enabled her to be more confident.

Bella's technology knowledge

Bella prepared a mathematics subject lesson plan about fractions for 3rd grade students. In her lesson plan, she integrated an online game, including Icy Slides Flips Turns, for students to practice what they learned at the class. Icy slides Flips Turns is an

online game that allowed students to practice the expression of 'slide, flip, and turn' by watching figures move. Bella described her use of online games in the TPACK survey, "I really wanted to play a game online to show the kids the vocabulary words in action. This would help the students that struggle with the mathematics concepts. Luckily I was able to find a game that demonstrated what I wanted the kids to see" (TPACK Survey).

Using an online game motivates student, as well as develops subject matter understanding. Therefore, the first component of the TPACK rubric, an overarching conception about the purposes for incorporating technology in teaching subject matter topic, Bella's technology knowledge is rated in the Accepting level. The online game helps students to practice to understand what slide, flip and turn means, repeatedly. Rather than getting new knowledge, it is practicing learned knowledge. Therefore, in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology, use of the online games is also rated in the Recognizing level. This online game used as an add-on to practice what students learned from their textbook aligned with curriculum goal. Therefore, in the third component, Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, Bella's use of technology is rated in the Accepting level. This activity of using an online game to learn mathematics vocabulary is closely related with subject-matter objectives. Therefore, in the last component, Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, Bella's technology use is rated in the Adapting level. For more specific description of each component and levels (See Table 52).

Table 52. TPACK Components and levels of Bella's use of an online game

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in	**Accepting**

teaching subject matter topics	• Main purpose of technology use is for demonstrations, which include presenting new knowledge.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Recognizing** • Technology is used primarily for student practice. • Technology integrated activities do not present any new material, and only provides space for applications and drills.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Accepting** • Teacher uses textbook-based approach to the curriculum topics with technology being used as add-on. • Technology is partially aligned with one or more curriculum goals.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Adapting** • Technology integrated activities are focused primarily around subject-matter objectives..

Valerie

Valerie is a female novice teacher who experienced her first year of in-service teaching. She graduated in August 2010 and immediately started teaching in August, 2010.

School and classroom technology infrastructure

In Valerie's school and classroom, there were an innovation station, devices for web conference, and TI-10 calculators, which were in class every day. Laptops, digital camera, digital video camera were available as needed.

Valerie owned digital devices personally, such as iPad, MP3 player, and laptop. Among those her personal devices, she used her iPad in the classroom to play songs for her students.

Valerie used an innovation station daily. Valerie's students also used technology in class for class activities. For web activities, Valerie's students used the online library

website. For productivity activities, Valerie's students used word processing and spreadsheets.

Human-technology infrastructure

Valerie also had human infrastructural support. Valerie positively perceived that she was supported by administration and technical staff and that her school has school policies. On the other hand, Valerie perceived that she did not have fellow teachers who could help her with technology integration (See Table 53). She described her school's human infrastructural support, saying, "It's basically one person providing all the tech support for the entire school, which is limiting, but she has a lot of great ideas and is willing to help teachers incorporate them in the classroom" (Novice Teacher Survey).

Table 53. Valerie's perception of her school's human infrastructural support

School's infrastructural support	**Rating***
The administration of the school is supportive of me using technologies for teaching.	4
There are technical staff in the school who I can request help for technical problems or difficulties.	3
There are school policies relating to technology.	3
I have fellow teachers who can help me when I face technological problems or difficulties.	2

* 1: Strongly Disagree, 2: Disagree, 3: Agree, 4: Strongly Agree

Valerie also shared a technological barrier that she experienced from her school. First, she said that the accessibility to use school laptops is low, saying, "It's hard to get laptops because they are on a cart in another teacher's classroom, so I don't access them" (Novice Teacher Survey). Second, her school limits teachers' use of personal devices at the school. Valerie said, "I feel pretty limited in the amount of technology I possess but am not allowed to use. For example, I have a MacBook Pro but am not allowed to hook it up to my classroom. This prevents me from creating things at home that I could use at

school. I also am hesitant to use my own technology with 6-year-olds, because if it breaks then I am financially liable for it" (Novice Teacher Survey).

Valerie's technology skills

Table 54 shows Valerie's use of communication activities. Valerie used all the communication activities more or completely for personal purposes. Valerie used writing/commenting on blog(s), sending messages to an email listserv, participating in Online Audio/video interactions and participating in text-based instant messaging most frequently.

The mean score of purpose of Valerie's use of communication activities is 2.7, which reflects she used communication activities more for personal rather than educational purposes. The mean score frequency of communication activities is 2.9, which indicates that Valerie used communication activities at an almost daily frequency.

Table 54. Valerie's communication activities

Communication Activities	**Use***	**Purpose****	**Frequency*****
Write/Comments on Blog(s)	Y	4	4
Send messages to an email listserv	Y	4	4
Read Blog	Y	4	3
Read Wiki	Y	4	3
Send email	Y	4	2
Read email	Y	4	1
Participate in Online Audio/Video interactions	Y	2	4
Participate in text-based instant messaging (SMS)	Y	1	4
Read online discussion boards/forums	Y	1	3
Post/send messages to online discussion boards/forums	Y	1	3
Participate in text messaging via phone	Y	1	1
Write/Edit Wiki(s)	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 55 shows Valerie's use of web activities. Valerie used most web activities more or totally personal purposes except for her use of the university library website (See Table 55). Valerie used the university library website, accessing music or videos, and downloading music, videos or podcasts most frequently.

The mean score of purpose of Valerie's use of web activities is 2.7, which indicates that she used web activities more for personal rather than educational purposes. The mean score frequency of web activities is 2.8, which indicates that Valerie used web activities at an almost daily frequency.

Table 55. Valerie's web activities

Web Activities	**Use***	**Purpose****	**Frequency*****
Use the university library website	Y	6	4
Use the Web from a cell/smart phone	Y	4	1
Access music or videos	Y	3	4
Download music, videos or podcasts	Y	1	4
Participate in online Multiuser computer game	Y	1	3
Participate in social networking websites	Y	1	1
Participate in online Virtual worlds	N	n/a	n/a
Build and tag bookmarks socially	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 56 shows Valerie's use of productivity activities. Except for desktop publishing, Valerie used productivity activities slightly more for educational purposes. Valerie used presentation software and desktop publishing most frequently, many times per day (See Table 56).

The mean score of purpose of Valerie's use of productivity activities is 5.3, which reflects she used productivity activities for both educational and personal purposes,

slightly more for educational purposes. The mean score frequency of productivity activities is 3.5, which indicates that Valerie used productivity activities between daily and many times per day.

Table 56. Valerie's productivity activities

Productivity Activities	**Use***	**Purpose****	**Frequency*****
Use Presentation software	Y	7	4
Use Word Processing	Y	5	3
Use Spreadsheets	Y	5	3
Use Desktop Publishing	Y	4	4
Use Online productivity suite	N	n/a	n/a
Use Concept Maps	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 57 shows Valerie's use of creation activities. Valerie used creation activities only for personal purposes. And all these activities were used frequently, many times per day (See Table 57).

The mean score of purpose of Valerie's use of creation activities is 1, which indicates that she used creation activities only for personal purposes. The mean score frequency of creation activities is 4, which indicates that Valerie used creation activities at a many times per day frequency.

Table 57. Valerie's creation activities

Creation Activities	**Use***	**Purpose****	**Frequency*****
Create or modify digital pictures or art	Y	1	4
Create or modify digital audio	Y	1	4
Create or modify digital video	Y	1	4
Create digital photo galleries or albums	Y	1	4
Produce podcasts	N	n/a	n/a
Produce vodcasts or screencasts	N	n/a	n/a

Create or modify web pages	N	n/a	n/a

* Y: Yes, N: No

** 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

*** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Table 58 summarizes Valerie's technology activities. Valerie used productivity activities most for educational purposes. Valerie used creation activities most frequently, but she used the technology activities totally for personal purposes.

Table 58. Summary of Bella's technology use

Technology Activities	**Mean Score Across All Activities**	
	Purpose*	**Frequency****
Communication	2.7	2.8
Web	2.7	2.8
Productivity	5.3	3.5
Creation	1	4

* 1: All Personal Purpose, 2: Mostly Personal Purpose, 3: More Personal Purpose, 4: Slightly More Personal Purpose, 5: Equally Personal/Educational Purpose, 6: Slightly More Educational Purpose, 7: More Educational Purpose, 8: Mostly Educational Purpose 9: All Educational Purpose

** 1: Monthly or less, 2: Weekly 3: Daily 4: Many times per day

Valerie's technology attitudes

Valerie's survey results showed that the mean score of her digital technology self-efficacy was 2.71, which is slightly positive. The mean score of Valerie's learning technology perception was 2.75, which is slightly positive.

Valerie shared her perception of her expertise of digital technology. Valerie's perception of her expertise level of communication, web, productivity, creation and education specific activities shows a different result, which shows her strong confidence. Valerie perceives that her expertise is at the expert level (See Table 59).

Table 59. Valerie's perception of her expertise of technology activities

Technology Activities	Perception*
Communication	Expert
Web	Expert
Productivity	Expert
Creation	Expert
Education Specific	Expert

Valerie felt confidence in integrating technology in her class (Interview). In addition, she had strongly positive attitude on herself (Interview). However, she still wanted to be creative in integrating technology for her class, saying, "I would like to be more creative about using technology" (Interview). According to Valerie, her confidence has changed due to the easy accessibility of necessary technology, saying, "My confidence has been increased by the familiarity with technologies. We've just got new projector and document camera. Learning to use the projector and document camera changes my confidence" (Interview).

Valerie's technology knowledge

Valerie prepared a mathematics lesson plan for 1st grade students. In her lesson plan, Valerie integrated a document camera to show how to use calculator to her students. The use of the document camera was rated in all of the TPACK components. Therefore, in the first component, an overarching conception about the purposes for incorporating technology in teaching subject matter topic, Valerie's technology knowledge is rated in the Accepting level. The use of document camera is for demonstration of information and teacher-centered activity. Therefore, in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology, use of the document camera is rated in the Accepting level, and in the third component, Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, Valerie's use of technology is rated in the Adapting level. In addition, students are recipients and listeners of information. Therefore, in the

last component, Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, Valerie's technology use is rated in the Recognizing level (See Table 60).

Table 60. TPACK Components and levels of Valerie's lesson plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Main purpose of technology use is for demonstrations, which include presenting new knowledge. • Technology integrated activities procedures concentrate on teacher demonstration and practice.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Technology is mostly used for teacher demonstrations or teacher-led student follow work with technology, it is rarely used for students' independent explorations.
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • Teacher uses didactic (teacher-directed) approach to teaching with technology to maintain control of the progression of the activities.
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Recognizing** • Technology integrated activity provides students only with opportunities for drill and practice, or for listening, receiving information.

For a language art class, Valerie integrated the DVD movie, Click Clack Moo: Cows that Type (TPACK Survey). The use of the DVD movie was rated in all of the TPACK components. The DVD animation was used for subject matter development, as well as for motivating students. And the DVD was the main resource of presenting information to the students. Therefore, in the first component, an overarching conception about the purposes for incorporating technology in teaching subject matter topic,

Valerie's technology knowledge is rated in the Accepting level. The DVD motivated students' learning and was the learning resource for students, therefore, in the second component, Knowledge of students' understandings, thinking, and learning in subject matter topics with technology, use of the DVD movie is rated in the Accepting level. This DVD is a one-way information presentation tool, which just replaces textbook information with animated information. The information is closely related with instructor's curriculum goal, thus the third component, Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics, is rated in the Adapting level. The instruction is totally teacher-led, so, the last component, Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies, is rated in the Recognizing level (See Table 61).

Table 61. TPACK Components and levels of Valerie's lesson plan

Rubric Component	Rubric Level
An overarching conception about the purposes for incorporating technology in teaching subject matter topics	**Accepting** • Technology is used for either or both motivation and actual subject matter development.
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	**Accepting** • Teacher sees the technology as either or both a motivational and learning tool..
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	**Adapting** • The technology is used as a replacement for non-technology based tasks in a traditional curriculum approach. • Technology is aligned with one or more curriculum goals. • Teacher chooses topics from school subject matter curricula; however, technology use does not provide any advantage for the chosen curriculum topics.

Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	**Accepting** • The instructions are teacher-led. Teacher structures lesson plan with limited student explorations with technology.

Distinctions in the novice teacher cases

The classrooms of Bella and Valerie had similar technologies. Bella's school and classroom had an innovation station, students' laptops, and devices for web conferencing and handheld device. In addition, digital camera and digital video camera were available as needed. Valerie's school and classroom were equipped with an innovation station, devices for web conference, and TI-10 calculators. Students' laptops, digital camera, and digital video camera were available as needed.

Both Bella and Valerie had human infrastructure at their schools, including technology support staff and supportive administration, yet Bella had more supportive human infrastructure, including peer teachers' support. These peer teachers were very eager to integrate technologies into their teaching and to help other teachers.

Even with the technology supportive school environment, both novice teachers experienced difficulty in using technology from the school because sometimes necessary devices were already checked out, and thus, they could not use the technology for class.

The distinctive points of Bella and Valerie were technology attitudes and skills. Bella and Valerie rated their perceptions of their expertise of technology activities similarly but had different technology attitudes. Bella's digital self-efficacy mean score was 3.19, which was positive. Bella's learning technology attitude was 3.58, which was very positive. Compared to Bella, Valerie had slightly low technology attitudes. Valerie's digital technology self-efficacy was 2.71 and Valerie's learning technology attitude was 2.75, which were both slightly positive.

Bella used her teacher's laptop, an innovation station, web conferencing devices, hand held devices, digital camera and digital video. Bella used productivity activities and creation activities more for educational purpose. In Bella's class, her students participated in online audio/video interactions for communication activities, the web from a cell/smart phone, downloaded music, video or podcasts, accessed music or videos, used the online library website, and participated in social networking websites for web activities, and students used word processing for productivity activities. However, Valerie used only the innovation station. Valerie used only productivity activities more for educational purpose. Valerie's students used the online library website, word processing and spreadsheets. Bella and Valerie showed that technology skills and attitudes are related. Bella, who used various technologies, had more positive attitudes, and Valerie who used fewer technologies, had less positive attitudes.

Chapter 5. Discussion

This chapter discusses findings of this study as well as describes the implications of this study for future research. This study explored a preservice teacher preparation program to understand how the tri-semester-program prepared preservice teachers with technology skills, attitudes and knowledge, and first year novice teachers' technology skills, attitudes and knowledge after graduation from the program. Based on the results of this study, this section discusses: a) alignment of technological infrastructure, b) accessibility of technologies, c) limited exposure to technological activities, d) preservice teachers' technology skills, e) technology experiences from the program and preservice teachers' technology attitudes, and f) programmatic impact on novice teachers.

ALIGNMENT OF TECHNOLOGICAL INFRASTRUCTURE

Aligning similar technology infrastructure from university classes to the PK-6 classroom fieldwork and to the inservice classroom is important for developing preservice teachers' technology experiences (Becker, & Anderson, 2000; Dexter, & Riedel, 2003; Ertmer, 1999; Ertmer et al., 1999; Lumpe & Chambers, 2001; Pope et al, 2002). This research showed that university classes, PK-6 classes for fieldwork and novice teachers' classrooms had an innovation station (or a media cart), Internet and computer as common technological infrastructure. These common technologies primarily support direct instruction through presentation.

Using technologies for delivering instruction is one of the important categories of technology integration in class for both teachers and students (Inan & Lowther, 2010). The participants' one of the most active technology uses was for information delivery. For example, among preservice teachers, Isaac, Sally, Arden and Neal thought information presentation technologies were useful for their instructional delivery. In

addition, both Bella and Valerie also explained that information presentation technologies were helpful and useful for their instructional delivery.

While the information presentation technologies are helpful for teachers' teaching, we can say that the information presentation technologies are limited to a teacher centered technology use. Previous research say that the information presentation technologies and relative instructional strategies limit students' collaboration and student-centered learning (Inan, Lowther, Ross, & Strahl; 2010; Morrison & Lowther, 2010; Solomon & Wiederhorn, 2000).

ACCESS TO TECHNOLOGIES

This research revealed that technology availability in classrooms is important for teachers to integrate technology in teaching. Even though certain technologies were accessible for the teachers, if the technologies were not available at the necessary time, teachers could not integrate the technologies. For example, Valerie, a novice teacher, could not use student laptops as the laptops were already checked out by another teacher. Bella also experienced difficulties checking out devices, as the devices she wanted to use were already checked out by other teachers.

Researchers (Mumtaz, 2000; Zhao et al, 2002) said that the technological infrastructure is important for teachers' technology use. Over the past two decades, considerable federal investment has been devoted to equipping the nation's K–12 schools with technology (Culp et al., 2005). However, still some teachers are still experiencing difficulties of technology accessibility, not because the devices are not equipped, but because the devices are already checked out. Thompson (2009) said that infrastructure itself does not guarantee technology accessibility. Therefore, schools and districts should evaluate technology accessibility and support to develop technology accessibility.

LIMITED EXPOSURE TO TECHNOLOGICAL ACTIVITIES

For preservice teachers to be prepared with technology integration in their teaching, they need to be exposed to the technology integration experiences and practices (Ertmer, 1999; Schrum, 1999). Researchers reported that technology integration modeling of faculty and cooperating teachers is an important support for the practice and experience of technology integration for preservice teachers (Banister, & Vannatta, 2006; Krueger, Boboc, Smaldino, Cornish, & Callahan, 2004; Mims, Polly, Shepherd, & Inan, 2006; Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003; Swain & Dawson, 2003).

However, this cross sectional case study found that preservice teachers' exposure to technological activities is quite limited and narrow. The data showed that university instructors' technology integration modeling was limited mostly to presentation of information with PowerPoint and class management with learning management software (LMS). In addition, Cooperating teachers' technology integration modeling was limited. Cooperating teachers most often used information presentation technology (Document Camera) and classroom management technologies (microphone and timer). Cooperating teachers' technology use focused on information presentation and classroom management.

In addition, during the program, preservice teachers had limited exposure to content-specific technologies, except educational websites. Cooperating teachers integrated educational websites for content-specific technology during their teaching, which was the only modeling of content-specific technology. University instructors did not use content-specific technology.

Many novice teachers teach as they learn (Lortie, 1975; Pierson, 2001). What technology skills, attitudes and knowledge preservice teachers learn from their instructors

influence future teachers' technology skills, attitudes and knowledge in their teaching (Crowe, 2004; Duran et al., 2006; Koh & Frick, 2009; Pope et al., 2002). If preservice teachers can learn more various technology activities from their instructors, they would be able to integrate various technologies in teaching.

PRESERVICE TEACHERS' TECHNOLOGY SKILLS

Frieden and Scott (2003) reported that preservice teacher preparation programs expect incoming students to enter with a foundation of skills that can be used in general education and applied in the context of PK-12 education within one's professional preparation. However, this research showed that at the beginning of the program, these two preservice teachers entered with widely different technology skills. The survey results show that Isaac and Tony had different technology skills, based on past experiences including active technology experiences during his high school period. We can assume that preservice teachers who have different technology skills would have different technology experiences. In the future, the program might evaluate preservice teachers' technology skills before grouping. The program may consider homogeneous grouping, as well as heterogeneous grouping. Whichever cohorts grouping method the program chooses, the program might be able to consider the preservice teachers' previous technology experiences.

TECHNOLOGY EXPERIENCES FROM THE PROGRAM AND PRESERVICE TEACHERS' TECHNOLOGY ATTITUDES

If the programmatic experiences do not require assignments that involve technology, there is little chance of focused growth. During the program, there were activities that could have at least encouraged possible technology use. For example, the lesson plan template did not require technology integration but could have mentioned it as a possibility for inclusion. If instructors required for the preservice teachers to

integrate technology in the lesson plan, preservice teachers might be able to consider technology infusion and to apply their technology knowledge in a practical teaching situation. Second, instructors' expectations for preservice teachers' technology use was limited. Instructors expected preservice teachers mainly to use email, word processing and electronic submission of assignments. Moreover, preservice teachers used these expected technologies mostly out of the classroom for completing and submitting assignments rather than using the technologies in class activities. Some instructors limited classroom technology use to avoid potential off-task behavior during in class activities.

The purpose of laptop initiatives is to enhance technology use in various aspects of preservice teachers' learning during the program and to prepare them as future teachers with technology competency. However, preservice teachers' in-class activities were limited to a few basic activities and/or regulated not to use the device. The program is expected to prepare preservice teachers to be technology leaders (Darling-Hammond, Chung, & Frelow, 2002). If the program wants to prepare preservice teachers to be technology competent teachers, the program may need to support more technology experiences for preservice teachers.

Experiences during the program can impact preservice teachers' attitudes (Demetriadis et al., 2003). It is an interesting issue if programmatic experience is an assimilation or accommodation effect, meaning does it accord with their pre-attitude and thus not change anything (assimilation) or does the experience jar them in some way and then their attitudes change (accommodation). Overall, most of the preservice teachers said that they were confident for technology integration and their attitudes did not change during the program as the required technology during the program was easy to use or was already known (assimilation). On the other hand, Sally and Tony said that PK-6 school

experiences and kids' positive reaction toward the preservice teachers' technology use made them more sure about their technology skills and strengthened their technology confidence (Accommodation).

PROGRAMMATIC IMPACT ON NOVICE TEACHERS

Not all the technology experiences from the program are transferred in novice teachers' technology use in their teaching (Bennet & Daniel, 1999; Cavucci, 2009). Novice teachers' technology use in their teaching was similar to or less than the preservice teachers' technology use. Both Bella and Valerie used productivity activities more for educational purposes. Bella used creation activities more for educational purposes, but Valerie used the activities totally for personal purposes. Creation activities were one of the focused technology activities during the program, including using iPhoto, iMovie and video edition. Not all novice teachers from the program used the technology skills that they experienced from the program for their teaching.

Practically, preservice teacher preparation program cannot control what is available in the future classrooms of preservice teacher graduates, but the program can prepare preservice teachers to be technology leaders who know how to advocate for technological needs, for example, help-request, products request, getting to know technology leaders in district, and writing small grants to foundations (Darling-Hammond et al., 2002). The program may help to develop technology leader beliefs within the preservice teachers, so as novice teachers, they may be able to use the technology leader beliefs to make change in the schools where they teach. Technology leadership may be referred to reorganizing teaching (Davies, 2010), of which characteristics include "a disposition to continually learn from and improve practice, collaboration with peers through critical examination and evolution of each other's teaching, participation in geographically diverse communities of practice, and making professional contributions

through speaking, writing, and teaching" (Riel & Becker, 2008, p. 397). Preservice teacher preparation program may develop activities and courses by considering the characteristics of the technology leader to prepare preservice teachers as future technology leaders.

SUMMARY

The discussion section discussed six issues. The first issue was alignment of technological infrastructure. The university classes and the PK-6 classes had an innovation station, Internet and computer. Novice teachers could access technologies that were equipped in school, but sometimes those devices were checked out by other teachers, so the novice teachers could not use the devices. The second issue was access to technologies. The equipment of digital devices did not guarantee teachers' access to those technologies, especially when the devices were already checked out. The third issue was limited exposure to technological activities. University instructors and PK-6 school cooperating teachers used certain technologies, such as PowerPoint, LMS and educational websites. Instructors modeled technology integration only with narrow and limited technologies. The fourth issue was preservice teachers' technology skills. Preservice teachers who entered the program had different technology skills at the starting point of the program. Compared to their technology skills, preservice teachers had a bit overestimated about their skills. The fifth issue was technology experiences from the program and preservice teachers' technology attitudes. Instructors' technology expectations of preservice teachers and technology related assignments were narrow and limited. Moreover, during the program, almost no technologies were used continuously throughout the three semesters, so preservice teachers could not have experiences to deepen technology skills. Technology experiences during the program influenced preservice teachers' technology attitudes. Most of the preservice teachers said that they

were confident for technology integration and their attitudes did not change during the program. On the other hand, Sally and Tony said that PK-6 school experiences and kids' positive reaction toward the preservice teachers' technology use made them sure about their technology skills and strengthened their technology confidence. The last issue was programmatic impact on novice teachers. The program could not guarantee the availability of the technologies in PK-6 school. And novice teachers seemed using fewer technologies than their technology use during the program.

PRACTICAL IMPLICATIONS

This section provides practical suggestions to teacher educators or teacher education institutions based on the findings and discussion. First, a teacher education program should set technology-specific goals and expectations for preservice teachers. Dexter and Riedel (2003) said that setting technology integration expectations of the program supported preservice teachers' technology integration in their teaching. The current program under study had ambiguous goals and did not set specific expectations for technology use and integration. Recently, the goal part has been removed from the website of the program, and there is only short goal of the program from the rationale, which says, "Teacher education students in this College will be at the center of this conversation [about technology development and potential], learning the best practices [of technology integration] to apply in their teaching practice" (Rationale, 2012).

If the program set specific technology goals and expectations, the program can plan specific technologies and technology activities, which will deepen preservice teachers' technology knowledge and skills. A good example of technology integration expectation and goals would be NETS-T (See Table 1). NETS-T describes specific technology integration standards of various levels that teachers can apply in their

teaching. These standards can set basic technology skills, attitudes and knowledge of teachers, and lead teachers to the higher level of technology integration.

Second, developing faculty technology skills and knowledge is necessary. Instructors are the important role model of preservice teachers for technology integration. Darling-Hammond (2006) said that faculty influences the transformation of teacher education. Mims et al. (2006) reported that once instructors know how to integrate technology, they develop their courses and model technology integration for preservice teachers. The more instructors have technology skills and knowledge, the more they will model technology integration, and the more preservice teachers will learn technology integration.

There are various ways of faculty development. Yilmazel-Sahin and Oxford (2010) summarized and introduced faculty development approaches, such as workshop models, mentoring models, and university-school collaboration model. First, the workshop models offer specific technology information, but usually do not consider faculty's needs. There are three types of workshop models, including brown-bag lunch seminar, skill-based workshop and project-based workshop. Second, the mentoring models offer mentorship, which mentors help mentees become competent with technology skills. There are three types of mentoring models, including technology expert mentoring model, education expert mentoring model and collaborative mentoring model. Third, the university-school collaboration models connect university and PK-6 schools to provide opportunities for inter-institute development of technology integration. However, the university-school collaboration can be complex to control "because of the multiple institutions and levels involved, each with its own political structure and needs (p. 708)."

Third, programs may create ways to support preservice teachers with various dimensions of technology integration. To support graduates' technology integration in their teaching, teacher education should prepare them in various dimensions of technology integration in teaching. Practically, preservice teacher preparation program cannot control what is available in the future classrooms of preservice teacher graduates, but the program can prepare preservice teachers to be technology leaders who know how to advocate for technological needs, for example, help-request, products request, getting to know technology leaders in district, and writing small grants to foundations (Darling-Hammond et al., 2002).

FUTURE RESEARCH

This research contributes to understanding how a preservice teacher preparation program prepares preservice teachers' technology integration by reflecting the experiences of six preservice teachers, who were in the program, and two novice teachers, who were the program graduates. However, there remain areas to be explored and developed in future research. First, methodologically more robust research with more participants will give us statistical information about preservice and novice teachers' technology skills, attitudes and knowledge. Second, longitudinal study will show us the development of preservice teachers' technology skills, attitudes and knowledge across the program, and eventually the impact of the program on novice teachers' technology skills, attitudes and knowledge.

Future research could also include a better understanding of faculty in this program. In particular, it would be a contribution to fully understand faculty's role in technology integration and technology expectations toward preservice teachers. To that end, research must move beyond examining evidence from course syllabi and include

observation of faculty's actual teaching in the classroom and interviews with faculty. This approach may lead us to deeper understandings of what faculty do with technology.

In the future, research could also offer deeper understanding of cooperating teachers' support and modeling for preservice teachers, by observing cooperating teachers' teaching in class.

Future research also could identify technology activities from the program that enables and disables technology integration for preservice teachers. For example, in this research, the lesson plan template for preservice teachers could include technology integration in it, but no instructor included technology integration section in the lesson plan template. Technology activities from the program would be important for enhancing preservice teachers' technology experiences.

LIMITATIONS

This study was conducted in one university's preservice teacher preparation program, so the influence of this research will be stronger in a similar setting, a one-to-one computing environment. The program includes technological support from a technology support center of the college of education. The technology support center of the college of education offered technology skill orientations for preservice teachers, which might be able to provide more information about preservice teachers' technology skills, attitudes and knowledge. However, this research did not include observing preservice teachers' technology experiences from the technology support center.

In this research, I collected instructors' data from syllabi, preservice teachers' perceptions of their own and their instructors' technology use, one observation and one interview. While the collected data was from multiple sources, it still inherently has limitations. More observations would have allowed collecting more information about the

faculty's technology use and their influence on preservice teachers' technology experiences during the program.

Finally, observation of novice teachers' teaching could have provided more information of novice teachers' technology experiences in their schools and would have strengthened this study. Unfortunately, it was logistically impossible to conduct classroom observations of the novice teachers in this study.

GENERALIZABILITY

As noted in the limitations, this research was conducted in one university's preservice teacher preparation program. The biggest features of this program are long period of training and one-to-one laptop initiatives. The program involves preservice teachers with technology integration throughout three semesters. All the preservice teachers and faculty are required to own a laptop with certain specification. Preservice teachers and faculty are asked to use laptop for their teaching and learning. Therefore, this study is generalizable to programs with similar conditions, such as a 3-semester program and employs a one-to-one laptop ubiquitous environment.

Appendix A. Preservice Teacher Survey

Intro and perceptions of technology

Thank you so much for deciding to participate! It is important for the education community to understand the new students in the professional sequence. In this survey, we will ask questions about your access to and use of technology, access to and use of technology in your past university courses, personal use of technology, and your attitude about technologies. The survey should take about **20 minutes** to complete.

You already signed a paper consent form IRB# 2008-05-0101 to participate in this **research study**, "Longitudinal Study of Laptop Initiative for Future Educators." Completion of the survey further communicates your consent.

At completion of the survey, an acknowledgment of participation will be generated and sent to your email address that you may print out or save to your computer to be used in your portfolio or for other purposes.

YOUR PERCEPTIONS OF INFORMATION TECHNOLOGY

In the next two questions, your answers help us understand your reactions to digital technologies and learning technologies (definitions included below with each question).

This question is about **Digital Technology**, which are electronic computers, computer software, handheld computing devices, and online applications that convert, store, protect, process, transmit, and securely retrieve information.

Below you will find a number of statements concerning how you might feel about digital technology. Please indicate the strength of your agreement/disagreement with the statements using a 4-point scale shown below. There are no *correct* responses; it is your own views that are important.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I find working with digital technology very easy.	○	○	○	○
I am very unsure of my abilities to use digital technology.	○	○	○	○
I seem to have difficulties with most of the software or online applications I have tried to use.	○	○	○	○
Digital technology frightens me.	○	○	○	○
I often have difficulties when trying to learn how to use a new software package or online application.	○	○	○	○
I rely heavily on instructions and manuals to help me use digital technology.	○	○	○	○
Most of the software packages or online applications I have had experience with have been easy to use.	○	○	○	○
I am very confident in my abilities to use digital technology.	○	○	○	○
I find it difficult to get digital technology to do what I want it to.	○	○	○	○
At times I find working with digital technology very confusing.	○	○	○	○
I find it easy to learn how to use a new software package or online application.	○	○	○	○
I seem to waste a lot of time struggling with digital technology.	○	○	○	○
I always seem to have problems when trying to use digital technology.	○	○	○	○
Digital technology jargon baffles me.	○	○	○	○

	Strongly Agree	Agree	Disagree	Strongly Disagree
Digital technology is far too complicated for me.				
I consider myself a skilled digital technology user.				
When using digital technology I worry I might press the wrong button and damage it.				

This question is about **Learning Technology (LT)**, which is an array of electronic computers, computer software, and handheld computing devices tools that might assist in student learning.

Below you will find a number of statements concerning how you might feel about learning technology. Please indicate the strength of your agreement/disagreement with the statements using a 4-point scale shown below. There are no *correct* responses; it is your own views that are important.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I support the use of learning technology in the classroom.				
A variety of learning technologies are important for student learning.				
Incorporating learning technology into instruction helps students learn.				
Content knowledge should take priority over technology skills.				
Most students have so many other needs that learning technology use is a low priority.				
Student motivation increases when learning technology is integrated into the curriculum.				
Teaching students how to use learning technology isn't a teacher's job.				
There isn't enough time to incorporate learning technology into the curriculum.				
Learning technology helps teachers do things with their classes that they would not be able to do without it.				
Learning technology interferes with "human" interactions between teachers and students.				
Knowledge about learning technology will improve my teaching.				
Learning technology facilitates the use of a wide variety of instructional strategies designed to maximize learning.				

Technology use

TECHNOLOGY USE

The next section's questions help us understand your frequency of use of technology activities, your use of those activities for educational purposes, and your perception of your instructors' use of these technology activities.

We have grouped the technology activities into the following five themes:

* Communication
* Web
* Productivity
* Creation

* Education-specific

COMMUNICATION ACTIVITIES

The first set of questions focus on technologies used for communication.

Considering your experiences prior to this semester, please mark which communication activities listed below you do. (Check all that apply.)

- ☐ Read email
- ☐ Send email
- ☐ Read Blog
- ☐ Write/Comments on Blog(s)
- ☐ Read Wiki
- ☐ Write/Edit Wiki(s)
- ☐ Participate in text-based instant messaging (SMS) (e.g., in ichat, aim, gmail chat, facebook chat)
- ☐ Participate in text messaging via phone
- ☐ Read online discussion boards/forums
- ☐ Post/send messages to online discussion boards/forums
- ☐ Send messages to an email listserv (e.g., OrangeBikeList)
- ☐ Participate in Online Audio/Video Interactions (Ichat, Skype)
- ☐ Read Microblogs (Twitter)
- ☐ Write Microblog (Twitter)

Please rate your frequency of use for your Communication activities and indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal use to all educational use:

	Please rate your approximate frequency of use for your Communication activities:				For your Communication Technologies, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Read email	○	○	○	○	○	○	○	○	○	○	○	○	○
» Send email	○	○	○	○	○	○	○	○	○	○	○	○	○
» Read Blog	○	○	○	○	○	○	○	○	○	○	○	○	○
» Write/Comments on Blog(s)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Read Wiki	○	○	○	○	○	○	○	○	○	○	○	○	○

	Please rate your approximate frequency of use for your Communication activities:				For your Communication Technologies, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Write/Edit Wiki(s)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Participate in text-based instant messaging (SMS) (e.g., in ichat, aim, gmail chat, facebook chat)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Participate in text messaging via phone	○	○	○	○	○	○	○	○	○	○	○	○	○
» Read online discussion boards/forums	○	○	○	○	○	○	○	○	○	○	○	○	○
» Post/send messages to online discussion boards/forums	○	○	○	○	○	○	○	○	○	○	○	○	○
» Send messages to an email listserv (e.g., OrangeBikeList)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Participate in Online Audio/Video interactions (ichat, Skype)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Read Microblogs (Twitter)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Write Microblog (Twitter)	○	○	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Communication Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

WEB ACTIVITIES

Next, we ask about how you use web-based activities.

Considering your experiences prior to this semester, please indicate which of the following Web-based activities you have used (check all that apply).

- ☐ Use the Web from a cell/smart phone
- ☐ Download music, videos or podcasts
- ☐ Access music or videos (youtube etc.)
- ☐ Use the university library website
- ☐ Participate in social networking websites (Facebook, MySpace, Bebo, LinkedIn, etc.)
- ☐ Participate in online Multiuser computer games (World of Warcraft, Everquest, Poker, etc.)
- ☐ Participate in online Virtual worlds (Second Life)
- ☐ Build and tag bookmarks socially (delicious.com, twine.com, etc.)
- ☐ Take a completely-online course for academic credit or learning enrichment

Please rate your frequency of use for your Web activities and indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal use to all educational use:

	Please rate your approximate frequency of use for your Web activities:				For your Web activities, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Use the Web from a cell/smart phone	○	○	○	○	○	○	○	○	○	○	○	○	○
» Download music, videos or podcasts	○	○	○	○	○	○	○	○	○	○	○	○	○
» Access music or videos (youtube etc.)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use the university library website	○	○	○	○	○	○	○	○	○	○	○	○	○
» Participate in social networking websites (Facebook, MySpace,	○	○	○	○	○	○	○	○	○	○	○	○	○

	Please rate your approximate frequency of use for your Web activities:				For your Web activities, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
Bebo, LinkedIn, etc.)													
» Participate in online Multiuser computer games (World of Warcraft, Everquest, Poker, etc.)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Participate in online Virtual worlds (Second Life)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Build and tag bookmarks socially (delicious.com, twine.com, etc.)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Take a completely-online course for academic credit or learning enrichment	○	○	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Web Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

PRODUCTIVITY ACTIVITIES

Next, we ask about your use of technologies for productivity activities.

Considering your experience prior to this semester, please indicate which of the following Productivity activities

you used. (Check all that apply.)

- Use Word Processing (MSWord)
- Use Spreadsheets (Excel, etc.)
- Use Presentation software (PowerPoint, Keynote etc.)
- Use Online productivity suite (Zoho, GoogleApps)
- Use Concept Maps (Inspiration, Visio, cmap)
- Use Desktop Publishing (MS Publisher, InDesign)

Please rate your frequency of use for your Productivity activities and and indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal use to all educational use:

	Please rate your approximate frequency of use for your Productivity activities:				For your Productivity Technologies, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Use Word Processing (MSWord)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use Spreadsheets (Excel, etc.)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use Presentation software (PowerPoint, Keynote etc.)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use Online productivity suite (Zoho, GoogleApps)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use Concept Maps (Inspiration, Visio, cmap)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Use Desktop Publishing (MS Publisher, InDesign)	○	○	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Productivity Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- Expert
- Very skilled
- Fairly skilled
- Not very skilled
- Not at all skilled

CREATION ACTIVITIES

Now, we ask about particular technologies that may support your creative side.

Considering your experience prior to this semester, please indicate which of the following Creation activities you have used. (Check all that apply.)

- Create or modify digital pictures or art (e.g., Photoshop, Illustrator, IPhoto)
- Create or modify digital audio (e.g., Audacity, GarageBand)
- Create or modify digital video (e.g., IMovie, MovieMaker)
- Produce podcasts
- Produce vodcasts or screencasts
- Create digital photo galleries or albums (e.g., Iphoto, flickr)
- Create or modify web pages (e.g., Dreamweaver, Iweb, googlepages)

Please rate your frequency of use for your Creation activities and and indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal use to all educational use:

	Please rate your approximate frequency of use for your Creation activities:				For your Creation Technologies, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Create or modify digital pictures or art (e.g., Photoshop, Illustrator, iPhoto)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Create or modify digital audio (e.g., Audacity, GarageBand)	○	○	○	○	○	○	○	○	○	○	○	○	○

	Please rate your approximate frequency of use for your Creation activities:				For your Creation Technologies, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.								
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	-	-	>	All Educational Use
» Create or modify digital video (e.g., iMovie, MovieMaker)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Produce podcasts	○	○	○	○	○	○	○	○	○	○	○	○	○
» Produce vodcasts or screencasts	○	○	○	○	○	○	○	○	○	○	○	○	○
» Create digital photo galleries or albums (e.g., iphoto, flickr)	○	○	○	○	○	○	○	○	○	○	○	○	○
» Create or modify web pages (e.g., Dreamweaver, iweb, googlepages)	○	○	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Creation Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

EDUCATION-SPECIFIC ACTIVITIES

Finally, we ask about three tools used specifically within education.

Considering your experience prior to this semester, please indicate which of the following Education-specific activities you have used. (Check all that apply.)

- ☐ Build an electronic portfolio of my coursework
- ☐ Participate in Course Management Systems (e.g., Blackboard, WebCT, Moodle)

Utilize subject-specific software or technology for your discipline (e.g., graphing calculators in mathematics, websites centered on historical events)

Please rate your frequency of use for your Education-specific activities.

	Many times per day	Daily	Weekly	Monthly or less
» Build an electronic portfolio of my coursework				
» Participate in Course Management Systems (e.g., Blackboard, WebCT, Moodle)				
» Utilize subject-specific software or technology for your discipline (e.g., graphing calculators in mathematics, websites centered on historical events)				

Think about your *overall* skill in using the Education-specific Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- Expert
- Very skilled
- Fairly skilled
- Not very skilled
- Not at all skilled

The survey is over. Thank you for your participation.

Appendix B. Novice Teacher Survey

Main Questions

Thank you so much for deciding to participate! It is important for us to understand your experiences in the program. We will ask questions about your access to and use of technology, access to and use of technology in your teaching experience, personal use of technology, your attitude about technologies and technological resources from your school. The survey should take about **20 minutes** to complete.

Remember you can stop anytime (to save what you've entered, just click forward to the next page of the survey). Come back by clicking on the survey link in the invitation email that was sent to you.

At completion of the survey, an acknowledgment of participation will be generated and sent to your email address that you may print out or save to your computer to be used in your portfolio or for other purposes.

YOUR PERCEPTIONS OF TECHNOLOGY

In the next two questions, your answers help us understand your reactions to digital technologies and learning technologies (definitions included below with each question).

This question is about **Digital Technology**, which are electronic computers, computer software, handheld computing devices, and online applications that convert, store, protect, process, transmit, and securely retrieve information.

Below you will find a number of statements concerning how you might feel about digital technology. Please indicate the strength of your agreement/disagreement with the statements using a 4-point scale shown below. There are no correct responses; it is your own views that are important.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I find working with digital technology very easy.	○	○	○	○
I am very unsure of my abilities to use digital technology.	○	○	○	○
I seem to have difficulties with most of the software or online applications I have tried to use.	○	○	○	○
Digital technology frightens me.	○	○	○	○
I often have difficulties when trying to learn how to use a new software package or online application.	○	○	○	○
I rely heavily on instructions and manuals to help me use digital technology.	○	○	○	○
Most of the software packages or online applications I have had experience with have been easy to use.	○	○	○	○
I am very confident in my abilities to use digital technology.	○	○	○	○

	Strongly Agree	Agree	Disagree	Strongly Disagree
I find it difficult to get digital technology to do what I want it to.				
At times I find working with digital technology very confusing.				
I find it easy to learn how to use a new software package or online application.				
I seem to waste a lot of time struggling with digital technology.				
I always seem to have problems when trying to use digital technology.				
Digital technology jargon baffles me.				
Digital technology is far too complicated for me.				
I consider myself a skilled digital technology user.				
When using digital technology I worry I might press the wrong button and damage it.				
	Strongly Agree	Agree	Disagree	Strongly Disagree

This question is about **Learning Technologies**, which are digital technologies put to use for instructional and student learning purposes.

Below you will find a number of statements concerning how you might feel about learning technology. Please indicate the strength of your agreement/disagreement with the statements using a 4-point scale shown below. There are no correct responses; it is your own views that are important.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I support the use of learning technology in the classroom.				
A variety of learning technologies are important for student learning.				
Incorporating learning technology into instruction helps students learn.				
Content knowledge should take priority over technology skills.				
Most students have so many other needs that learning technology use is a low priority.				
Student motivation increases when learning technology is integrated into the curriculum.				
Teaching students how to use learning technology isn't my job.				
There isn't enough time to incorporate learning technology into the curriculum.				
Learning technology helps teachers do things with their classes that they would not be able to do without it.				
Learning technology interferes with "human" interactions between teachers and students.				
Knowledge about learning technology will improve my teaching.				

	Strongly Agree	Agree	Disagree	Strongly Disagree
Learning technology facilitates the use of a wide variety of instructional strategies designed to maximize learning.	○	○	○	○
	Strongly Agree	Agree	Disagree	Strongly Disagree

TECHNOLOGY USE

The next section's questions help us understand your frequency of use of technology activities, your use of those activities for educational purposes, your perception of your instructors' use of these technology activities, and your overall perception of you skill with these tools.

We have grouped the technology activities into the following five themes:

* Communication
* Web
* Productivity
* Creation
* Education-specific

COMMUNICATION ACTIVITIES

The first set of questions focus on technologies used for communication.

Please check all the Communication Activities below that you have done.

- ☐ Read email
- ☐ Send email
- ☐ Read Blog
- ☐ Write/Comment on Blog(s)
- ☐ Read Wiki
- ☐ Write/Edit Wiki(s)
- ☐ Participate in text-based instant messaging (SMS) (e.g., in ichat, aim, gmail chat, facebook chat)
- ☐ Participate in text messaging via phone
- ☐ Read online discussion boards/forums
- ☐ Post/send messages to online discussion boards/forums
- ☐ Send messages to an email listserv (e.g., OrangeBikeList)
- ☐ Participate in Online Audio/Video interactions (ichat, Skype)

For each Communication Activity you, your students or both have used (noted below), tell us about the frequency of use and its use for personal or educational purposes.

	Please rate your approximate frequency of use for the following Communication activities:				For each Communication Technology you use, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.						
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	>	All Educational Use
» Read email	○	○	○	○	○	○	○	○	○	○	○
» Send email	○	○	○	○	○	○	○	○	○	○	○
» Read Blog	○	○	○	○	○	○	○	○	○	○	○
» Write/Comment on Blog(s)	○	○	○	○	○	○	○	○	○	○	○
» Read Wiki	○	○	○	○	○	○	○	○	○	○	○
» Write/Edit Wiki(s)	○	○	○	○	○	○	○	○	○	○	○
» Participate in text-based instant messaging (SMS) (e.g., in ichat, aim, gmail chat, facebook chat)	○	○	○	○	○	○	○	○	○	○	○
» Participate in text messaging via phone	○	○	○	○	○	○	○	○	○	○	○
» Read online discussion boards/forums	○	○	○	○	○	○	○	○	○	○	○
» Post/send messages to online discussion boards/forums	○	○	○	○	○	○	○	○	○	○	○
» Send messages to an email listserv (e.g., OrangeBikeList)	○	○	○	○	○	○	○	○	○	○	○
» Participate in Online Audio/Video interactions (ichat, Skype)	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Communication Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled

- Fairly skilled
- Not very skilled
- Not at all skilled

Check any of the Communication activities that your **students** used for classroom activities.

- Read email
- Send email
- Read Blog
- Write/Comment on Blog(s)
- Read Wiki
- Write/Edit Wiki(s)
- Participate in text-based instant messaging (SMS) (e.g., in ichat, aim, gmail chat, facebook chat)
- Participate in text messaging via phone
- Read online discussion boards/forums
- Post/send messages to online discussion boards/forums
- Send messages to an email listserv (e.g., OrangeBikeList)
- Participate in Online Audio/Video interactions (ichat, Skype)

WEB ACTIVITIES

Next, we ask about how you use web-based activities.

Please check all of the following Web Activities below that you have done.

- Use the Web from a cell/smart phone
- Download music, videos or podcasts
- Access music or videos (youtube etc.)
- Use the university library website
- Participate in social networking websites (Facebook, MySpace, Bebo, LinkedIn, etc.)
- Participate in online Multiuser computer games (World of Warcraft, Everquest, Poker, etc.)
- Participate in online Virtual worlds (Second Life)
- Build and tag bookmarks socially (delicious.com, etc.)

For each Web Activity you have used (noted below), tell us about your frequency of use and its use for personal or educational purposes.

	Please rate your approximate frequency of	For each Web Technology you use, indicate how much you use it for personal and

	use for the following Web activities:				educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.						
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	>	All Educational Use
» Use the Web from a cell/smart phone	○	○	○	○	○	○	○	○	○	○	○
» Download music, videos or podcasts	○	○	○	○	○	○	○	○	○	○	○
» Access music or videos (youtube etc.)	○	○	○	○	○	○	○	○	○	○	○
» Use the university library website	○	○	○	○	○	○	○	○	○	○	○
» Participate in social networking websites (Facebook, MySpace, Bebo, LinkedIn, etc.)	○	○	○	○	○	○	○	○	○	○	○
» Participate in online Multiuser computer games (World of Warcraft, Everquest, Poker, etc.)	○	○	○	○	○	○	○	○	○	○	○
» Participate in online Virtual worlds (Second Life)	○	○	○	○	○	○	○	○	○	○	○
» Build and tag bookmarks socially (delicious.com, etc.)	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Web Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

○

Expert

- Very skilled
- Fairly skilled
- Not very skilled
- Not at all skilled

Check any of the Web activities that your **students** used for classroom activities.

- Use the Web from a cell/smart phone
- Download music, videos or podcasts
- Access music or videos (youtube etc.)
- Use the university library website
- Participate in social networking websites (Facebook, MySpace, Bebo, LinkedIn, etc.)
- Participate in online Multiuser computer games (World of Warcraft, Everquest, Poker, etc.)
- Participate in online Virtual worlds (Second Life)
- Build and tag bookmarks socially (delicious.com, etc.)

PRODUCTIVITY ACTIVITIES

Next, we ask about your use of technologies for productivity activities.

Please check all of the following Productivity Activities below that you have done.

- Word Processing (MSWord)
- Spreadsheets (Excel, etc.)
- Presentation software (PowerPoint, Keynote etc.)
- Online productivity suite (Zoho, GoogleApps)
- Concept Maps (Inspiration, Visio, cmap)
- Desktop Publishing (MS Publisher, InDesign)

For each Productivity Activity you have used (noted below), tell us about your frequency of use and its use for personal or educational purposes.

	Please rate your approximate frequency of use for the following Productivity activities:	For each Productivity Technology you use, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.

	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	>	All Educational Use
» Word Processing (MSWord)	○	○	○	○	○	○	○	○	○	○	○
» Spreadsheets (Excel, etc.)	○	○	○	○	○	○	○	○	○	○	○
» Presentation software (PowerPoint, Keynote etc.)	○	○	○	○	○	○	○	○	○	○	○
» Online productivity suite (Zoho, GoogleApps)	○	○	○	○	○	○	○	○	○	○	○
» Concept Maps (Inspiration, Visio, cmap)	○	○	○	○	○	○	○	○	○	○	○
» Desktop Publishing (MS Publisher, InDesign)	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Productivity Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

Check any of the Productivity activities that your **students** used for classroom activities.

- ☐ Word Processing (MSWord)
- ☐ Spreadsheets (Excel, etc.)
- ☐ Presentation software (PowerPoint, Keynote etc.)
- ☐ Online productivity suite (Zoho, GoogleApps)
- ☐ Concept Maps (Inspiration, Visio, cmap)
- ☐ Desktop Publishing (MS Publisher, InDesign)

CREATION ACTIVITIES

Next, we ask about your use of technologies for productivity activities.

Please check all of the following Creation Activities below that you have done.

- ☐ Create or modify digital pictures or art (e.g., Photoshop, Illustrator, iPhoto)
- ☐ Create or modify digital audio (e.g., Audacity, GarageBand)
- ☐ Create or modify digital video (e.g., iMovie, MovieMaker)
- ☐ Produce podcasts
- ☐ Produce webcasts
- ☐ Create digital photo galleries or albums (e.g., iphoto, flickr)
- ☐ Create or modify web pages (e.g., Dreamweaver, iweb, googlepages)

For each Creation Activity you have used (noted below), tell us about your frequency of use and its use for personal or educational purposes.

	Please rate your approximate frequency of use for the following Creation activities:				For each Creation Technology you use, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.						
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	>	All Educational Use
» Create or modify digital pictures or art (e.g., Photoshop, Illustrator, iPhoto)	○	○	○	○	○	○	○	○	○	○	○
» Create or modify digital audio (e.g., Audacity, GarageBand)	○	○	○	○	○	○	○	○	○	○	○
» Create or modify digital video (e.g., iMovie, MovieMaker)	○	○	○	○	○	○	○	○	○	○	○
» Produce podcasts	○	○	○	○	○	○	○	○	○	○	○
» Produce webcasts	○	○	○	○	○	○	○	○	○	○	○

	Please rate your approximate frequency of use for the following Creation activities:				For each Creation Technology you use, indicate how much you use it for personal and educational use. Find a place that represents your use on the scale that ranges from all personal to all educational use and variations in between.						
	Many times per day	Daily	Weekly	Monthly or less	All Personal Use	<	-	-	-	>	All Educational Use
» Create digital photo galleries or albums (e.g., iphoto, flickr)	○	○	○	○	○	○	○	○	○	○	○
» Create or modify web pages (e.g., Dreamweaver, iweb, googlepages)	○	○	○	○	○	○	○	○	○	○	○

Think about your *overall* skill in using the Creation Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

Check any of the Creation activities that your **students** used for classroom activities.

- ☐ Create or modify digital pictures or art (e.g., Photoshop, Illustrator, iPhoto)
- ☐ Create or modify digital audio (e.g., Audacity, GarageBand)
- ☐ Create or modify digital video (e.g., iMovie, MovieMaker)
- ☐ Produce podcasts
- ☐ Produce webcasts
- ☐ Create digital photo galleries or albums (e.g., iphoto, flickr)
- ☐ Create or modify web pages (e.g., Dreamweaver, iweb, googlepages)

EDUCATION-SPECIFIC ACTIVITIES

Finally, we ask about three tools used specifically within education.

	Please rate your approximate frequency of use for the following Education-specific activities:					Indicate if your teacher preparation instructors helped you use or used the Education-specific activities listed below for teaching or learning in your program.	
	Many times per day	Daily	Weekly	Monthly or less	Never	Yes, instructors used	No, instructors did not use
Build an electronic portfolio of my coursework	○	○	○	○	○	○	○
Participate in Course Management Systems (e.g., Blackboard, WebCT, Moodle)	○	○	○	○	○	○	○
Utilize subject-specific software or technology (e.g., graphing calculators, websites centered on historical events)	○	○	○	○	○	○	○

Think about your *overall* skill in using the Education-specific Technologies you indicated above that you use for both personal and educational purposes. Please rate your overall skill level:

- ○ Expert
- ○ Very skilled
- ○ Fairly skilled
- ○ Not very skilled
- ○ Not at all skilled

Technological Resources from School

The following statements focus on technology support you experience from your school. Please indicate your level of agreement with each of the following statements.

	Strongly Agree	Agree	Disagree	Strongly Disagree
I have fellow teachers who can help me when I face technological problems or difficulties.	○	○	○	○
There are technical staff in the school who I can request help for technical problems or difficulties.	○	○	○	○
The administration of the school is supportive of me using technologies for teaching.	○	○	○	○
There are school policies relating to technology.	○	○	○	○

Please provide any examples that explain how the technological support at your school supports or inhibits your technology integration in classroom instruction.

For each of the following technological software or hardware listed on left, please indicate (a) the availability of the specific hardware/software in your school and (b) if available to you, the frequency of your use of the specific hardware/software at your school.

Definitions
1. Classroom Response system: Wireless system allowing a teacher to pose a question and students to respond using "clickers" or hand-held response pads, with responses compiled on a computer.
2. Document Camera: Device that transmits images of 2- or 3-dimensional objects, text, or graphics to a computer monitor or LCD projector.

	Type of availability			Frequency of use if available				
	Not Available	Available as Needed	In Classroom everyday	Many times per day	Daily	Weekly	Monthly or less	Never
Laptop	○	○	○	○	○	○	○	○
Digital projector	○	○	○	○	○	○	○	○
Room or devices for Web conferencing	○	○	○	○	○	○	○	○
Interactive whiteboard (e.g., SMART Board, Activboard)	○	○	○	○	○	○	○	○
Classroom Response System	○	○	○	○	○	○	○	○

	Type of availability			Frequency of use if available				
	Not Available	Available as Needed	In Classroom everyday	Many times per day	Daily	Weekly	Monthly or less	Never
Digital Camera								
Digital Video Camera								
MP3 player/iPod								
Document camera/ELMO								
Handheld device (e.g., Palm OS, Windows CE, Pocket PC, BlackBerry)								
Content Specific hardware/software								

If you use content specific hardware/software, please describe the the hardware/software items you use.

If you use any "other" hardware/software, please indicate the hardware/software in the following box. If you have more other hardware/software than you marked in the previous section, please describe how they are available and how much you use them.

If you have any issues with accessing necessary hardware/software, please describe the context and issues you face.

Please describe how you think about the overall technology resources such as your fellow teachers, technical staff, administrative support and technology hardware/software of your school and how the technology resources influences your classroom teaching.

Thank you - goodbye

Thank you so much for completing the survey. We *greatly* appreciate your time and effort for this project.

Appendix C. TPACK Survey

Please take a look of this survey.

In this short survey, I would like to see one of your recently-developed lesson plans which you thought about or decided to use technology within it (a lesson on any subject topic).

The survey should take you about 15 minutes.

Thank you,

Helena Hyo-Jin Yoon

Please tell us your name:

We are interested in seeing a lesson plan that YOU created during your teacher preparation. We would prefer the lesson to be one in which you thought about or decided to use technology within it. It does not have to include technology.

1. To send the lesson plan file, copy the following email address (mysticeyess@gmail.com) and send the file to us as an attachment. **Please be sure to write your name in the subject line of the email.**

All the questions in this survey will relate to the lesson plan you just submitted to us. Please take just a few minutes to review the lesson you created so that you can best answer the following questions.

In the following section, you will be asked to indicate the percentage of "thinking time" you spent during the development of the lesson plan you submitted above focused on three areas: pedagogy, content/subject matter, and technology. Please read the definitions of pedagogy, content/subject matter, technology, and thinking time below.

Pedagogy is another word for Instruction. It refers to the practices, processes, strategies, procedures, and methods of teaching and learning. For example, thinking about how to group students or how to present materials to students or how to explain difficult ideas to students are all pedagogy.

Content / Subject Matter is the subject matter that teachers teach and students learn. For example, science, math, English/language arts, physical education and other school subjects are content / subject matter areas.

Technology is digital hardware, related software, and infrastructure. For example, handheld computing devices, online applications or websites, the Internet, word processing software, and SmartBoards are examples of technologies that are used for teaching and learning purposes. There are many, many more.

Thinking Time is the time that you spent developing your lesson ideas and writing your lesson plan.

Please describe the kinds of PEDAGOGY issues you thought about while planning the lesson you submitted above.

Pedagogy is another word for Instruction. It refers to the practices, processes, strategies, procedures, and methods of teaching and learning. For example, thinking about how to group students or how to present materials to students or how to explain difficult ideas to students are all pedagogy.

Please describe the kinds of CONTENT / SUBJECT AREA issues you thought about while planning the lesson you

submitted above.

Content / Subject Matter is the subject matter that teachers teach and students learn. For example, science, math, English/language arts, physical education and other school subjects are content / subject matter areas.

Please describe the kinds of TECHNOLOGY issues you thought about while planning the lesson you submitted above.

Technology is digital hardware, related software, and infrastructure. For example, handheld computing devices, online applications or websites, the Internet, word processing software, and SmartBoards are examples of technologies that are used for teaching and learning purposes. There are many, many more.

Please describe or discuss how the lesson was enacted in your classroom. You may mention: the lesson's success, your satisfaction with the lesson, or what you might do differently next time you teach that topic.

Specifically: How did the lesson turn out? What did you think of the results?

Appendix D. Observation Protocol

Field Note

- I will take field note with word processing program on a laptop.

- I will record the class under the consent of the instructor.

What will I be noticing during the observation?

- University Class

1. What kind of technological infrastructure is equipped in the classroom?
2. What kind of technology does the preservice teacher use during class?
    a. For what purpose does the preservice teacher use the technology?
3. What kind of technology does the instructor use during class?
    a. For what purpose does the instructor use the technology?
4. What kind of technology-related activities is performed during the class?

- K-12 class

1. What kind of technological infrastructure is equipped in the classroom?
2. What kind of technology does the student teacher use during class?
    a. For what purpose does the student teacher use the technology?
3. What kind of technology-related activities is performed during the class?

Appendix E. Observation Note Example

Observation Note_102510
Students: 5th grade _Silver Creek Elementary School
Equipment of the first room: 5 emacs, headsets, screen, 2 OHPs, 1 telephone, 1 CT laptop (mac air), calculators

Math. 7:45

- On the OHP, there is a math problem sheet.

- PS3 projects how to solve the problem.

- He turns of the light of the OHP when it is not under use.

- [**Short chat with the PS3:** I used to use the innovated room, so I didn't wanna show this to you. - smiles._ he already knew that I observe the tech use, so he said this 3 times, 1 on the phone, 1 through email, and the other 1 now, oral.]

- Turns on the OHP to show what is 3 3/4 --> Turns off.

- He faces an issue with 4/6 (that the result is unlimited 0.66..). Rather giving oral explanation, he gives calculators to the students which visualize the result.

- He rolls up the screen to show how to solve the problem on the whiteboard with markers.

- PS3 turns on the OHP but does not roll down the screen and a student rolls down the screen. He seems that he does not notice this.

- The CT steps out from the classroom and later comes back with his laptop.

- PS3 asks a student to cleanse the transparent sheet, which was used on the OHP.

<Home room for Social Studies> From 9: 25 --> This room is the innovative room that he said.

Equipment: 4 emac, 1 doc cam, a cart, screen, overhead projector, printer, calculators, 1 telephone, CT laptop (Mac Pro), air mouse, headsets with the emacs.

- PS3 opens his laptop (mac pro) and connects it with the screen. And goes to "discovery education" website and logs in. But he has Internet connection problem with his laptop. It seems that he needs ID and PW. He tries to find the PW on his cell phone, but it seems failed. So he disconnects his laptop from the screen and takes his CT's laptop. Trys to connect the Internet but it does not work. He apologizes about the technical problem. Now he tries to connect Ethernet line with the computer. At that time, the CT comes in the classroom. The PS3 discuss the Internet issue to her and she changes the Internet signal and it is connected.

- PS3 turns on a movie about the Puritans' transfer from England to America. From time to time, the PS3 stops the movie clip to have short discussion with students about words (rubbish), political issues (vote), and religious freedom.

<Specials> 10:05

Students' special activities such as music, P.E. etc. PS3 just look around students. No technology.

<Language Arts> 10:50

PS3 helps with students with their learning during the class. No technology.

< Science>

- He is giving oral introduction about solar collector function in the calculator and how to look at it.

- Students seem cover the solar collector with paper, so he's using doc cam to show how to use solar collector, to correct students' error. After the explanation, he disconnects the signal from the doc cam to the screen.

- The PS3 is able to see that the CT uses laptop and shows 3 video clips about light energy from the discovery education web site.

- The PS3 goes to the Optical research Association website, which offers text information about "light"

- After the online resources (the video clip from the discovery education and ORA) are done, the PS disconnect the signal from the computer to the projector.

Appendix F. Preservice Teacher Interview Questions

A. Technology, Pedagogy, and Content

1. Tell us about how you see technology's role/place within your disciplines (English, social studies, math, science, etc.)

2. What are the technologies you think are really important for teaching/learning in the future? Why? How did you find about these technologies?

B. Technology and PDS

1. What technologies did you learn about in your professional development sequence?

2. How would you describe laptop role in your learning?

3. How often did you use it? (Why that level of use?)

C. Confidence

1. How confident do you feel about technology integration right now?

2. Has that changed since you started your program?

3. Are there ideas you have of things that could have been done to have increased your confidence in tech integration.

4. Do you think you'll need to keep learning about technology as a teacher?
    a. If so, how do you think you will do that / or the best way to do that is? How will you find out about new ideas?

Appendix G. Novice Teacher Interview Questions

A: Technology use at school

1. What technologies do you use in the classroom?
    a. For what purpose do you use the technology?
2. How do you incorporate technology into your classroom teaching? Into student' assignments?
3. Do you use for administrative tasks? If so, which would you say you use it more for, administration or teaching?
4. How often do you use technology?
5. How would you rank your technological adeptness?

B: Students technology use

1. What sort of activities do your students do using technologies?
    a. For what purpose do your students use the technology?

C: Confidence

1. How confident do you feel about technology integration right now?
2. Has that changed since you started your program?
3. Why do you think it changed / not changed?
4. Are there ideas you have of things that could have been done to have increased your confidence in tech integration.
5. Do you think you'll need to keep learning about technology as a teacher?
    a. If so, how do you think you will do that / or the best way to do that is? How will you find out about new ideas?

D: Infrastructure of School

1. Do you have human resource that can help you with technological issues in your school?
    a. If you have, who are they?
    b. If you don't have, how do you solve technological issues?
2. What kind of technological infrastructure does hour school is equipped with?
    a. What do you use?
3. How is the culture about using technology in your school?

The interview questions A and B are adopted from Harwood and Asal (2007).

Appendix H. TPACK Rubric

TPACK Components	TPACK Levels				
	Recognizing (1)	Accepting (2)	Adapting (3)	Exploring (4)	Advancing (5)
An overarching conception about the purposes for incorporating technology in teaching subject matter topics.	• Technology is used for motivation, rather than actual subject matter development. • All learning of new ideas presented by the teacher mostly without technology. • Technology integrated activities do not include inquiry tasks. • Technology integrated activities procedures concentrate on drills and practice only.	• Technology is used for either or both motivation and actual subject matter development. • Main purpose of technology use is for demonstrations, which include presenting new knowledge. • Technology integrated activities do not include inquiry tasks. • Technology integrated activities procedures concentrate on teacher demonstration and practice.	• Teacher is one who is using technology in a way that is new and different from teaching without this technology (dynamic nature, linked representations) and used for learning new knowledge by students) • Technology integrated activities include inquiry tasks. • Technology integrated activities procedures concentrate on subject matter tasks with connections and on inquiry activities that use or develop connections.	• Main purpose of technology use is for students' exploration and experiment with it of new knowledge and practice with it. • Technology integrated activities include inquiry tasks. • Technology integrated activities procedures concentrate on subject matter tasks with connections and doing subject matter – and on inquiry activities that use or develop connections (especially between multiple representations).	• Technology tasks provide students with deeper conceptual understanding of subject matter and its processes. • Technology integrated activities include inquiry tasks of high cognitive demand. • Technology integrated activities procedures concentrate on subject matter tasks with connections and performing subject matter knowledge – and on inquiry activities that use or develop deep subject matter knowledge representing connections (especially between multiple representations) and strategic knowledge.

TPACK Components	TPACK Levels				
	Recognizing (1)	Accepting (2)	Adapting (3)	Exploring (4)	Advancing (5)
Knowledge of students' understandings, thinking, and learning in subject matter topics with technology	• Technology is used primarily for student practice. • Technology integrated activities do not present any new material, and only provides space for applications and drills.	• Technology is mostly used for teacher demonstrations or teacher-led student-follow work with technology, it is rarely used for students' independent explorations. • Teacher sees the technology as either or both a motivational and learning tool. • Technology integrated activities mirror the structure of the textbook presentation of subject matter without active explorations.	• Teacher focuses on students' thinking of subject matter while students are using technology on their own – both for learning new knowledge and review of prior knowledge • Technology integrated activities provide an environment for students to perform/do/engage subject matter knowledge with teacher guidance.	• Teacher focuses on students' subject matter conceptual understanding and serves as a guide of student learning with technology, not a director. • Technology integrated activities provide an environment for students to deliberately take actions on subject matter objects or representations, which is meaningful for subject matter. • Teacher guidance is necessary in order for students to see the meaningful consequences of those actions on subject matter.	• Teacher facilitates students' high level thinking with technology (linked representations, reasoning and proofs) • Technology integrated activities provide an environment for students to deliberately take meaningful actions on subject matter objects or representations and to immediately see the meaningful consequences of those actions, which is meaningful for subject matter.

TPACK Components	TPACK Levels				
	Recognizing (1)	Accepting (2)	Adapting (3)	Exploring (4)	Advancing (5)
Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics	• Technology if used is not aligned with one or more curriculum goals.	• Teacher uses textbook-based approach to the curriculum topics with technology being used as add-on. • Technology is partially aligned with one or more curriculum goals. • Teacher has difficulty in identifying topics in subject matter curriculum for including technology as tool.	• The technology is used as a replacement for non-technology based tasks in a traditional curriculum approach. • Technology is aligned with one or more curriculum goals. • Teacher chooses topics from school subject matter curricula; however, technology use does not provide any advantage for the chosen curriculum topics.	• Teacher independently envisions how curriculum might be taught with the technology. • Students are given problem solving tasks with technology and are asked to expand subject matter ideas on the basis of technology explorations. • Technology is aligned with curriculum goals. • Teacher chooses important topics of school subject matter curricula and technology use adds curricular advantage for the chosen curriculum topics.	• Teacher uses technology in a fully constructive way, including tasks for development of higher level thinking and deepening understanding of subject matter concepts. • Teacher challenges the traditional curriculum - engaging students in learning quite different topics with the technology and eliminating some of the topics that have traditionally been taught. • Technology is strongly aligned with curriculum goals. Teacher chooses essential topics of school subject matter curricula. Technology use adds curricular advantage and there's evidence of learning gains by students for the chosen curriculum topics.

TPACK Components	TPACK Levels				
	Recognizing (1)	Accepting (2)	Adapting (3)	Exploring (4)	Advancing (5)
Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies	• Teacher focuses on how to use specific technology rather than how to explore subject matter ideas, using teacher-directed lectures followed by student practice. • Technology integrated activities are not focused primarily around subject-matter objectives but may be generally focused on learning objectives	• The instructions are teacher-led. Teacher structures lesson plan with limited student explorations with technology. • There is limited to no opportunity for student reflection. • Technology integrated activities have a mixed focus on subject-matter and general learning objectives	• Teacher uses didactic (teacher-directed) approach to teaching with technology to maintain control of the progression of the activities. • Technology integrated activities are focused primarily around subject-matter objectives • There is opportunity for student reflection – especially the posing of questions for sense-making.	• Teacher uses various instructional strategies (didactic or student-centered) and focuses on students' thinking about subject matter. • Teacher's use of technology is beyond textbook-based approaches to curricular topics. • Technology integrated activities are built around subject matter objectives • Technology integrated activities explicitly promote student reflection – especially the posing of questions for sense-making.	• Teacher focuses on students' hands-on and experimentation of new subject matter ideas with technology, and focuses on conceptual development. • Technology integrated activities are built subject matter objectives • Technology integrated activities explicitly promote student reflection – especially the posing of questions for sense-making and reasoning, including explanation and justification.

Appendix I. Data collection timeline

	Preservice Teachers			Novice Teachers
Level	**1st Semester**	**2nd Semester**	**3rd Semester**	**1st Year**
Technology and skill Survey	Before 09/24/10		11/17/10-12/10/10	12/01/10-12/18/10
TPACK	11/17/10-12/10/10			12/01/10-12/18/10
Observation	1st Observation: 09/10/10 - 09/30/10 2nd Observation: 10/18/10-11/01/10 3rd Observation: 11/22/10-12/17/10			
Interview	1st Interview: 09/10/10 - 09/30/10 2nd Interview: 10/18/10-11/01/10 3rd Interview (Final): 11/22/10-12/17/10			1st Interview: 12/01/10-12/18/10 2nd Interview: 10/18/10-11/01/10
Lesson Plan	11/17/10-12/10/10			12/01/10-12/18/10
Technology Related Documents from K-12 School				09/15/10-12/18/10

Appendix J. Research Matrix

Research Question	Data Sources	Specific data to answer this question	Analysis Required	What will this allow me to say?
1. How are two preservice teachers in each level (semester) of a one-to-one laptop preservice program prepared to used technology in their future PK-6 classrooms?				
a. How do technology-related skills, attitudes, and knowledge of the six preservice teachers develop and change during the program?	Skills and Attitude Survey (for Preservice teachers)	**ATTITUDE** - Digital technology self-efficacy - Learning technology self-efficacy	**ATTITUDE** - (SPSS) Score for each scale	*- e.g. The average score of the Digital technology self-efficacy of preservice teacher was 4, which means high digital self-efficacy .*
		SKILL - Communication technology - Web technology - Productivity technology - Creation technology - Education specific technology	**SKILL** - (SPSS) Frequency	*- e.g. The certification students used A, B, and C technology for communication technology.* *- e.g. Certification students and student teachers did not have difference in technology skills.*
	Document - Preservice teachers' Lesson Plan (Will be collected from TPACK Survey)	**KNOWLEDGE** - Use TPACK rubric	**KNOWLEDGE** - Score of ICT-TPACK performance of each participant - Description of the information from the lesson plan which meets the criteria	*- e.g. The overall ICT-TPACK score of preservice teacher B was 20, which shows high ICT-TPACK performance.*
	TPACK Survey	**KNOWLEDGE** - Q3, Q4, Q5, Q6, Q7	**KNOWLEDGE** - Q3: Compare percentages of thinking time that preservice	*- e.g. The preservice teacher C spent 25% of thinking time for pedagogy, 60% of thinking time for content,*

			teachers spend for developing lesson plan - Q 5,6,7,8: • Open Coding • Axial Coding • Selective Coding	*and 15% of thinking time for technology when preparing lessons.* *- e.g. The preservice teacher D, who created a lesson plan for mathematics class thought technology is not very necessary for the subject matter.*
	Observation - Student Teaching (Observation protocol)	**SKILL** - K-12/1,2,3	**SKILL** - List up the technology that the preservice teachers use during teaching - Check the technology by categories (- Open Coding - Axial Coding - Selective Coding)	*- e.g. The preservice teacher C used word process as a learning technology.*
	Interview (Preservice Teacher Interview Protocol)	**KNOWLEDGE** - A1,2 **ATTITUDE** - C1,2,4,5 **SKILL** - B1,2,3	- Open Coding - Axial Coding - Selective Coding	*-e.g. The technology attitude of preservice teachers changed due to the technology experience through classes and orientations* *-e.g. Preservice teachers used similar technology during the program.*

b. What kind of activities and practices prepare the six preservice teachers during the program?	Observation - University Class - Student Teaching (Observation protocol)	**Technology-related Practices** - Observation protocol	**Technology-related Practices** - Open Coding - Axial Coding - Selective Coding	- *e.g. Preservice teachers were assigned to create a website for introducing specific information.*
	Documents - Instructors' Syllabi - Preservice teachers' observation note	**Technology-related Practices** - Documents	**Technology-related Practices** - Open Coding - Axial Coding - Selective Coding	- *e.g. Student teacher E observed how the inservice teacher integrates technology for teaching and managing the class.*
	Interview (Preservice Teacher Interview Protocol)	- A2 - C3 - B1,2	- Open Coding - Axial Coding - Selective Coding	-*e.g. Instructors' modeling impacted on preservice teachers' technology use [Example.]*
2. How are two novice teachers, who are the graduates of the one-to-one laptop preservice program, enabled/disabled in using technology in their PK-6 classrooms?				
a. What technology skills, attitude, and knowledge do the novice teachers have in the first	Skills and Attitude Survey (for novice teachers)	**ATTITUDE** - Digital technology - Learning technology	**ATTITUDE** - (SPSS) Score for each scale	**ATTITUDE** - *e.g. The average score of the Digital technology self-efficacy of novice teacher was 3, which means medium digital self-efficacy .*

year of teaching?		**SKILL** - Communication technology - Web technology - Productivity technology - Creation technology - Education specific technology	**SKILL** - (SPSS) Frequency	**SKILL** *- e.g. The novice teachers used A, B, and C technology for communication technology.*
	Document - Novice teachers' Lesson Plan	**KNOWLEDGE** - Use TPACK rubric	**KNOWLEDGE** - Score of ICT-TPACK performance of each participant - Description of the information from the lesson plan which meets the criteria the criteria	**KNOWLEDGE** *- e.g. The overall ICT-TPACK score of novice teacher B was 22, which shows high ICT-TPACK performance.*
	Interview (Novice Teacher Interview Protocol)	**KNOWLEDGE** - A2,3 **SKILL** - A1,4,5 **ATTITUDE** - C1,2,3,4,5	- Open Coding - Axial Coding - Selective Coding	*-e.g. Novice teacher A in the first year of teaching does not use technology much.* *-e.g. Novice teacher G has confidence in using technology, but integrating it into teaching needs more time.*
b. What kind of technologies do the teachers and students access in the classroom?		**TECHNOLOGY INFRASTRUCTURE** - C1,3	C1 - (SPSS) Score for each scale C3	*-e.g. Novice Teacher G could access document camera, students' laptops, and web conference system at her school.*

			- List of devices and frequency of use	
c. What kind of technologies do the teachers and students use?	Skills and Attitude Survey (for novice teachers)	**SKILL (Teachers)** - Communication technology - Web technology - Productivity technology - Creation technology - Education specific technology **SKILL (Students)** - Communication technology - Web technology - Productivity technology - Creation technology - Education specific technology	**SKILL** - (SPSS) Frequency	**SKILL** *- e.g. The novice teachers used A, B, and C technology for communication technology.* **SKILL (Students)** *- e.g. The students in the class of novice teachers D used A, B, and C technology for communication technology.*
d. What human, technology, and infrastructural resources exist at the novice teacher's school site to support technology integration	Novice Teacher Survey	Context Section - C1,2,3,4,5,6,7	C1 - (SPSS) Score for each scale C3 - List of devices and frequency of use C2,4,5,6,7	*- e.g. School culture of teacher A is supportive for technology integration.* *-e.g. All the novice teachers have LCD projector, digital camera and whiteboard in their school.*

efforts?			- Open Coding - Axial Coding - Selective Coding	- *e.g. Usually colleague teacher helped teachers to solve the technological problem.*
	Documents - Technology related school documents	Documents	- Open Coding - Axial Coding - Selective Coding	- *e.g. The school where the novice teacher C reports technology goal of ISD to the teachers.*
	Interview (Novice teacher interview protocol)	D 1,2,3	- Open Coding - Axial Coding - Selective Coding	- *e.g. Teacher A felt school is equipped with the devices but using them needs more effort.*

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