Examining Pre-service Teachers' Technology Integration Perceptions and Practices

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Abstract

In this digital age, teachers are novice learners themselves of educational technologies. Pre-service teachers, in particular, face multiple layers of demands and challenges. Not only do they frequently need to learn how to use digital educational tools, but they also may need to adjust their pedagogies, which are directly connected to their beliefs about teaching and learning (Ertmer & Newby, 2016; Tondeur et al., 2017) and their confidence in the practice of technology integration (Hur et al., 2016). Current research lacks insight into pre-service teachers' learning progress during their teacher training and its connection to their ongoing development of contemporary teaching practices that support diverse learning experiences (Ottenbreit-Leftwich et al., 2015). The purpose of this dissertation was to gain further insights into the conceptual changes pre-service K-12 teachers' experience related to technology integration during their teacher preparation that prepares them for future classrooms.

The qualitative case study method (Merriam, 2001) was selected in this study to explore pre-service teachers' perceptions and their influences on the "how" and "why" of technology integration practices. This retrospective study examined 69 pre-service teachers' learning trajectories and their conceptual changes related to technology integration within an educational technology course.

Guided by learning sciences approaches (Hoadley & Van Haneghan, 2012), a technology integration model (Roblyer & Hughes, 2018), and the ISTE standards (2016; 2018), a qualitative content analysis was conducted through three steps of analysis to triangulate how pre-service teachers construct their perceptions. First, three major

themes, ranging from limited use, conservative use, to constructive use of technology, were identified in the pre-course questionnaire analysis, while two main aspects, separated or integrated use of technology, were uncovered in the post-course questionnaire analysis. Finally, three focal participants were purposefully chosen to illustrate their developmental growth and how they translated their beliefs into instructional design.

The results of this study offer suggestions and applications for pre-service teacher educators and teacher preparation in designing new approaches to better address the ongoing challenge of technology integration in K-12 classrooms.

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CHAPTER 1

INTRODUCTION

A Brief History of K-12 Technology Integration and Teacher Learning

Since the World Wide Web became accessible to the general public in the early 1990s, digital technologies have impacted educational reforms. The impact of the internet in K-12 education contexts is different from traditional technologies, such as a TV or a projector, that are used mostly as an object to support passive knowledge acquisition in the classroom. In contrast, digital technologies including computers and other internet-infused environments change the ways people acquire new knowledge, which is more active and supports learners' knowledge creation (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2018).

Today, in the digital age, while K-12 students are engaging in 21st century skills and 21st century learning (Battelle for Kids, 2019), teachers are novice learners themselves of educational technologies. In other words, both teachers and students consistently need to acquire new sets of technical skills and competencies as technology continues to advance/evolve. In the early 2000s, in efforts to prepare teachers for teaching in the digital age, national plans emphasized teachers needing to learn how to effectively use technology ranging from operating hardware and software to applying computers within content areas/subjects (National Center for Education Statistics [NCES], 1999; NCES, 2000; NCES, 2005). There was also attention on training teachers for navigating "instructional technology" or "educational technology."

Beginning around 2005, as we entered the "Mobile Technologies, Social Media, and Open Access Era" (Roblyer & Hughes, 2018), there were more virtual and ubiquitous learning environments already embedded within digital technologies, such as iPads and all of the apps that can be used on them. There were also new teaching and learning approaches / pedagogies (e.g., blended learning, Flipped classroom) emerging and thus growing new focuses for teachers on their "capacity to use technological tools to enable transformative learning and teaching" (Office of Educational Technology [OET], 2017, pg. 1). These capabilities of teachers included the digital literacies to operate technologies fluently as well as the ability to use technologies to solve unexpected problems (OET, 2017; National Assessment of Educational Progress [NAEP], 2018). During this time, and as evidenced by these new teaching approaches and expanding expectations for teachers, there was a parallel shift towards more constructivist orientations to learning (Bednar et al., 1992; Brown et al., 1989; Jonassen, 1991; National Research Council [NRC], 2000; Piaget, 1971; Vygotsky 1978). "The new science of learning is beginning to provide knowledge to improve significantly people's abilities to become active learners who seek to understand complex subject matter and are better prepared to transfer what they have learned to new problems and settings" (NRC, 2000, pg. 13). While constructivism was not a new educational theory, the translation of this sociocultural theory into practice took time and the parallel rise of educational technologies that could facilitate it propelled it forward (NRC, 2000).

This shift towards constructivism is also visible in education frameworks that highlight the 4C skills with technology (i.e., critical thinking, creativity, collaboration,

and creativity) such as the Framework for 21st Century Learning (Battelle for Kids, 2019). Other frameworks perceive learning with technology as a way of thinking (Binkley et al., 2012), while others suggest using technology to perform practical tasks (Organization for Economic Cooperation and Development [OECD], 2012). An additional framework considers learning with technology to be an empowering action (New Media Consortium, 2017), and others focus on it as an integrated skill (International Society for Technology in Education [ISTE], 2016). All of these frameworks/perspectives also stress that teachers need to design, create, and teach using constructivist approaches in order to provide diverse learning opportunities for students in technology-supported environments (ISTE, 2016; UNESCO, 2018). Regardless of framework, the changing perspectives about learning represented in and across the frameworks have prompted the redefinition of the roles of technology, teacher, and learners in K-12 classrooms.

Technology Integration and Pre-Service Teachers

While the call to shift from traditional direct instruction to more active, creation-focused, technology-infused pedagogies in K-12 schools is a positive development, the new expectations this shift demands of teachers are immense. These expectations include knowing how to use technology to differentiate instruction, interpreting online course management dashboard data, personalizing learning, understanding data management and privacy, and facilitating authentic learning in digital collaborative environments. Pre-service teachers, in particular, are facing multiple layers of demands and challenges. **Pre-service teachers** are individuals pursuing teaching licensure certification or credentials

so that they are able to teach in K-12 schools. They are not only novices in understanding teaching professional knowledge, but also in learning technologies specific to education. Most of the time, pre-service teachers are still constructing their own personal educational philosophies and studying pedagogical strategies while simultaneously learning how to integrate technology and leverage digital resources. This is a lot of learning happening at the same time, and often within licensure programs that span only 1 or 2 years. While pre-service teachers are introduced to educational technologies and technology integration strategies during their programs, it is only an introduction. They need more time and experience to adapt their pedagogical strategies depending on how they approach technology usefulness/capacities/uses in teaching and learning practices.

It is essential that pre-service teacher programs support appropriate technology integration (Kolb, 2020) and "the redesign of teaching" (OET, 2017, p. 1) in order to support pre-service teachers' professional growth and preparedness for entering schools. **Technology integration** refers to the process through which teachers purposefully incorporate technology into their teaching and learning environments. Purposeful technology integration can help students better navigate using technology as a resource for active learning, including problem-solving and increasing their own agency as learners. Recent research on technology integration has focused on teachers' knowledge and readiness (Burden et al., 2016; Instefjord & Munthe, 2016) or explored new pedagogies through technologies (McCormack & d'Inverno, 2012; Polly & Rock, 2016; Santori & Smith, 2018). While there is consensus about the importance of incorporating technology into teaching and learning, there are discrepancies in the uses of technology in

K-12 schools where teachers have a historic role as a "gatekeeper to the classroom" (Cuban & Jandrić, 2015, p.429) and there is a disconnection between teacher preparation and actual classroom practices (Ottenbreit-Leftwich et al., 2015).

According to the National Educational Technology Plan (OET, 2017), teacher educators and teacher education programs need to ensure "every new teacher is prepared to meaningfully use technology to support student learning" (p. 1). The Office of Educational Technology, in collaboration with educational innovators, created four guiding principles for the use of educational technology in teacher preparation (https://tech.ed.gov/edtechtprep/):

1. Focus on the active use of technology to enable learning and teaching through creation, production, and problem solving.
2. Build sustainable, program-wide systems of professional learning for higher education instructors to strengthen and continually refresh their capacity to use technological tools to enable transformative learning and teaching.
3. Ensure pre-service teachers' experiences with educational technology are program-deep and program-wide rather than one-off courses separate from their methods courses.
4. Align efforts with research-based standards, frameworks, and credentials recognized across the field.

While these principles can be useful in establishing high-level benchmarks or goals, what was missing is *how* to enact these principles. So, the national Office of

Educational Technology working group established the Teacher Educator Technology Competencies (TECs) (Foulger et al., 2017) as a starting point for teacher educators to translate these principles into practice. There are 12 competencies that aim "to support the redesign of teaching in teacher education programs so that ALL teacher educators are prepared to model and integrate technology in their teaching. Teacher candidates who receive consistent and appropriate experiences with technology throughout their teacher education programs will be more prepared to integrate technology into their own classrooms" (https://site.aace.org/tetc/). While the TECs are a step in the right direction, they lack specificity for direct translations into practice. For example, "Teacher educators will use online tools to enhance teaching and learning" is one of the TEC competencies. This competency is expanded to name, "communicate using online tools" as a strategy to meet this competency. Teacher educators themselves must figure out the logistics — What tools? Communicate with whom? For what purposes?

In addition, *how* these recommendations and guidance impact pre-service teachers' learning and development is yet to be examined. For example, what is still missing in current teacher training? How might integrating technology further change teacher educators' roles as well as learning opportunities in pre-service curricula/programs? While current pre-service teachers have grown up to some extent with computer experiences and exposure to smartphones and social media, can we assume they know how to integrate educational technology into teaching in a meaningful way?

These gaps stem from the reality that technology is frequently perceived as an intervention in the classroom rather than "an enabler of pedagogy" by educators when they attempt to incorporate technology into teaching (McKnight et al., 2016). Meanwhile, both teacher educators (Foulger et al., 2017) and pre-service teachers must first engage in a dynamic learning process with new technologies themselves. Not only do they frequently need to learn how to use digital educational tools, but they also may need to adjust their pedagogies, which are directly connected to their beliefs about teaching and learning (Tondeur et al., 2017) and their confidence in the practice of technology integration (Hur et al., 2016). Current research lacks insight into pre-service teachers' learning progress during their teacher training and its connection to their ongoing development of contemporary teaching practices that support diverse learning experiences (Ottenbreit-Leftwich et al., 2015). If pre-service teachers experience more diverse and reflective uses of digital tools themselves during their teaching preparation, they may be more likely to imagine and design technology-infused, active learning environments for their learners (Ertmer et al., 2012).

Purpose of the Study and Organization of Chapters

This dissertation stems from my personal interest in how pre-service teachers approach technology integration. Prior to my own learning about the possibilities of technology integration, I completed my teacher training with an elementary school teaching license. However, growing up in the millennial generation, my previous experience in using technology for teaching and learning were in traditional ways like projecting learning materials on a screen, watching educational videos, editing film for

educational materials, or playing games for whole-class rewards. Limited technology exposure in my own K-12 experiences strained my imagination in seeing the possibilities of incorporating technology into teaching and learning as a teacher. I was not concerned about using technology and in different ways in the classroom. By the time I began to teach a required educational technology course for pre-service teachers during my doctoral studies, I had devoted myself (mostly through self-taught experiences as a novice learner) to exploring various digital technologies and identifying useful, practical frameworks to guide pre-service teachers' technology integration.

However, in my role as a pre-service teacher educator, I was frustrated when some pre-service teachers only asked for help in preparing their SMARTboard skills to ensure their readiness in a future school workplace, or, on the other hand, were inclined to limited use of technology throughout the course. At the end of each semester, I engaged in reflection about ways to refine the course, whether the tools used or the activities themselves. I soon recognized that regardless of changes I made to the curriculum or to the pedagogical strategies I used, most pre-service teachers were not going to change their perceptions about the use of technology in K-12 classrooms, at least during the course. As the semester progressed and the evolution of newer technology products became faster, future classrooms themselves were also changing rapidly. Some classrooms updated the SMARTboards while others equipped every student with tablets or VR devices. Under these circumstances, I recognized that my responsibility as a teacher educator was not to promote specific digital technologies, but rather to empower pre-service teachers with a diverse pedagogical mindsets so that they would not

constraining their own teaching practices (and their students' learning), which are not connected to technology tools themselves.

The purpose of this dissertation was to gain further insights into the conceptual changes pre-service K-12 teachers' experience related to technology integration during their teacher preparation that prepare them for future classrooms. The study offers useful suggestions and applications for pre-service teacher educators and teacher preparation in designing new approaches to better address the ongoing challenge of technology integration in K-12 classrooms.

In the following chapters, I share my research study that is set within the context of a required educational technology course within 69 pre-service teachers during Spring 2016 to Summer 2017. In Chapter 2, I review pertinent literature related to technology integration. Literature topics include the role of technology and its historical influences on teaching and learning as well as the importance of addressing pre-service teachers' development and challenges in their approaches to technology integration. In Chapter 3, the study's conceptual and analytical frameworks are outlined along with its methodology, methods, and analytic steps. In Chapter 4, I present the findings of my research including main patterns of participants' initial perceptions of technology integration. I also illustrate three focal participants' learning trajectories (through a deeper analysis of their pre/post-course questionnaire responses, coursework, and lesson plans) as snapshots to uncover how they develop conceptual changes about technology integration. Finally, in Chapter 5, the conclusions of this study are shared including an overview of my findings and implications for pre-service teacher research and teacher

education programs. I conclude with a discussion of study's limitations and ideas for future research.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to provide a rationale for and establish the importance of my research focus at the intersection of technology, teaching and learning — exploring pre-service teachers' conceptual changes related to technology integration. Specifically, I use the literature to demonstrate the relationship between teaching and learning purposes/practices and perceptions about the role of technology in K-12 education. This chapter begins with an overview of the history of technology's influence in education including national plans and models of technology integration. Next, I review research specific to pre-service teachers and technology integration. This large body of research spans the topics of skills, knowledge, pedagogy, beliefs, and practices related to technology integration. Finally, I describe learning sciences approaches for guiding pre-service teachers' learning development.

A Brief History: The Changing Role of Technology and Its Influences on Teaching and Learning

Catching a Moving Train

Back in the 1970s and 1980s, prior to the birth of the internet in the 1990s, the term "technology" was used to describe media including broadcasting tools (e.g., radio, TV) and computers. The concept, "learning with media," proposed by Kozma in 1991, highlighted how media/technology plays a role within learning processes. When technology met pedagogy to become instructional media, technology was first applied in

the management of instruction (teaching). This relationship began researchers' and practitioners' interest in whether broadcasting could play an instructional role in teaching and in how to select media to use for instruction (Reiser & Gagne, 1983). Clark (1983) also argued that there were no learning benefits to using media for delivering instruction and asked research directions on instructional methods and learner attributions. Cuban (1986) further investigated how instructional TV had been applied in classrooms from 1954 to 1983, and further considered ways to use computers in the classroom. Researchers were then urged to examine the use of computers in schools to "catch a moving train" (p.20, Becker, 1998). The swift progression of the increasing role of computers in classrooms pushed researchers to speed up their examinations of effective uses in education. As a result, the call for computer literacy (Molnar, 1979) and the development of computer knowledge and attitudes by pre-service K-12 teachers (Woodrow, 1992) became a major movement during this time.

Beyond Effective Use

With the development of the World Wide Web (WWW) in 1989 and the launch of the first public website in 1991, the increasing use of the internet defined the Internet era. The role of technology in education was not limited only to computers — people were starting to understand the potential power of the internet (Web-Based Education Commission, 2000). A broad umbrella term began being used, "multimedia," which indicated a series or variety of digital resources and technologies such as videoconferences and audio/video learning materials. Technology created new opportunities for teaching and learning, including supporting and reimagining teaching

practices and making learning more authentic with direct connections to the real world. This impact continues today, with digital technologies offering ubiquitous opportunities for K-12 teachers to design instructional content with digital tools, and for learners to engage in collaborative learning experiences, create learning artifacts, and share knowledge and ideas in technology-supported environments (New Media Consortium, 2017).

Today's teachers are still being asked to rethink the fundamental connection between pedagogy and technology. A growing constellation of perspectives from fields spanning cognitive science to computer science call for teachers to rethink teaching, learning, and technology in order to prepare learners for the contemporary world. For example, while some research has focused on teachers' digital literacy (Knobel & Kalman, 2018; Pianfetti, 2001) and the impact of teachers' beliefs on educational technology use (Ertmer, 2005; Tondeur et al., 2017), other research projects have centered on the role of technology integration in active learning, performance tasks, and learning environments (Laine & Nygren, 2016; Kimmons et al., 2015; Miller, 2015).

With rapid changes in technologies themselves, teachers not only must acquire new technological skills, but also be able to connect these advanced digital tools with shifting pedagogical mindsets and practices in order to facilitate learners' acquisition and creation of knowledge through the purposeful use of technology. Examples of this reality can be illustrated by the research on 1-to-1 iPad integration in K-12 schools (Livingston, 2009) and the challenging issue of the persistent and increasing digital divide over the past two decades (Pew Research Center, 2016). Collectively, the role of digital

technologies in education enables both teachers and learners to self-learn multiliteracies (Santori & Smith, 2018) through engaging in the active use of technology, including contributing new content and sharing this content with others in online communities (Ito et al., 2013). It is this connected, social role of technology that bridges digital participation happening in the schooling environments with the outside world (Jenkins et al., 2016). In other words, today it is possible for both teachers and students to not only use technology, but also to contribute new knowledge, make meaningful contributions, and participate in digital engagement with others outside classrooms. This reality calls for an urgent need for K-12 educators to (re)consider the role of technology as more than passive use of digital tools by students and themselves, but rather how to create active, technology-enhanced environments for all.

Changes in National Ed Tech Plans and Standards

Two decades ago, "integrat(ing) educational technology into the grade or subject taught" was mentioned as one of the requirements for K-12 teachers in a report by the National Center for Education Statistics (NCES) entitled, *Teacher Quality: A Report on The Preparation and Qualifications of Public School Teachers* (1999). As stated in one of the report's requirements about teachers' feeling of preparedness, "integrating technology into classroom instruction and employing new teaching strategies" were two components in the need to train and "upgrade [teachers'] skills and knowledge." During this time, the International Society for Technology in Education (ISTE) also created and released the National Education Technology Standard (NETS) for students (1998) and teachers (2000). The NETS standards reflected the beginning of the Internet era, outlining

the skills and attitudes needed by the next generation of students and educators including basic operations and concepts of technology and the application of technology for productivity, research, communication, problem solving, and decision making. Later on, due to the influence of technology on facilitating more constructivist approaches to learning, ISTE updated the NETS standards (and re-branded them as ISTE standards) for students (2007) and teachers (2008). These updated standards highlighted 4C skills (i.e., creativity, collaboration, communication, critical thinking) that are enabled through the use of internet-based technology. The changes throughout this decade from 1999 to 2008, in part due to technology's blossoming presence in all parts of life, shifted understandings about how learning happens (NRC, 2000). Research on learning demonstrated that learning is social, active, and connected to the world (NRC, 2000). Educational technology, to some extent, was considered "a vehicle for transforming education" (NCES, 1999).

The changes to national plans and standards related to technology integration continued in the following decade. In 2017, the National Education Technology Plan (NETP), released by the Office of Educational Technology (OET), stated that the role of technology in schools is preparing and empowering learners to "be active, creative, knowledgeable, and ethical participants in our globally connected society" (p. 9). This plan also provided guidance in teacher preparation recommending that teachers aim for "the active use of technology to enable learning and teaching through creation, production, and problem-solving" (OET, 2017, p. 9). In alignment with this vision for learning, the International Society for Technology in Education (ISTE) updated its

standards for students (2016), and identified learners who actively use technology as being as *knowledge constructors* (e.g., use digital tools to produce creative artifacts), *innovative designers* (e.g., use various digital tools to design and solve problems by creating new solutions), *computational thinkers* (e.g., use algorithmic thinking to create new solutions), and *creative communicators* (e.g., use various digital media to express themselves creatively) (https://www.iste.org/standards/for-students). ISTE provides a short summary of the evolution of its student standards on its website: 1998: Learning to use technology; 2007: Using technology to learn; 2016: Transforming learning with technology. These changes reflect the expectations for skills and dispositions adults need in the world today, changing expectations for learners are mirrored in the updated standards for teachers. In 2017, ISTE further outlined revised standards for educators that encouraged them to include empowerment within the use of technology in the classroom (https://www.iste.org/standards/for-educators). These standards named seven roles that educators can use in their teaching practices (e.g., collaborator, facilitator, designer). The revised ISTE standards demonstrated a shift from "using technology for facilitating certain skills" to "using technology through active roles for continued growth" (see Tables 1 and 2).

Table 1.

The Influence of Technology for Students in 2007-2016, Using ISTE Standards as Examples

ISTE Standards for Students (2007)	ISTE Standards for Students (2016)

1. Creativity and innovation - Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.	1. Empowered Learner - Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.
2. Communication and collaboration - Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.	2. Digital Citizen -Students recognize the rights, responsibilities, and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
3.Research and information fluency - Students apply digital tools to gather, evaluate, and use information.	3. Knowledge Constructor - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
4. Critical thinking, problem solving, and decision making - Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.	4. Innovative Designer - Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
5. Digital citizenship - Students understand human, cultural, and societal issues related	5. Computational Thinker - Students develop and employ strategies for understanding and solving problems in ways

to technology and practice legal and ethical behavior.	that leverage the power of technological methods to develop and test solutions.
6. Technology operations and concepts - Students demonstrate a sound understanding of technology concepts, systems, and operations.	6. Creative Communicator - Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
	7. Global Collaborator - Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

Table 2

The Influence of Technology for Educators in 2008-2017, Using ISTE Standards as Examples

ISTE Standards for Teachers (2008)	ISTE Standards for Educators (2017)
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 both face-to-face and virtual environments.	1. Learner -Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning.

2. Design and Develop Digital Age Learning Experiences and Assessments - 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 attitudes.	2. Leader -Educators seek out opportunities for leadership to support student empowerment and success and improve teaching and learning.
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.	3. Citizen - Educators inspire students to positively contribute to and responsibly participate in the digital world.
4. Promote and Model Digital Citizenship and Responsibility - Teachers understand local and global societal issues and responsibilities in an evolving digital culture and exhibit legal and ethical behavior in their professional practices.	4. Collaborator - Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems.
5. Engage in Professional Growth and Leadership - Teachers continuously improve their professional practice, model lifelong learning and exhibit leadership in their school and professional communities by promoting and demonstrating the effective use of digital tools and resources.	5. Designer - Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability.

	6. Facilitator - Educators facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students.
	7. Analyst - Educators understand and use data to drive their instruction and support students in achieving their learning goals.

Practical Models of Technology Integration in K-12 Contexts

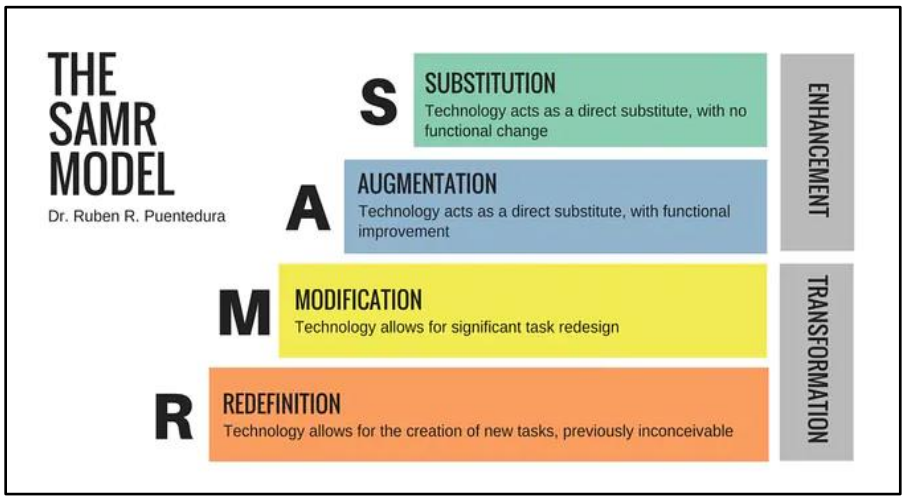
While the national plans and ISTE standards provide clear benchmarks or goals for teachers about integrating technology, teachers always seek out practical models to use in planning for and evaluating teaching and learning. There are two common models used within K-12 schools that outline the versatile ways technology can be used in teaching and learning.

First, the SAMR model is commonly used in K-12 schools by administrators and teachers to help guide and assess technology integration efforts and instructional design (Green, 2014). Puentedura (2012) developed the SAMR model based on different levels of technology integration and the functional changes the levels have on classroom tasks. The SAMR model categorizes four levels of technology integration: Substitution, Augmentation, Modification, and Redefinition (see Figure 1). According to Puentedura (2012), the Substitution and Augmentation levels demonstrate that technology can be used as a replacement or efficiency tool. The Modification and Redefinition levels both demonstrate transformative ways to integrate technology. In particular, the Redefinition

level is identified when “computer technology allows for new tasks that were previously inconceivable.” The SAMR model enables teachers to identify different ways of teaching and learning with technology, including the role of students’ engagement with educational technology. A common misconception of this model is that teachers should always strive for the Redefinition level, interpreting the model as sequential or hierarchical steps rather than fluid examples of different ways to integrate technology into education. Ultimately, the goal is for educators to design instruction that affords transformative learning opportunities with technology.

Figure 1

Illustration of the SAMR Model



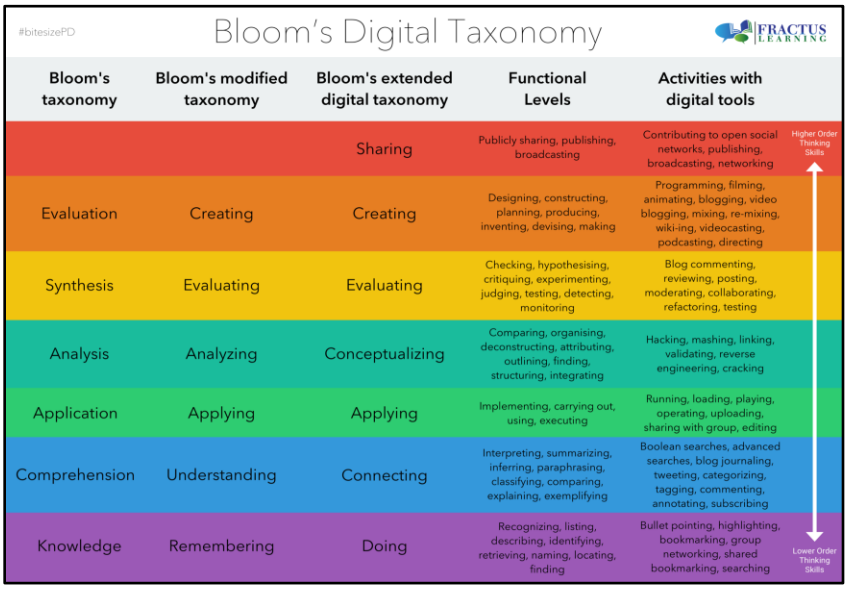
Note. From “Wikimedia Commons” by Leffler, 2016 (https://commons.wikimedia.org/wiki/File:The_SAMR_Model.jpg). is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. Reprinted with permission.

Another common model that classifies learning with technology is Bloom’s Digital Taxonomy (BDT). BDT is an extension of Bloom's Taxonomy (BT) which was

originally created by Bloom (1956) and revised by Anderson et al. (2001). In 2008, Churches adopted BT into BDT by incorporating the usage of technology tools in learning (see Figure 2). Though BDT maintains the cognitive thinking skills at both lower and higher levels (e.g. remembering, understanding, applying, analyzing, evaluating, and creating), Churches (2008) claimed that there is no specific cognitive order when students learn with technology. BDT helps educators acknowledge that skills such as googling or subscribing are also a form of students' learning and literacies. For instance, BDT implies higher-order thinking skills at the creating level when learners are "generating/creating new ideas, products, or ways of viewing things" (p.37) through technologies.

Figure 2

Bloom's Taxonomy for the Digital World



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What's Next?

The ongoing changes in technology and technology integration standards and models demonstrate a shift toward constructivist-minded and student-centered approaches to K-12 teaching and learning in which digital tools are used actively by learners. However, it is important to remember that the technology itself cannot directly empower learners; while it may be a catalyst, technology is not useful without appropriate and purposeful pedagogy (Roblyer & Hughes, 2018).

The updates to standards and models of technology integration also reflect and drive the multiple and changing role(s) of the K-12 teacher. Currently, the internet is breaking down barriers between knowledge and learners and creating new opportunities for distance education and open resources (Fishman & Dede, 2016). These new opportunities are accessible for learners to learn, search, contribute, collaborate, share, and even review or assess their peers. In other words, teachers are no longer the only knowledge resource or assessment standard in classrooms. The teacher's role is evolving into a facilitator that designs and supports differentiated learning to meet individual learners' needs. To avoid students becoming simply consumers of technology, the teacher's role is to prioritize pedagogy above the usage of technology (Roblyer & Hughes, 2018). Therefore, preparing teachers for the information age and examining how to design and use technology in practice are emerging challenges for K-12 teacher preparation. There is also a critical need to specifically examine the role of technology in teaching practices which can constrain or expand students' learning. Thus, this study examined pre-service teacher development related to technology integration; how they

perceive the role of technology in education *(perceptions)* and how they strive to implement technology *(practices)*.

Pre-service Teachers and Technology Integration

Technology integration (TI) refers to teachers' enactment of designing purposeful and appropriate use of technology (Ertmer, 1999; Roblyer & Doering, 2009). Previous research has studied its approach, instruments, environments, and resources in pre-service teacher education and in-service teacher professional development (e.g., the UNESCO ICT Competency Framework for Teachers, field experience, knowledge gaps, self-efficacy). Having pre-service teachers learn educational technologies themselves without or separate from pedagogical design is not technology integration. Pre-service teachers might already be exposed to technology in their daily lives but many have not yet experienced the possibilities of different technology tools for teaching and learning purposes. Pre-service teachers often are trained in their teacher preparation programs about how to use some of the most common digital tools in K-12 classrooms (e.g., Google Meets for online teaching; Kahoot! for digital quizzes; SMARTboards in the classroom). Without complementary theoretical and practical directions about pedagogical strategies, pre-service teachers could feel overloaded in mastering a digital tool before starting to think about how to apply it in their classrooms. Ertmer and Newby (2016) suggest viewing technology integration as a reciprocal relationship between learning theory and technology itself: "changes in theory prompt changes in tools"(p. 69) as well as "changes in tools prompt changes in theory" (p. 70).

Currently there are several clusters of research related to this reciprocal relationship between theory and technology for pre-service teachers: (1) skills, knowledge, and pedagogy; (2) beliefs, perceptions, and practices; and (3) learning sciences approaches. I will first describe each cluster to share how these aspects scaffold pre-service teachers' development. Then I will summarize across clusters to share how these perspectives informed my research design.

Skills, Knowledge, and Pedagogy

Research consistently shows that teachers' prior knowledge about technology and related pedagogical approaches must be understood in order to help them grow professionally (Esquivel, 1995; Ertmer, 2005; Hew & Brush, 2007; Ottenbreit-Leftwich et al., 2015). According to the Information and Communication Tools (ICT) Competency Framework for Teachers (UNESCO, 2018), technology literacy as well as understanding knowledge deepening and knowledge creation approaches are imperative for teachers to effectively integrate technology into curriculum. Building technology literacy is the first stage of preparing teachers to utilize digital tools purposefully in their classrooms, yet technology skills are not enough without coupling them with TI strategies. Without knowledge of TI pedagogies, technology integration practices often remain at surface levels (e.g., substitution in SAMR; lower levels of cognitive engagement in BDT) which do not engage students in deep learning.

Some TI research shifts away from focusing on visible practices and instead focuses on cognitive knowledge as a way to help scaffold teachers in ways to use technology in teaching and learning. For example, the technological pedagogical content

knowledge (TPACK) model can be used in this way, which was introduced by Koehler and Mishra in 2009. The TPACK model (tpack.org) represents the intersection of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). It guides teachers in cognitive reflection in order to help them infuse their technological knowledge with their pedagogical and content knowledge. However, critics of the TPACK model (e.g., Archambault & Barnett, 2010; Graham, 2011; Stoilescu, 2015; Willermark, 2018) express concerns about the validity of this model as well as its complexity of the separate knowledge domains (technological, pedagogical, and content) which often results in a difficulty in identifying and incorporate each knowledge into practice. In addition, there are other knowledges that teachers may have or lack that are not represented in the TPACK model, such as multiliteracies, technology-related-classroom management skills, and alternative assessment skills.

It is well documented and understood in the TI field that knowing how to navigate a digital tool is not sufficient to develop pre-service teachers' knowledge on how to teach with meaningful technology-infused designs (Ertmer & Ottenbreit-Leftwich, 2010). Researchers and practitioners continue to investigate ways for teachers to use/design with technology to foster deeper learning (including distributed knowing and thinking, engagement, community and communication, and knowledge-building) (Fisher et al., 2012; Scardamalia & Bereiter, 2014). These ongoing investigations are due to the fact that teaching with the digital tools is often not aligned with more traditional pedagogies that aim to deliver knowledge to students. Rather, technology-infused teaching can "design an experience which has the potential for learning" (Loveless & Williamson,

2013, p. 150), which requires pedagogies that support students in engaging in active, collaborative, authentic learning. Therefore, preparing teachers today involves a more holistic view of TI that considers teachers' personal experiences and pedagogical mindsets through different phases of teaching: design, development, planning, implementation, interaction, and evaluation (Ertmer & Ottenbreit-Leftwich, 2010; Hudson, 2011). In other words, when preparing pre-service teachers' capacities for TI, preparation must include not only developing technological skills and knowledge (e.g., digital literacy and zoomdagogy) but also soft skills such as pedagogical skills and knowledge.

Beliefs, Perceptions, and Practice

While teachers' skills, knowledge and pedagogy are important components that impact how technology is integrated into teaching and learning, there is an additional factor that is the most influential — teachers' beliefs. Technology integration practice is greatly affected by teachers' beliefs and perceptions (e.g., Burden et al, 2016; Ertmer, 1999; Ertmer, 2005; Ertmer et al., 2015; Hew & Brush, 2007; Kopcha et al., 2020; Prestridge, 2012; Tondeur et al., 2017; Tsai & Chai, 2012). Learning outcomes are varied depending on teachers' beliefs about learning approaches and their values/perceptions of technology in learning (Ottenbreit-Leftwich et al., 2018), such as perceiving TI as a learning experience through digital creation or as a thinking process for new solutions using various digital tools to solve problems. For example, Hughes et al. (2020)' research also examined pre-service and in-service teachers' pedagogical reasoning. They found that teachers who valued technology-supported lesson activities

expressed different reasons for the same types of activities. Pre-service and in-service teachers valued different features of technology that translated into differing technological reasoning. For instance, teachers might value authentic digital activities to help students scaffold idea formation or simply enable learning product creation.

Research continually documents that although teachers can hold constructivist-minded, student-centered (e.g., collaboration, creativity) beliefs, their instructional design and practices may often reflect different pedagogies that do not align with these beliefs/values. For example, Ertmer and Ottenbreit-Leftwich (2010) investigated four variables of teacher change (teacher knowledge, self-efficacy, pedagogical beliefs, and school culture), and concluded that teachers' mindsets (beliefs) are the linchpin in practices of technology integration. Related research concludes that teacher beliefs are extremely resistant to change (Kagan, 1992; Pajares, 1992), hence the ongoing, decades-long challenge of integrating technology into K-12 schools.

Similarly, Ertmer et al. (2012) found that teachers who are inclined toward student-centered or constructivist beliefs (i.e., students acquire learning through student inquiry and authentic environments) are more likely to integrate technology through learner-centered activities such as problem-solving or collaboration. They note that teachers who have more confidence and actual experiences using a technology tool are more likely to take pedagogical risks and perform better in a transitioning to tech-integrated practices. Most importantly, teachers with these types of mindsets are likely to use innovative technology integration practices to advance learning. This study again found that teacher beliefs have the greatest impact on the integration of technology to

facilitate student learning (Ertmer et al., 2012). Therefore, it is essential for teacher educators to address pre-service teachers' existing beliefs and design curriculum for reflection on and possible shifts in these beliefs alongside experiences with educational technology tools.

Learning Sciences Approaches

Learning sciences [LS] approaches emerge as a major theme in current design science research that investigates learning within different technology-enhanced contexts. Broadly, learning scientists strive to build context-informed, tech-supported supports for teaching and learning. Hoadley and Van Haneghan (2012) describe these approaches as investigating "how new tools and artifacts created from the available technology we have can be used to help facilitate learning" (p. 57). Collectively, LS approaches consider systematic (e.g., learning theories) and elemental (e.g., learning contexts) levels together with "the approach determined by the nature of phenomenon" (Nathan & Sawyer, 2014, p. 29). Thus, learning sciences has three primary research focuses: (a) thinking and knowing, (b) learning processes, and (c) learning environments (Hoadley & Van Haneghan, 2012). These focuses position technology as both (1) a *tool* that involves interactive learning processes to create new thinking and knowing of learners and (2) an *environment* that empowers learning (Kohen-Vacs et al., 2016; Kopcha et al., 2016).

I share two illustrations of LS research approaches. The first example highlights the learning process focus. When technology is used purposefully and as an interest-driven medium, learning can be expanded to include authentic, meaningful, and creative learning processes (Ito et al., 2013) such as creating storytelling in groups through

iMovie and sharing with an online community that enable learners to create, collaborate, and share (Kafai & Resnick, 2011). The next example highlights the environment focus. Personalized learning (Redding, 2013; Song et al., 2012) through tech-based or gamified learning environments is one way to motivate students to monitor their own learning progress, to learn at their own pace, and to connect with broadened interests and participatory networks (Jenkins et al., 2016).

Using learning sciences approaches within teacher preparation programs could benefit pre-service teachers learning about, designing, and enacting technology integration. Current LS research expands insights about these topics ranging from understanding how individuals' motivation, social media interaction, cognitive process, digital creation, and multimedia literacy could influence teachers' pedagogical mindsets and teaching practices. For example, Sawyer (2014) recommends focusing on "how novices think and what misconceptions they have" (p. 8) through having novices [pre-service teachers] evaluate and contribute new ideas and then relate/reflect them into new practices. In alignment with contemporary changes in schooling such as the shift from uniform learning to customized learning, or from knowledge in individuals' heads to distributed knowledge, learning scientists suggest that teachers' own learning should also reflect these changes. This would help them develop technology integration skills through the lenses of student-centered approaches, collaborative discourses, situated cognition, and active knowledge construction (Sawyer, 2014). Therefore, there is a need to prioritize and investigate pre-service teachers' thinking about and plans for integrating technology in teaching and learning.

Chapter Summary

This literature review highlights the evolution of technology and its ongoing influence on teaching and learning. While technology updates and changes constantly, our perspectives on how to utilize and benefit from technology in education also continuously change. The literature also documents concerns about pre-service teachers' readiness for technology integration, given that they are still novice learners on both pedagogical training and educational technology skills. Thus, there is a need to investigate how pre-service teachers mediate these demands into their own learning related to technology integration. With the lens of studying teaching as a design science, this dissertation focuses on the connections or disconnections between pre-service educators' perceptions and practices when they incorporate technology into their own learning, course activities, and instructional plans.

CHAPTER 3

METHODOLOGY

In this chapter, I first describe my conceptual and analytical frameworks to illustrate how they guide my orientation to this study and its analysis strategies. Next, I outline my research questions and share my rationale for conducting a qualitative case study, along with the description of this study's contexts, participants recruitment/selection and data sources. Finally, I illustrate my data analysis processes to demonstrate how I unpack pre-service teachers' learning. This study was reviewed and approved by UMN's Institutional Review Board (see Appendix A).

Frameworks

Conceptual Framework

This study was guided by a conceptual framework. Maxwell (2013) defines conceptual frameworks as "the system of concepts, assumptions, expectations, and theories that support and inform your research" (p. 39). He describes it as a central to the design of research studies and also as "a lens...or set of lenses, for making sense of things" (2016, pg. xii). Ravitch and Riggan (2016) suggest a conceptual framework "allows researchers to make reasoned, defensible choices about how we might explore topics or themes heretofore underexplored or to explore old questions in new contexts" (2016, pg. xv). While a researcher creates a conceptual framework at the beginning of the research process, it is not static, and continues to guide researchers' thinking during data collection/analysis processes (Ravitch & Riggan, 2016). More importantly, conceptual

frameworks encourage researchers' reflection as they evolve in the end of the study (Maxwell, 2016). I used my conceptual framework to ground me throughout the conceptualization and analysis phases of this study.

There are two theoretical perspectives that comprise the conceptual framework for my dissertation: (1) learning sciences (LS) approaches and (2) a technology integration model. I used LS research approaches to anchor my researcher perspectives, particularly in guiding my orientation to investigating pre-service teachers' learning. Next, I used a technology integration model as a foundation for understanding the different ways teachers can integrate technology into teaching and learning. Together, both of these perspectives provided interconnected lenses that helped me identify ways to access and understand pre-service teachers' perceptions and practices related to technology integration.

Learning Sciences Approaches. Through a learning sciences lens (see Table 3), I explored and investigated pre-service teachers' (a) thinking and knowing, (b) learning processes, and (c) learning environments (Hoadley & Van Haneghan, 2012) within an educational technology course. As noted in LS theoretical perspectives, "individuals may learn the same content differently" (Hoadley & Van Haneghan, 2012, p.57) and will use their prior knowledge first to start their thinking and knowledge processes (Sawyer, 2014). Research on teacher learning from LS orientations are particularly interested in "the development of teachers' knowledge, beliefs, identity, and practice in context" (Fishman et al., 2014, p. 707). Therefore, asking pre-service teachers' about previous perceptions of and experiences with technology integration can be a first step in

analyzing their initial thinking and knowledge. This analysis could be further pursued by investigating pre-service teachers' conceptual changes about technology integration through analyzing their reflections and learning artifacts pertaining to technology integration. In addition to *thinking and knowing*, investigating pre-service teachers' learning process could also help illustrate conceptual changes. Finally, pre-service teachers are new to their exposure to digital technologies used for educational purposes, so there is also another LS approach to consider — pre-service teachers' environments (i.e., technology-enhanced learning environments) and how they translate their digital technologies experiences into designing a technology-enhanced learning environment.

Table 3

Learning Sciences (LS) Approaches Applied in This Study

LS research focuses (Hoadley & Van Haneghan, 2012)	LS perspectives (Hoadley & Van Haneghan, 2012; Sawyer, 2014)	**Ideas for researching the development of pre-service teachers' technology integration knowledge/practice**
(a) Thinking and knowing	- Propositional knowledge and skills - Deeper conceptual knowledge	Explore pre-service teachers' prior knowledge and beliefs
	- Teachers' knowledge - Teachers' belief	Explore conceptual changes of their knowledge and beliefs
(b) Learning processes	- Sense-making and meaning-making process	Investigate how pre-service teachers develop their understanding

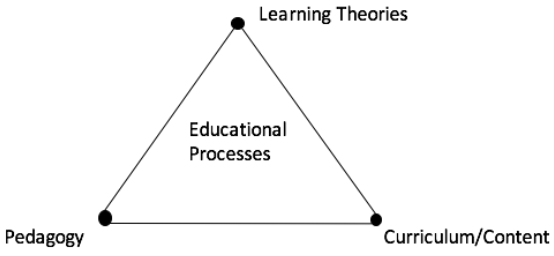
	- Development of identity and practices in context	Identify what influences pre-service teachers to construct their teaching identity and practices Provide supplemental angles to illustrate conceptual changes
(c) Learning environments	- Performances and participations - Learner-centered environment - Technology-supported learning environment	Recognize that pre-service teachers are also new in knowing how infuse technology within learning environments Investigate how pre-service teachers translate their digital technologies experiences into designing technology-enhanced learning environments

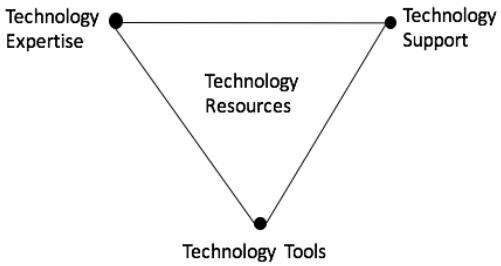
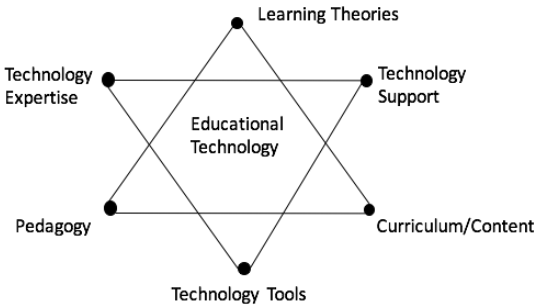
Technology Integration Model. Technology integration in K-12 teaching and learning has been discussed and researched for over two decades. At the very end of the 20th century, Ertmer (1999) identified the first-order and second-order barriers that impact technology integration in K-12 schools. While first-order barriers include a lack of external technology resources and institutional support for teachers, second-order barriers focus on internal attitudes, beliefs, knowledge, and skills that influence pedagogy. Ongoing research investigates both first-order and second-order barriers, support, and resources for teachers to explore missing components of teacher development. Driven by Ertmer's research on barriers, I use Roblyer and Hughes' (2018) technology integration model to guide my investigation of pre-service teachers' technology integration development.

According to Roblyer and Hughes (2018), the term, technology integration (TI), merges perspectives about *educational processes* and *technology resources* in order for teachers to integrate technologies that address educational needs. Roblyer and Hughes' definition reflects both perspectives and is a framework for teachers to use themselves for recognizing learners' needs, using technology as a resource to identify solutions, and evaluating the use of technology in their classrooms. This framework reveals blurred boundaries between first- and second-order barriers to technology integration, and provides an overview of the dynamic processes of how teachers utilize their knowledge and beliefs to incorporate technology into classrooms. While this framework was designed for *in-service* teachers' practices in school contexts, I modified it for research purposes in order to better examine *pre-service* teachers' TI development (see Table 4).

Table 4

Roblyer & Hughes (2018) Technology Integration Model and the Modified Version Used in This Study

A Framework for Integrating Educational Technology (Roblyer & Hughes, 2018, p.6)		**A modified version used in this study**
(a) **Identify problems of practices** (which teachers engage in everyday)		**Identify pre-service teachers' thinking development of their educational beliefs and perceptions**

(b) **Identify technology possibilities** (that are available at teachers' schools)		**Identify pre-service teachers' development of their digital experiences and connections**
(c) **Use and assess of educational technology** (for teachers to assess its effectiveness in solving the target problem)		**Access pre-service teachers' artifacts on technology integration including digital creations and instructional lesson/activity designs**

Summary. Due to the intersections between the LS approaches and Robyler and Hughes' (2018) TI model, I used both as my conceptual framework to guide my orientation to the study. This conceptual framework helped me understand pre-service teachers as novice learners who are simultaneously experiencing conceptual changes and learning new digital skills and knowledge within their teacher preparation programs. Pre-service teachers face a two-fold learning process: they are (a) reconstructing perceptions of and integrating new pedagogical beliefs while simultaneously identifying different strategies to foster students' learning, and (2) continuing to self-teach themselves new digital educational tools and then transferring these experiences into their educational practices. In my study, I used this framework to help me identify what aspects and attributes of pre-service teachers' learning could be examined, connected, and analyzed.

Analytical Framework

I applied two additional perspectives as my analytical framework: (1) technology integration (TI) strategies (Roblyer & Hughes, 2018) and (2) ISTE Standards for Students (2016) and Educators (2017). These strategies and standards were both the lenses and the actual tools I used to analyze pre-service teachers' coursework included in the study (described later in this chapter).

Technology Integration Strategies. Roblyer and Hughes (2018) identify varied TI strategies teachers use that are influenced by theoretical foundations, directed teaching methods, and constructivist methods that result in different learning outcomes (see Table 5). The directed TI strategies are grounded in behaviorist and cognitive-behaviorist theories. The constructivist TI strategies are grounded in sociocognitive theories and include learner-centered approaches such as discovery learning and scaffolding. Notably, all of these TI strategies are meaningful in supporting learning.

Table 5

Technology Integration (TI) Strategies for Directed, Constructivist, or Both Models (Roblyer & Hughes, 2018, p.53)

Directed Models	Both Models	Constructivist Models
- TI to remedy identified weaknesses or skill deficits	- TI to generate motivation to learn	- TI to foster creative problem solving and metacognition
- TI to promote skill	- TI to optimize scarce personnel and material	- TI to help build material models and increase

fluency or automaticity	resources	knowledge transfer
- TI to support efficient, self-paced instruction	- TI to remove logistical hurdles to learning	- TI to foster group cooperation
- TI to support learning and review of concepts	- TI to develop digital citizenships	- TI to allow for multiple and distributed intelligences

The TI strategies outlined by Roblyer and Hughes (2018) served as an evaluation tool that I used to examine and categorize pre-service teachers technology integration and for what learning purposes in lesson plans they created (described in more detail later in this chapter). I also used them as conceptual tools that supported my own understanding and categorizations of technology integration.

ISTE Standards. As discussed in the literature review for this study, the changes and updates in the ISTE standards reflect a focus of encouraging the active use of technology by teachers and students. ISTE views digital technologies as supportive resources for improving teaching and learning. Through the ISTE standards lens, learning a certain technology skill is not the primary focus; rather, the standards support both changes in teachers' and learners' roles in the learning process that may shift or transform in multiple ways through using technologies. Ultimately, digital technologies help teachers create learning environments that provide meaningful learning opportunities for students that expand and enrich essential technological competencies. I used the current ISTE standards to complement the timeframe of the data collection and to analyze/review

how pre-service teachers situate both learners' and teacher's roles within a technology-infused lesson plan design (see Table 6).

Table 6

ISTE Standards for Students and Educators

ISTE Standards for Students (2016)	**ISTE Standards for Educators (2017)**
1. Empowered Learner - Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.	1. Learner -Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning.
2. Digital Citizen -Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.	2. Leader -Educators seek out opportunities for leadership to support student empowerment and success and improve teaching and learning.
3. Knowledge Constructor - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.	3. Citizen - Educators inspire students to positively contribute to and responsibly participate in the digital world.
4. Innovative Designer - Students use a variety of technologies within a design process to identify and	4. Collaborator - Educators dedicate time to collaborate with both colleagues and students to

solve problems by creating new, useful or imaginative solutions.	improve practice, discover and share resources and ideas, and solve problems.
5. Computational Thinker - Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.	5. Designer - Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability.
6. Creative Communicator - Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.	6. Facilitator - Educators facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students.
7. Global Collaborator - Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.	7. Analyst - Educators understand and use data to drive their instruction and support students in achieving their learning goals.

Summary. This analytical framework guided my content analysis strategies, coding rubrics, and analytical memos. In particular, it helped me examine the gap between pre-service teachers' knowledge about and actual practice of technology integration through analyzing their instructional designs in the form of a lesson plan. The framework also helped me revisit and better understand how teachers' perceptions may impact the positioning and roles of technology and the teacher in their instructional designs.

Research Questions & Methods

This research aims to address these questions: *What are the connections or disconnections, if any, between pre-service educators' perceptions and practices when they incorporate technology into their own learning, course activities, and instructional plans?*

1) In what ways do pre-service teachers' perceptions about technology integration change over time?
2) How does pre-service teachers' learning influence their use of technology in their digital creations or instructional plans?

The qualitative case study method (Merriam, 2001) was used in this study to explore pre-service teachers' perceptions and its influences on technology integration practices through a "how" and "why" inquiry. Kolodner (2004) indicates the importance of "scruffy" perspectives (factual observation of human behavior for representing simulations) for connecting theories into practice in order to support teaching and learning in real contexts. Driven by this "scruffy" perspective, I explored the connections and disconnections between perceptions, beliefs, and practice when pre-service teachers are learning about integrating technology into teaching and learning.

I applied a qualitative approach to case study in order to "understanding how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences" (Merriam & Tisdell, 2016, p.6). I was interested in how pre-service teachers describe, experience, and develop their own mean-making about technology integration. My purpose was to describe and understand pre-service teachers'

perceptions and practices, so my philosophical/epistemological perspective was situated in social constructivism in which researchers respect the reality as socially constructed and they further explore the complexity of views (Creswell, 2013) to "understand the meaning people have constructed" (Merriam & Tisdell, 2016, p.15).

According to Clark and Creswell (2010), case study has the advantage of helping researchers identify and understand the research problem through an in-depth exploration of a case. Merriam and Tisdell (2016) further note that a qualitative case study "is an in-depth description and analysis of a bounded system" (p.37). In particular, the unit of analysis is the main characteristic in determining a case study. The research case might be one particular program or activity that involves a single or several individuals which represents a bounded system, and it is usually selected in order to illustrate a specific issue through in-depth data collection with multiple sources of information. In this study, a licensure course for pre-service teachers (a bounded system) is considered the case that explores individual learning processes including these teachers' perceptions and practices as research units. Three focal participants from the case were identified to provide in-depth snapshots of learning processes.

Context and Data Sources

Context

The context of this case study is a 1.5-credit required teacher licensure course about educational technology offered at a public university in the Midwest. Participants included pre-service teachers who enrolled in this course during Spring 2016, Spring

2017 and Summer 2017 (for a total of 5 course sections). I was the instructor of these courses. As the instructor, I followed the course requirements to cover teachers' digital competencies included in the state standards and respected the natural trajectories of participants' learning. The course was designed for pre-service teachers to explore the impact of technology integration in their future classrooms and to help them achieve the teaching licensure standards of effective practice. The course met seven times (during either 14-week or 7-week timeframes) in a blended learning mode.

All students enrolled in this course were pursuing teaching licensure in either elementary education, early childhood, or special education. By selecting this licensure course as a single case study, it respects a natural setting including participants' engagement and learning outcomes with no research alterations or interventions during the class. During the course, students were expected to engage in course discussion and reflect on the role of technology in education, including technology integration frameworks, digital citizenship, 21st century learning skills, instructional media, classroom management, alternative assessments, differentiation, and culturally-responsive teaching. As part of their coursework, students had opportunities to explore various technologies, create a personal website, create an example of instructional media, and develop a lesson plan, all based on learners' choice (see Table 7).

Table 7

Research Context

Case	Courses	Format	Weekly Topics

77 students 1 instructor	EDU 100: Section 1 (spring 2016) EDU 100: Section 2 (spring 2016) EDU 100: Section 3 (spring 2017) EDU 100: Section 4 (spring 2017) EDU 100: Section 5 (summer 2017)	Seven blended learning classes F2F and online components	• Digital citizenship • 21st century learning and technology integration • Instructional media • Technology for assessments • Online learning and learning management systems • Technology for diverse learners • Instructional design

Participants

All students enrolled in this course participants were pursuing teaching licensure in either elementary education, early childhood, or special education. Seventy-seven (77) students were enrolled in the courses and were invited to participate in this study after the end of the course. All of them consented to participate in this study. However, ten of them were excluded due to an uncompleted post-course questionnaire. In the end, sixty-nine (69) students were included as participants in this study who completed both pre- and post-course questionnaires.

Data Sources

Multiple data sources in the form of learning artifacts were collected from pre-service teacher participants as a way to investigate their general perceptions of and practices in the role of technology in teaching and learning. Data sources include: (1) pre- and post-course open-ended questionnaires about their perceptions (beliefs, approaches, attitudes) of technology integration, (2) teaching philosophy assignments, (3) digital

project artifacts, (4) digital portfolio contents, (5) technology integration lesson plans, (6) peer evaluations, and (7) reflective journals. Descriptions and examples of questionnaires, assignment descriptions, and guidelines for lesson plan can be found in Appendix B.

Data Analysis

According to Merriam (2001), "data analysis is the process of making sense out of the data" (p.175). Importantly, the qualitative researcher serves as "the *primary instrument* of data collection and analysis, an inductive investigate strategy, and the end product being richly descriptive" (Merriam & Tisdell, 2016, p.37). In this qualitative case study, I was the primary investigator that conducted in-depth analysis of multiple sources of information to explore this group of pre-service teachers which represents a bounded system. Creswell (2013) reminded me about one of the hallmarks of case study research, so I reported the holistic case study analysis with "case description and case-based themes" (p.97). Data analysis in the qualitative case study is a process that consists of inductive and comparative analysis, happening in five steps (Merriam, 2001): (1) category construction: using open coding and axial coding (Strauss, 1987) to construct meaning; (2) sorting categories and data: using inductive and deductive approaches to revise coding categories; (3) naming the categories; (4) quantifying categories; and (5) becoming more theoretical. I specifically used these five steps as a guide to review open-ended questionnaires responses and pre-service teachers' learning artifacts.

There were several strategies for promoting validity and reliability used in this study: triangulation, adequate engagement in data saturation, researcher's reflexivity,

audit trail, and maximum variation (Merriam & Tisdell, 2016, p.259). As both the primary researcher and instrument, I recognized that my data sources were not produced for research purposes which may not be explicit at the first glance. But there is an advantage of using these data sources' "stability" (Merriam & Tisdell, 2016, p.182) as nonreactive measures to review what participants produced and grounded independently within this case. Therefore, I carefully detailed my procedures and decisions points in an audit trail and used analytical memos (Saldaña, 2016) throughout content analysis in order to document participants' perspectives and for explicitly supporting my reflexivity about my position as a researcher. Throughout my analysis process, I continually triangulated with multiple sources of data and sought variation in focal participant selection.

To answer the research questions in this case study, two units of analysis were used: (1) pre-service teachers' development during the course, including digital experiences and thinking development, and (2) pre-service teachers' artifacts of technology integration during the class, including digital creations and instructional designs (see Table 8). I used three steps to complete my analysis process, which consisted of unpacking multiple sources of information and constructing participants' perspectives. More details of my analysis audit trail (analysis steps, categories derived decisions, and analytical memoing) are described below.

Table 8

Data Sources and Analysis

Research Questions	The Units of Analysis	Data Sources	Data Analysis
1. In what ways do pre-service teachers' perceptions about technology integration shift or change over time?	Pre-service teachers' development during the course, including digital experiences and thinking development	<u>Primary sources</u>: Pre- and post- course open-end questionnaires a. Previous technology exposure in their own K-12 school lives b. General perceptions (beliefs, approaches, attitudes) on technology integration <u>Secondary sources</u>: Coursework reflections on technology integration a. Technology teaching philosophy (coursework at week 4) b. Digital tools explorations & reasons	(1) Content analysis to analyze general patterns of participants' development of technology integration (2) Constant comparative method to triangulate findings
2. How does pre-service teachers' learning influence the use of technology in their digital creations or instructional plans?	Pre-service teachers' artifacts on technology integration during the class, including digital creations and instructional design	<u>Primary sources</u>: a. Technology teaching philosophy (coursework in week 4) b. Tech-integration lesson plans <u>Secondary sources</u> a. Self-evaluation on lesson plans b. Digital project artifacts	(1) Semi-structured coding by using the technology integration strategies (Roblyer & Hughes, 2018) and ISTE standards (2016) as rubrics to review lesson plans (2) Content analysis on participants' statements about pedagogical reasons

Data was first collected through downloading online course documents but all participants' names were removed when transmitted to data storage. All participants were assigned a random numeric number to help put distance between my role as the primary researcher who was also the instructor of the courses prior to the study. All data were then organized and labeled by its type (e.g., pre-course questionnaire responses, post-course questionnaire responses, lesson plans) to help me track the pres-service teachers' individual growth and development at different points during the courses. Data was further imported into MAXQDA software for qualitative analysis.

Overall, I conducted content analysis to describe pre-service teachers' perceptions and practices of technology integration using both the inductive and comparative analyses. For the coding process I conducted first-cycle open coding followed by second-cycle coding to identify pattern codes (Saldaña, 2016) and themes of the case (Creswell & Poth, 2018). Moreover, any additional schemes derived from the open coding process were investigated with constant comparative analysis to triangulate the findings and to identify the saturation of results. The inductive and deductive coding strategies were applied for content analysis on open-ended questionnaires, course artifacts, reflections, and lesson plans.

Analysis Process: Step 1. With the sixty-nine pre-service teachers' open-ended questionnaire responses, I first conducted initial coding (i.e., open coding) to review each response and note it with analytic memos (see Table 9). Based on the analytic memos, I applied a mixed use analytical technique (Saldaña, 2016) starting with *versus coding* on technology integration stances (pro or con). Next, I paid attention to participants' values,

beliefs, and attitudes through *value coding* and documented the way they described technology integration via *in-vivo coding.* Additionally, *axial coding* was conducted in the analysis of post-questionnaire responses to link the categories for identifying themes. A list of codes/categories is included in Appendix C.

Table 9

Example of Initial Coding with Analytic Memos

Excerpt of responses	**Analytic memos**	**Initial coding**	**Categories**
"Up until high school, I only ever remember using technology to learn how to type. We would spend an hour a week on "Type to Learn" to get our typing speed faster. Sometimes, we would use Excel or Powerpoint to create presentations, but we were never really taught how to use these tools outside of these presentations. In high school, I got my own laptop and was able to explore on my own how technology could be used. This is also when I got Facebook so I was really only using it for communication with peers and writing	Data labels: [pre-course questionnaire response] [prior K12 exposure] Memo: "Learn how to type" "get our typing speed faster" "create presentations" "Excel or PowerPoint" "my own laptop" "Facebook" "never really taught" "explore on my own" *(in-vivo coding)* - only remember using technology to learn how to type - use Excel or PowerPoint to create presentations - got laptop to explore on	Computer skills & computer education	Technology = objects (computers, projectors, laptops, smartboard)

papers" (PT#C7).	my own (write papers) - got Facebook for communication with peers *(value coding)*

This analytic process enabled me to reflect on three emergent patterns present in pre-service teachers' initial perceptions: (1) concerns about using technology in the classroom, (2) considerations for using technology as an efficient tool, and (3) recognition of using technology to leverage learning. These patterns further served as a category-generating method (Saldaña, 2016, p.54) to identify focal participants for an in-depth analysis of pre-service teachers' learning trajectories.

Analysis Process: Step 2. There were two analysis phases in purposefully selecting focal participants: (1) I checked the "limited use" category (i.e., technology should be limited or be used in moderation) to identify participants who initially strongly hesitated to integrate technology into the classroom (pre-course questionnaire); (2) I reviewed these participants' final perceptions to identify any changes in their values, beliefs, or attitudes toward technology integration by the end of the course (post-course questionnaire). These two phases enabled me to confirm those pre-service teachers whose initial perceptions were ideologically opposite to their final perceptions of technology integration (on the post-class questionnaire). Next, I further reviewed and investigated four participants (B7, E14, B5, C13) whose initial perception of technology integration fell into the "limited use" category but their exposure to the use of technology in their

prior K-12 experiences was varied. During the part, one of the participants (Kenzie, B5) was excluded from the analysis due to incomplete data.

At the end of this step, three participants were confirmed as focal participants based on their post-course questionnaire responses (Emma, Hailey, Jade). Their responses demonstrated a mindset shift from "limited use" of technology at the beginning of the course to "constructive use" of technology at the end of the course. In other words, all three participants began the course with a distrust toward using technology in their pre-K classrooms, but by the end of the course, they had developed constructive use mindsets: over the duration of the course they broadened their technology integration practices with ideas for both teaching and learning with technology (see Table 10).

Table 10

An Overview of Focal Participants (All Names are Pseudonyms)

	Emma (B7)	**Hailey (E14)**	**Jade (C13)**
Self-identified as...	A senior with a major in Early Childhood education. Passionate about education equity	A senior with a major in Early Childhood education. Planning to become a toddler teacher in a play-based preschool	With a B.A. degree in Early Childhood education, currently pursuing a Master in education for a license to teach kindergarten through 3rd grade
Initial perceptions about technology	"Too large", "too clumsy" "Should not be	"Not necessary"	"Unnecessary" "A hindrance to children's learning"

integration (pre-course questionnaire)	necessary"		
Post perceptions about technology integration (post-course questionnaire)	"Technology can be integrated into all levels of a lesson plan"	"Not necessary" in terms of social-emotional learning, but there are advantages in "communication and development milestone tracking"	"A lot easier than I had originally thought"

Analysis Process: Step 3. In order to create detailed snapshots of these focal participants (an embedded unit of analysis), I analyze two of their digital artifacts in order to uncover the complexity of their conceptual development in technology integration over the duration of the course. There were three analysis phases to this step where I triangulated and constantly compared to confirm my analysis became saturated.

The digital artifact I analyzed first was their teaching philosophy assignment from the beginning of the course (primary data source). I applied a mixed use analytical technique (Saldaña, 2016) starting with *versus coding* on the technology teaching philosophy (pro or con technology), paying attention to participants' values, beliefs, and attitudes through *value coding* and citing the way they described technology integration via *in-vivo coding.* This phase helped me to triangulate HOW the participants were thinking at the beginning of the course and WHAT philosophies they have drawn from in the design of their lesson plan projects at the end of the course.

Next, I reviewed each participants' lesson plan (from the end of the course) (primary data source) thoroughly, including memoing on how they stated their lesson goal and pedagogy statement which were included in their lesson plans. I used the two analytic frameworks in this phase: (1) the technology integration (TI) model (Roblyer & Hughes, 2018) and (2) ISTE Standards for Students (ISTE, 2016) and Educators (ISTE, 2017). Next, I identified what technologies they decided to use and categorized the purpose of these tools in teaching or learning (e.g., student use, teacher use). I used a semi-structured coding technique using the ISTE rubrics to identify both students' role and the teacher's role when engaging in their technology integration design. I also applied the TI strategies as another rubric to examine TI pedagogical approaches (see Table 11). The frequency of each category in the rubrics was calculated to help me see the breadth of their instructional design. An overview of coding categories is included in Appendix D.

Table 11

Example of Emma's Lesson Plan Analysis

Label: [students use]		
Excerpts from Lesson Plan	**ISTE Standard for Students**	**Technology Integration (TI) Strategies for Directed, Constructivist, or Both Models**
"Students will work to create drawings that	*[Standard 6. Creative Communicator]*	[Constructivist]

represent themselves and their families, they will then turn these drawings into a short video using Skitch and Vidlab to share with the class and international partners." (Emma, lesson activity)	Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. [6a]. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication	Technology Integration to allow for multiple and distributed intelligences
Label: [teacher use]		
Excerpts from lesson plan	**ISTE Standard for Educators**	**Technology Integration (TI) Strategies for Directed, Constructivist, or Both Models**
"Teachers will work to scaffold learning and assist students. They will also engage with students pushing them to reflect on how this food interacts with their family, culture, and self. As much as possible teachers will help students build language to describe these ties in their videos." (Emma, lesson activity)	*[Standard 5. Designer]* Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability. [5a]. Use technology to create, adapt and personalize learning experiences that foster independent learning and	[Constructivist] Technology Integration to help build material models and increase knowledge transfer

accommodate learner differences and needs.

Chapter Summary

This chapter presented how I have drawn research ideas from the literature review to identify theoretical perspectives for establishing my conceptual and analytical frameworks. Both frameworks guided my orientation to my dissertation, helped me raise research questions, and informed its methodology, designs, and strategies. I further outlined descriptions of how I derived my decision to conduct a qualitative case study and also shared details of my research design and processes. Most importantly, I outline my analysis steps to illustrate how I acknowledged the attribute of my data, the reflexivity of my role as a researcher, and investigated it through multiple phases to discover results. The next chapter outlines the findings of this study.

CHAPTER 4

RESULTS

There are five sections in this chapter. In the first section, I present the analysis of 69 participants' responses in their pre-course questionnaire to show their initial experiences with and perceptions of technology. Next, the analysis of post-course questionnaire responses from these 69 participants is presented to demonstrate their post-course mindsets and practical ideas for technology integration. This questionnaire analysis provides an overview in response to this study's first question (RQ1). The third, fourth, and fifth sections of this chapter highlight three focal participants (Emma, Hailey, Jade) with illustrative details about their conceptual changes, learning trajectories, and lesson plans, which address both of this study's research questions (RQ1 and RQ2).

RQ1: In what ways do pre-service teachers' perceptions about technology integration change over time?

RQ2: How does pre-service teachers' learning influence their use of technology in their digital creations or instructional plans?

Initial Experiences With and Perceptions Of Technology Integration

Prior to the course starting, each enrolled pre-service teacher was invited to 1) share their connection with technology when they were a K-12 learner and 2) describe their initial perceptions of the term "technology integration" via a pre-course questionnaire. The 69 responses were analyzed first in an open-coding cycle to determine patterns. Results for both prompts showed a similar pattern for both teachers'

prior K-12 experiences with technology and their initial perceptions of technology integration. These attitudes ranged on a spectrum from (a) limited use of technology, to (b) conservative use of technology for efficiency purposes, to (c) constructive use of technology for multiple purposes.

Table 12 documents the 43 responses that demonstrate an intersection of the two prompts /dimensions: (1) prior K-12 experiences and (2) initial perceptions of tech integration. The remaining 27 responses were not included in this analysis (and table) because their responses only shared one dimension (e.g., one participant shared that she used a computer in K-12 but her initial perceptions only expressed that technology is great with no explanation) OR their answers were too short to construct understandings about their perceptions (e.g., expressing technology is great without sharing why technology is great).

Table 12

The Distribution of Pre-Service Teachers' Initial Perceptions About Technology Integration at the Beginning of the Course

(1) Prior K-12 experiences	**Limited Use**	**Conservative Use**	**Constructive Use**
(2) Initial perceptions of tech integrations	*The role of technology was minimal and limited*	*Overheads, computers, and smartboard*	*Learn to type, present slides, play games/videos and research on projects*

Limited Use	*Technology should be limited or be used in moderation*	B7	E14	B5, C13
Conservative Use	*Technology utility as an add-on is to increase efficiency*		A2, A7, A12, A13, A15, B1, B2, B10, B13, C2, C3, C4, C6, C10, C12, D2, D8, D10, E1, E2, E11, E13	A8, A10, A11, B1, B2, C9
Constructive Use	*Technology is useful for engaging and personalizing*	A4, A16, B4, C18, E5, E6	B3	B6, C7, D6, D11

Note. All 69 pre-service teachers' responses were analyzed in the first open-coding cycle to determine their perception patterns: (a) limited use, (b) conservative use, and (c) constructive use. This table presents the 43 pre-service teachers' responses that demonstrate an intersection of two dimensions: (1) prior K-12 experiences and (2) initial perceptions of tech integration.

Prior K-12 Experiences Using Technology in School

There were three categories of open coding results that were apparent after analyzing all sixty-nine participants' responses about their prior K-12 experiences in using technology: (a) The role of technology was minimal and limited (limited use); (b) Overheads, computers, and smartboard (conservative use); (c) Learn to type, present slides, play games/videos and research on projects (constructive use).

The Role of Technology was Minimal and Limited. A majority of pre-service teachers responded that the use of technology was "rare" or "never" in their own K-12

learning experiences. Some of the teachers had a negative impression of technology in the classroom. For instance, one teacher claimed that the lack/absence of technology in their own K-8 education generated their current distrust of the use of technology in early education contexts. They recalled technology being used sloppily and often in ways that they did not particularly enjoy in classrooms (pre-service teacher #B7). Another pre-service teacher viewed themself "always far behind the curve when it came to tech" (#C1). Similarly, another teacher expressed that "computers evolved very quickly and I have never been super comfortable with them" (#A16). In sum, a pattern of under confidence in mastering the use of technology due to lack of relevant K-12 learning experiences was evident in this category.

Overheads, Computers, and Smartboard. A recognition of specific technology-based instructional devices and their related environments was highlighted in the pre-course questionnaire responses. For instance, one teacher recalled that they noticed "many classrooms use smart boards, and have mobile computer labs that can be rented into classrooms. When I was in elementary school, we used these same things, just not very frequently" (#A12). In general, pre-service teachers' exposure to technology varied depending on their own school contexts and funding during their experience as K-12 students. In this category, pre-service teachers reacted to the use of technology through their impressions of how their teachers applied a device in the classroom. They remembered seeing "overhead projectors," "a shared computer in one classroom," or "a computer lab." Others demonstrated more exposure to technology in their K-12 classroom. For example, one teacher explained that when she was a student,

"smartboards were utilized for activities and everyday learning. Computers were used for occasional activities and projects. Overhead projectors were occasionally used as well" (#D9). This category illustrates how pre-service teachers' previous learning exposure and impressions were situated within their own observations of the use of educational technology.

Learn to Type, Present Slides, Play Games/Videos and Research on Projects. The purpose of why they were using technology during their K-12 experiences was widely mentioned in this response category. There was a range of purposes including both drill practice and constructive learning. For instance, some of the pre-service teachers recalled that the use of a computer lab was to "prep for state tests" or "learning to type in Word/Excel," whereas others experienced "searching for research," "writing papers" or "presenting for projects." Their collective responses demonstrated a range of active (e.g., using computers for research projects) and passive (e.g., a free day for using a computer to play games or watch video instruction) experiences. Interestingly, one preservice teacher recalled their experiences by describing "more freedom" when they made the transition from passive use to active use of technology:

> When I was in elementary school, technology was only used when we had assigned time in the computer lab or media center to take a reading counts quiz. This was also true throughout my time in middle school but there was more freedom on computers, guided towards research and class assignments. In High School, that freedom only enhanced and I had the opportunity to take a course learning technology to film, edit, and air the school TV news each week. During

> my senior year, each communication classroom was granted a cart of laptops that could be utilized by each student. This was extremely useful in my College English class when we spent (the) majority of our class time working on writing and editing our papers. After I graduated, the school received more grants to give each student in grades 9-12 their own personal laptop for the year that they had to return at the end. (#B1)

Initial Perceptions of Technology Integration

There are also three categories of open coding results in the analysis of the 69 participants' responses about their initial perceptions of the role of technology: (a) Technology should be limited use or be used in moderation (limited use); (b) Technology in the classroom: its utility as an add-on is to increase teacher efficiency (conservative use); (c) Technology is useful for engaging students and personalizing learning (constructive use).

Technology should be limited use or be used in moderation. There were ten participants who explicitly expressed concerns about using technology in their classrooms. They recognized the ubiquitousness of technology, with students surrounded by its use at home or after school. This phenomenon contributed to their belief that teachers should use limited technology so that "students are not using it too much and letting technology take over them and their learning" (#A14) or think technology "is not necessary" for students (#E14). A few of the teachers shared that they will use the technology for assistance in the classroom but stated that it "needs to be used correctly in moderation" (#C8) and "not overdone" (#D13). One pre-service teacher named the use of

technology as “another alternative tool for teaching and active activities [because] it can be effective and engaging but it can be the total opposite” (#D8). Similarly, another respondent mentioned that technology is an integral part of life but “it is important to not let technology take over children's lives as it can be dangerous” (#C16). Another pre-service teacher worried using technology could become a “crutch” for teachers “who may placate students with videos or too much ‘iPad time’ that can take away from actual instruction” (#C5).

Technology in the classroom: Its utility as an add-on is to increase teacher efficiency. In general, the majority of respondents in this category recognized the importance of using technology in the classroom because of its efficiency and ubiquitousness in the real world outside of schools. However, most of them viewed technology as an add-on as it “provides instructors with speed, accuracy, and ease they need in order to properly educate a classroom” (#B12) or because it ”plays a huge role in communicating with other teachers and parents” (#D7). Most pre-service teachers viewed technology as a medium “for teachers to teach lessons, display students’ work, and collect data” (#C7). For example, one teacher shared that technology:

> helps teachers to make the curriculum more effective since we can look up ideas online. It also plays an important role in sharing documents with other colleagues. In terms of instruction, using technology is a time-saving way to present to students compared to using chalk to write on the board. When it comes to assessment, technology helps to analyze students' answers faster. (#C3)

Technology is useful for engaging students and personalizing learning. Some of the pre-service teachers' responses highlighted positive uses of educational technology to "enhance and enrich the curriculum" (#C5), streamline various activities (#C7), keep students interested, "take instructions one step further" (#B3), differentiate instructions, provide assistance for learning difficulties, and "meet students at their specific levels" (A16). One teacher explained why the role of technology is valuable in classrooms:

> [it] can be engaging and interactive to teach concepts - usually having digital examples and resources is a good way to help explain concepts or solidify ideas that are already existing. Also, you can have a lot of fun with technology too, such as music, videos, interactive websites, games, etc. There is lots of room for personalization for the students. (#C18)

Conceptual Changes About Technology Integration

Sixty-nine (69) participants' post-course questionnaire responses were analyzed to understand their perceptions of technology integration at the end of the educational technology course. In the post-questionnaire, each pre-service teacher was invited to share their personal mindset (i.e., pedagogical approach) and decision-making process for planning technology-integrated instruction. They were also asked to describe their future plans about tech-integrated practices and/or related topics they might wish to explore more in the future.

Analysis showed that a majority of participants' attitudes shifted some degree toward constructive use of technology integration, including greater consideration of

students' needs and more attention to the development of their own pedagogical approach. Based on the open coding analysis, four main response categories represent the pre-service teachers' post-course mindsets (e.g., value of technology integration, purposeful integration) and intended-practices (e.g., new teaching ideas/pedagogies, future plans). Next, axial coding analysis revealed two levels of beliefs about technology and instruction: A *basic* level wherein technology and instruction are separated, and an *advanced* level wherein technology and instruction are tied together. Notably, **some** respondents demonstrated mixed beliefs containing both levels, which is an indication that they were shifting between mindsets. Table 13 provides an overview of post-course questionnaire responses based on the open coding and axial coding analyses.

Table 13

An Overview of Pre-Service Teachers' Perceptions of Technology Integration at the End of the Course

		Open coding analysis			
		Post-Course Mindsets		**Intended-Practices**	
		Value of tech integration	**Purposeful integration**	**New teaching ideas/ approaches**	**Future plan**
	***Basic level*:** **Technology and**	- Compiling a list of different tools that can be used	- Providing an alternative learning experience	- Using anonymous quizzing apps	- Balancing technology for less student distraction

	instruction are separated	in the class			
Axial coding analysis	***Advanced level*:** **Technology and instruction are tied into other**	- Allowing students to become active learners to explore knowledge and solve problems	- Considering students' needs - Making learning meaningful and relevant	- Creating a classroom environment with choices -Using culturally-relevant pedagogy	- Exploring more assessments to support individual student needs - Seeking support from workplace resources

Most Valued: Options, Student Choices, and New Learning Opportunities

In contrast to participants' pre-course questionnaire perceptions that technology was primarily an efficient add-on for teachers in the classroom, the majority of responses in the post-course questionnaire was that technology can help provide new possibilities for students' learning. Pre-service teachers cited the importance of individual learners' needs and reflected that "technology can be used as a tool to help students learn to the best of their abilities" and it can "include materials for every type of learner"(#E6). At the end of the course, they were inspired to make changes in instructional moves, such as "will give students a choice in which to engage with the material" (#B12), or, to enable them as a teacher to "create different forms of assessment for different kinds of learners" (#A3). One pre-service teacher, who originally demonstrated conservative uses of technology at the beginning of the course, shifted her mindset, explaining that it is the

teacher's responsibility to "manage and integrate resources" into classrooms in order to provide students with choices for exploration. She shared:

> ...one way that we can do this is by creating authentic and open-ended tasks that have been proven to give students more motivation in projects and assignments; essentially you get out what you put into it and students get a lot more out of authentic tasks versus sticking straight to the books. I think if students are given assignments that allow them to explore a multitude of different apps and then use those to create a presentation surrounding a topic of their choice, they would be very motivated and engaged by this. This would also allow growth in problem solving abilities by having to work through problems that arise and how they will get to their end goal to demonstrate their learned knowledge for the teacher and their class. (#B1)

Rethinking the Purpose of and Approach to Technology Integration

In the post-course questionnaire responses, when reflecting on their decision-making processes, pre-service teachers devoted the most attention to the purpose of integrating technology. They noted that they "became aware of all the many technology tools [they] could integrate into one lesson" (#C13) and recognized that

> "[in] doing this lesson plan [assignment for CI 5307] I had to intentionally plan technology into my lesson - where I've only really had experience using technology in the classroom during like breaks (i.e. wii during free play or brain breaks doing a song on the smartboard) but intentionally using it in the class

allows you to create the integration." (#C18)

Pre-service teachers reported intending to utilize technology in their classrooms through consideration of meaningful and engaging approaches. One pre-service teacher reflected that "it is important [to] think critically about how technology can be used to enhance students' learning, deepen their understanding of material, and help them to experience content in new ways" (#A11). Age-appropriateness was mentioned as they considered "what [would be] a developmentally appropriate technological tool or resource to use for the age group [they] planned the lesson for" (#D10). Respondents also acknowledged the investment and efforts that came along with learning to integrate technology.

For some pre-service teachers, they shared that "it often takes time and experience to understand a technology's value within a classroom" (#E2). They embraced life-long learning attitudes as they noted that "we should always be learning as teachers…, it is an ongoing learning process that we will get to share with our students and other teachers" (#D1). Some respondents confirmed that a teacher's pedagogical approach could help reflect/inform the purpose of technology integration (#E15). One pre-service teacher, who originally perceived technology as a valuable tool for student engagement, started identifying each part of a lesson and asked, "how could I do this differently" when figuring out where to incorporate technology (#B3). Another teacher, who already supported the essentialness of technology for teaching and learning at the beginning of the course, elaborated on their new stance that "technology integration is just an extension of our pedagogical approach":

...what I mean is that we will still teach in the same relative way and we will still

> teach the same curriculum but technology allows us to try different methods, allows for new ways to assess education, allows for new ways for students to express themselves. It diversifies the ways we can teach beyond textbooks, pencils, and note-taking. I find it important to remember that I don't have to change how or what I teach but that I am changing the tools that I use to accomplish my job. The best example I saw of this was in people's lesson plan presentations where I saw a multitude of examples of teachers teaching material that has been taught for years but finding newer, more effective ways to do so. (#E9)

Two Mindsets/Approaches in Using Technology: Separated or Integrated Ideas

By inquiring about pre-service teachers' future plans in the post-course questionnaire, I found that overall they demonstrated can-do attitudes through sharing an abundance of teaching ideas, including topics ranging from establishing digital citizenship for students (#B5), to finding creative ways for assessments and differentiation (#C12), to managing resources in their classroom (#D8). Respondents also noted a willingness to connect with colleagues to consult/discuss the use of technology (#E7), and find out about potential resource support (e.g., reliable access to devices) from school administration (#A10).

In addition, compared to their pre-course questionnaire responses that acknowledged the usefulness of technology without explanations, pre-service teachers in the post-course questionnaire used concrete details and explanations to describe their future actions. When sharing how they would execute their future ideas/plans, responses

illustrated a range of conceptualizations about technology integration from conservative use to constructive use. Some responses contained a mix of the perspectives. For example, one pre-service teacher described a math lesson in which students would be asked to work in groups to solve problems via an interactive math game on iPads; the teacher added that those who were behind on the task "[would] spend more time on iPad" (#D6). Similarly, another pre-service teacher acknowledged the presence of technology but seemed to view it as separated from instruction:

> I wish to explore on a deeper level how much technology should be given to my students for a day or week without having technology as a distraction to their overall learning. Also how to find the balance of both technology and instruction so that one component doesn't outweigh the other. (#A8)

For those respondents that described wanting to use technology constructively but also in isolation, their rationales depended on whether they viewed technology as a *separate* component that adds value to learning, or as an *inclusive* part of instruction, pedagogy, and student learning. Additionally, I found the pre-service teachers with integrated views and inclusive beliefs of educational technology expressed more transformative ideas such as redesigning the classroom environment or adjusting assessments. For example, one teacher proposed the idea of setting up technology-integrated stations in their classroom with purposeful weaving together of pedagogical strategies and formative assessment:

> ...when working on projects or larger units I would love to give students multiple different technology tools to use. For instance, if we are learning a math lesson

> instead of just getting a worksheet at the end of the lesson I would love to set up stations. One could be a game on an iPad that has the student practice what we just learned, one could be using the SMARTboard to answer some questions, and one could even be creating a video teaching what we just learned. I think that setting up stations is a great way for students to think critically since they are able to apply their knowledge and choose how they want to do so. It also ties great into problem solving skills as well as performance skills since students pick and choose in which ways they want to learn and practice their skills while the teacher can assess and observe. (#A12)

Similarly, another pre-service teacher suggested a potential way for adjusting assessment along with technology integration:

> ...when students are making their story book online...., a way of making sure that students are critically thinking is by walking around the classroom and giving students opportunities for response, meaning asking them questions about what colors, what picture they want to upload and checking throughout the lesson that they know how to upload the media elements that they need. After the class activity, looking at the student's iPads to see how many pictures they added to their work, how much text they have written and how the pictures connect with the story, this will help the teacher know if they have an understanding of story and picture connection as well as the use of the iPad to make this happen. (#D14)

Summary

The first and second sections of this chapter provided an overview of pre-service teachers' experiences, understandings, and ideas about technology integration before and after taking an educational technology course. This analysis answered the first question of my dissertation: (1) In what ways do pre-service teachers' perceptions about technology integration change over time? At the beginning of the course, despite exposures to technology in their K-12 experiences, ten pre-service teachers expressed hesitation, distrust, or lack of confidence in their own abilities or in technology itself as they contemplated technology integration in their future teaching. In contrast, post-course questionnaire responses showed that overall pre-service teachers had fruitful ideas for pedagogical approaches and demonstrated increased capabilities to apply technology in their classrooms.

Overall, their ideas about technology integration shifted in two ways over the course of the semester: 1) they showed a greater interest in and emphasis on searching for new possibilities in integrating technology into the classroom; and 2), they acquired a greater capacity for reflection on the relationship between educational mindsets and the purposes of technology integration. Their questionnaire responses revealed that their conceptualizations of technology integration changed over time, and these shifting mindsets influenced their planning for future uses of technology in their teaching practices. These shifts occurred along a continuum. That is, the shifting mindsets of some participants showed them moving from separated to integrated perspectives over the semester, suggesting they would use a mixture of both approaches in their future teaching. Other respondents' intentions for technology use suggested they would remain

at the separated level in their future teaching. These results indicate how, in the movement from basic to advanced levels of technology integration, mindset changes could be carried forward (or left behind).

These sections represent an overview case analysis at the macro-level in order to identify developmental patterns related to technology integration among pre-service teachers. Next, I reviewed these major patterns to provide a direction for purposefully selecting three focal participants for a micro-level analysis of individual learning trajectories. These focal cases are illustrated in the next sections.

Perceptions Change: Different Perspectives, More Ideas

In this section, I present detailed snapshots of three focal participants to illustrate changes in their perceptions about technology integration based on the comparison of their pre- and post-course questionnaire responses. The results of this analysis helped me identify how these three participants' perspectives changed during the course with different intentions for classroom implementation. This analysis addressed both questions of my dissertation: (1) In what ways do pre-service teachers' perceptions about technology integration change over time? and (2) How does pre-service teachers' learning influence their use of technology in their digital creations or instructional plans? The changes in their perceptions evolved and shifted when they elaborated on the expectation of teachers' roles, the consideration of students' needs, and their individual stances on educational theories. The three focal participants illustrate pre-service teachers who shifted from "concerned about the use of technology" to "value of technology

integration" over the duration of the course. Together, these components drive how they see the possibilities of technology integration in their future classrooms.

Emma: Mindfulness and intentionality in Exploring New Approaches

Emma was a senior undergraduate college student majoring in early childhood education. In her prior experience as a learner, there was no technology used in grades K-8. She explained that due to this background, she is "distrustful of the necessity of use of technology in early education." As for her experience of technology in high school classrooms, she "did not enjoy" it. When she reflected on her initial beliefs about the role of technology in her future classroom, she described technology as having a place in the classroom but worried it would be "too large and too clumsily utilized." She questioned the use of technology and explained that it should "enhance not impede" the learning. She even described how phone or computer use caused her to feel both stress and anxiety. Her stance on technology integration was further demonstrated by her statement that technology "should not be necessary to communicate the main points of the lessons."

Emma's post-course questionnaire responses reflect a changed perception of technology and its possibilities in the classroom. In addition to her recognition that "technology can be integrated into ALL levels of a lesson plan," she saw the possibilities of technology to redefine learning spaces. She highlighted the critical nature of mindfulness and intentionality for technology integration. Specifically, she addressed teachers' responsibility to model the use of technology for students, especially by "engaging in respectful ways." As a reflection of this change in beliefs, she developed more versatile ideas for engaging in technology integration. For example, she proposed a

use of technology for a future assessment, such as using Kahoot and Google Drive to view students' learning progress. She gained more interest in exploring new ways of telling stories and expanding students' critical thinking and creativity, such as teaching students to use Vidlab to edit their own videos and integrate with Skitch for creative expression. Because of her early childhood background, she wants to maintain the importance of hands-on activities for active student learning. For example, she developed a new idea to connect hands-on activities with technology by creating a scavenger hunt with iPads or interactive games.

Hailey: Putting More Emphasis on Purposeful Pedagogical Design

Hailey was also a senior undergraduate college student majoring in early childhood education. When prompted to recall any technology exposure in her K-12 experiences on the pre-course questionnaire, she described the role of technology primarily as an object. " She reflected on the roles of technology including classroom projector slides ("When I was in school the fanciest technology was the projector slides you could write on") and a computer lab for typing, learning MS Word, or playing math games. Additionally, she shared her observations, based on her own teaching practicums, about how others are using SMARTboards installed in classrooms for kids to use. In her initial perceptions prior to the beginning of the course, she conveyed a negative attitude toward technology integration: she claimed that it is "not necessary" to have technology, such as SMARTboards or iPads, in the classroom. Her preferred exposure to technology was related to personal reasons like using smartphones for listening to music and taking pictures.

By the end of the course, Hailey started to express different perspectives on the role of technology. While she continued claiming that technology is not age-appropriate for pre-K and is not necessarily needed because of the importance of social-emotional learning, she highlighted some advantages of technology integration. For example, she found that technology can be used to enhance communication, like tracking developmental milestones of students and building relationships between teachers, students, and parents. She also valued the role technology can play in "new creations" such as "encourag[ing] students to experiment with new things" and "help[ing] students find new interests." In her future plans, she wants to continue evaluating "what specific purpose the technology serves" and desires to work with colleagues to seek support for more technology integration ideas. She intends to use purposeful pedagogical design to cautiously integrate technology for preK students. For instance, when having students look up information on a technology device, she would like to encourage them to be engaged in critical thinking so that it is not just for searching answers but should involve question making and deeper thinking.

Jade: The Possibilities of Differentiation and Authentic Assessment

Jade is a master's student in education and plans to teach grades kindergarten to third grade. Her exposure to technology in her K-12 experiences was "a learning experience." She identified technology as "a tool later need(ed)," for her targeted grade levels such as for learning "how to type, use excel and [MS] Word" in the future. She also recalled differing use and time related to technology integration in her K-12 schooling. She stated that technology was a small component and a fun reward in her

elementary school, like “playing games if [the students] got done early.” But later on in high school, technology became ubiquitous in all aspects of her learning, especially iPads that were “an essential component of our learning.” Although she had broad exposure to technology in her K-12 education, she hesitated to commit to integrating technology in her future classroom as an elementary teacher. In her initial perceptions, she shared that she would use technology “only [if] it is adding to the learning.” She explained that technology would be “unnecessary” if it became “difficult to use and creates more problems” which may cause “a hindrance to childrens’ learning.”

In Jade’s post-course questionnaire responses about her beliefs in the role of technology in education, her mindset had changed. She asserted that technology integration is “a lot easier than originally thought” and it is possible to “incorporate it into different aspects.” Jade found herself “becom(ing) aware of all of the many tools" and wanted to “explore more technology tools for preschoolers and kindergartners.” She further identified several reasons for integrating technology into her classrooms: helping to differentiate instruction, reinventing lessons, and making students more engaged. She suggested that she would start integrating technology slowly by substituting tech tools for original activities or directions. But once she became more comfortable and effective with using technology, she would “start to use technology more” in her future lessons. In this way, she wanted to introduce new forms of technology so that students could learn how to use it. Additionally, Jade was inclined to use technology for differentiation of instruction since she viewed herself as an advocate for authentic assessment and for Gardner’s theory of multiple intelligences. She expected teachers to provide a variety of

choices, initiate the differentiated use of technology, and allow students to "present and demonstrate their knowledge."

Developmental Growth in Constructing Technology Integration Beliefs

In this section, I provide snapshots of the three focal participants' coursework by reviewing their (a) Technology and Teaching Philosophy assignment (see Appendix E) and (b) Digital Tool Exploration assignment (Appendix F) to better understand how their perceptions of technology integration shifted over the duration of the course. The philosophy assignment was the primary data source in this analysis, and the digital tool exploration assignment was used as a secondary triangulation data source.

In the early stage of this course (Week 4), all students were required to reflect on and write about their technology and teaching philosophy. This was an individual statement and one of the components that need to be shared and posted in their digital portfolio (i.e., their own teaching website). The length varied but pre-service teachers were required to compose a statement that described their pedagogical philosophy and goals for technology integration. In this assignment, Emma, Hailey, and Jade started to connect their teaching philosophies with educational theories, reflect on the reasons for integrating technology in teaching and learning, and identify what their roles as teachers could be in future classrooms.

After I analyzed their philosophy statements, I used their digital tool exploration assignment (in Week 1, Week 3, Week 5, and Week 7) as a triangulation data source for additional insights into how they affirmed their decision-making or preferences in

selecting or evaluating a technology. This additional analysis revealed that Emma and Jade continued to gain new ideas about purposeful use of educational technology by exploring new tools while Hailey maintained her pre-course stances and concerns regarding age- and development-appropriateness of technology use for preschoolers and toddlers.

Emma: Transforming Classrooms and Reevaluating Assessments

Emma's philosophy statement described that the duties and responsibilities of teachers should include the integration of technology to "transform classrooms in ways we cannot yet imagine." She expressed the importance of the idea that "children learn best through observation" and learning "how to be citizens in a digital age." Therefore, teachers' duties should include introducing new technology, demonstrating the usage of technology, and providing an environment where students can make "progress [in] their own technology skills" and develop "digital citizenships." The possibilities of teaching with technology provided Emma with a new perspective on having learners pursue knowledge differently. She proposed ideas specifically focusing on "differentiating classrooms to best fit all types of learners" and providing "individualized formative assessments" instead of standardized summative assessments through technology. As she continued exploring more technology tools through other coursework activities, including the digital tool exploration assignment, she was particularly interested in searching for interactive platforms and hoping these could be alternative assessments, such as collaborative mind mapping and interactive kidblogs, so that the collaboration among teachers and students could be elevated and the traditional summative assessment could

be transformative.

Hailey: Staying Open But Being Aware of Developmental Appropriateness

In her teaching philosophy statement, Hailey stated that she perceived technology "is an invaluable resource for finding and researching new information." Thus, she emphasized that a teacher's role is to provide accessible technological tools and environments to support students' self-discovery and academic inquiry. She described that she herself is "try(ing) to stay open" toward technology and fully supports the inclusion of technology in upper elementary school and high school classrooms. However, her career aspirations are to teach toddlers and preschoolers. For these grade levels, she believes technology is not "a necessary presence in the classroom" because toddlers are not "researching advanced topics or writing academic papers." Hailey further described her teaching as "very child- and play-centered" and provides "hands on and child-driven activities." She believes it is crucial to design curricula around children's interests and to have toddlers and preschoolers to interact with real-world situations to "promote social understanding and whole knowledge," which she drew from John Dewey's social activism theory. So, although she recognized the possibilities that using technology could "individualize a child's learning," she described herself as stubbornly convinced that technology is not "developmentally appropriate in the context of early elementary, preschool, or toddler classrooms."

Jade: Allowing Student Choices and Expanding Real World Experiences

In her statement, Jade shared that her teaching beliefs are based on a progressive

philosophy of teaching. She referred to Howard Gardner's Theory of Multiple Intelligences to support the importance of developing "the whole child, not just certain aspects." Using this theory, she thinks it is the teacher's role to "create experiences for students to learn through." Therefore, "focusing on the child," "learning through real life experiences," having students "come up with their own questions and ideas" are her core pedagogical beliefs. Jade identified that integrating technology into teaching could support her beliefs and help her to design learning activities differently. For instance, she brainstormed that she could use technology to "expand students' real-world experiences," "gain access to different cultures and world events," and "communicate with students in another part of the world." Jade also wanted to respect individual learning needs. She added that technology could "accommodate different types of learning" and provide options for students to present their knowledge:

> *"For example, students can use iMovie to record a movie with their information, they can use Garageband to record a song, they can use PowerPoint to create a slideshow, they can write a blog post: the possibilities are endless. Allowing students to have choice is a great motivation tool."* (Jade, excerpt from Teaching Philosophy statement)

Evidence of Developing Beliefs: Practical Uses in Technology Integration Lesson Plans

At the end of course, students created lessons to demonstrate their learning about technology integration (Table 14). This section of the chapter highlights the analysis of focal participants' lesson plans in order to better understand how they were translating

their developing knowledge and beliefs about technology integration into pedagogical designs and actual practices. Their lesson plan activities are included in Appendix G.

I analyzed their technology integration lesson plans using multiple analytical frameworks: ISTE's standards for students (2016), ISTE's standards for educators (2018), and Roblyer and Hughes' (2018) directed or constructivist model (see Table 15 & Table 16) (for more detailed charts that include standard/model descriptions, see Appendix H). Overall, all three lesson plans demonstrate constructive learning environments. However, learners' roles and the teacher's role varied depending on the purpose and approaches of technology integration. For example, in their final lesson plans, both Emma and Jade chose to use digital creation for students' learning activities where digital tools were a medium for students to present their knowledge and discuss their thinking with others. In such learning environments, students are exposed to multiple uses of technology and experience different roles (e.g., knowledge constructor, creative communicator) that are leveraged when engaging in digital creations. Similarly, this type of classroom environment exposes teachers to expanded roles themselves and encourages them to become designers. In contrast, Hailey chose to integrate a SMARTboard solely for displaying content and relied on other non-technology-based pedagogical strategies to create a learning environment that engaged students in multiple interactive discussions with each other. In Hailey's lesson plan design, students were positioned as knowledge constructors and the teacher as a facilitator.

Table 14

An Overview of Focal Participants' Technology Integration Lesson Plans

	Emma	Hailey	Jade
Students' grade	Kindergarten	Kindergarten	Grade 1
Subject/topic	Lunchbox Story Time	Reading/Language Art, Poetry	Life Cycle
Technology used	iPad Video viewing on YouTube Skitch (App) Vidlab (App)	SmartBoard	SmartBoard Popplet Thinglink Piktochart Infographic Vizio MoMa Art Lab on iPads

Table 15

Frequencies of Students' Roles in Emma, Hailey, and Jade's Lesson Plans Using ISTE's Standards for Students (2016) and Roblyer and Hughes (2018).

	Emma	Hailey	Jade
ISTE Standards for Students (ISTE, 2016)			
Empowered Learner	0	0	1
Digital citizen	0	0	0
Knowledge Constructor	1	4	1
Innovative Designer	0	0	0

Computational Thinker	0	0	0
Creative Communicator	1	0	2
Global Collaborator	1	0	0
Directed, Constructivist, or BOTH Models (Roblyer & Hughes, 2018)			
Directed	0	0	0
BOTH	2	1	0
Constructivist	2	3	7

Table 16

Frequencies of Teachers' Roles in Emma, Hailey, and Jade's Lesson Plans using ISTE's Standards for Educators (2018) and Roblyer and Hughes (2018).

	Emma	**Hailey**	**Jade**
ISTE Standards for Educators (ISTE, 2018)			
Learner	0	0	0
Leader	0	0	0
Citizen	0	0	0
Collaborator	1	0	0
Designer	1	0	2
Facilitator	1	4	0
Analyst	0	0	0

Directed, Constructivist, or BOTH Models (Roblyer & Hughes, 2018)			
Directed	0	0	0
BOTH	2	1	2
Constructivist	2	3	2

Emma: Digital Storytelling and Creations

In the lesson plan that Emma developed at the end of the course, "students will create a video story to share about their favorite food with classmates and students around the world." She identified the purpose of this lesson is to help children "develop a more integrated sense of self while simultaneously encouraging them to interact with other diverse perspectives." Using storytelling as a medium, Emma intended to "strengthen students' speaking and reflection skills" through discussing basic facts about themselves, their families, and customs. She also wanted to "familiarize students with a range of media platforms." She further elaborated on her ideas by highlighting her consideration of social/emotional skills development along with forming autobiographical memory and connecting with the world:

> As (a) teacher in early learning I understand it is important for children to be able to communicate about themselves with others, and engage in the formation of autobiographical memory. By being asked to tell a story and reflect on a specific food they like students will work [from] a basis of self, from this children are then able to understand that other people may have a different idea or point of view.

> This awareness is critical for development of both social/emotional skills as well as academic development. By integrating a range of media platforms students will also become familiar with how to tell their own stories in the digital age, and learn that with technology it is possible to connect with other kids around the world. (Emma, excerpt from Lesson Plan statement)

There are four technology tools that Emma planned to integrate into these learning activities. First, students will view a video (as a class) called 'School Lunches Around The World' on YouTube. Then, after a class discussion about different foods and cultures, students will be invited to draw a food that is important to them, "take a photo of it with the iPad," and "annotate the picture with Skitch (App)." Finally, students will "make a short video with Vidlab (App) [to give] a short introduction and tell their story about the food." Emma referred to these videos as students' "products" that can be shared with the class and potentially shared with other students around the world such as sharing videos over WeChat.

Through the analysis of students' roles and the teacher's roles (Table 4) in Emma's lesson, I found that students exercised their roles as knowledge constructors, creative communicators, and global collaborators; and the teacher had roles as a collaborator, designer, and facilitator. For example, in the first part of the lesson when students view a video on YouTube together, the teacher plays the role of a facilitator to "facilitate a class discussion about different foods and culture." Students bocame knowledge constructors that build knowledge about the world and themselves by

reflecting on their own favorite food and telling the class a story about this food. In the next part of the lesson when students work collaboratively on drawing, taking pictures, annotating, and video editing, Emma takes on a dual-role as a designer and a collaborator to expand students' authentic learning experiences. Students work as communicators and collaborators while working on their digital creations.

In terms of what models of technology integration approaches (Roblyer & Hughes, 2018) Emma uses, at the beginning of the lesson, Emma's technology integration activities reflect the BOTH model (a combination of Directed and Constructivist models). To be more specific, the technology is used to optimize personal and digital materials and to motivate students' learning. In the next part of the lesson, the Constructivist model is reflected when students work on their digital creations.

Hailey: Displaying Content on a SmartBoard

Hailey's final lesson plan aimed to help kindergarteners in "forming a critical opinion of literature" while they are learning about "poetry and patterns in writing." In this 45-minute lesson, students are asked to describe what they "notice about the picture/pattern of writing" about an illustration of a poem displayed on a SMARTBoard. They read this poem together and are asked critical thinking questions that also review poetry elements. Next, "students will turn to 'rooftop partners' and share their likes and dislikes" about the poem. Pairs of students are asked to share with the class in order to form connections. Afterwards, students work independently by responding to a prompt in short journal entries and depicting their sentences with a picture. Finally, all students return to the large group for sharing and thinking about similarities across their journal

entries. They also review the list of likes and dislikes on a SMARTBoard to "look at the differences and make connections." Hailey describes her pedagogical strategies this way:

> *Early elementary students learn best when collaborating with peers, creating an open, exploratory environment to express ideas. By reading aloud the poem to the large group, then turning to "rooftop partners," students are given various opportunities to connect and share with their classmates. The independent practice of writing in their journals allows them to concentrate and deepen their thinking, demonstrating their thought process through writing and creating original illustrations to help share their idea. Closing as a large group again allows students to share what they have created, which is an important aspect of learning for many students--it adds importance to their work, and builds pride in their learning. ...It is important for young readers to not only think critically about literature/creative writing but also understand what aspects and qualities of a piece they like or don't like, as that will better inform them on how to choose books in the future. This will lead to an appreciation of literature that doesn't come from simply picking apart written work without discussing what makes it good.* (Hailey, excerpt from lesson plan statement)

There is only one technology, a SMARTBoard, integrated into Hailey's lesson plan. She uses this technology three times: at the beginning (anticipatory set), in exploring (poem reading), and at the end (closure) of the lesson. All three uses support displaying content and facilitating discussion. In other words, Hailey uses the SMARTboard in the same way a teacher might traditionally use a blackboard. In this

lesson, technology is used by the teacher as a substitution for non-technology tools, with the focus on direct instruction in order to engage students in expressing ideas. For example, in the anticipatory set, Hailey wants to encourage students to identify patterns within the poem, ask what they think the poem might be about, and "remind students of poetry elements by showing a table of definitions and examples on the SmartBoard, asking for and providing examples." In the exploration set, students read the poem that is displayed on the SMARTboard and are asked "critical thinking questions like what patterns do we notice in this poem." Similarly, in the closure, the teacher writes a list of likes and dislikes shared by the class on the SMARTBoard, and has the "students look at the differences and make connections," "relate common likes to other books they have read," and "discuss what kinds of books we liked." In summary, the main purpose of the SMARTBoard present in Hailey's classroom is to serve as a vehicle for direct instruction.

In the analysis of the students' and teacher's roles in this lesson, I found that students are positioned as knowledge constructors, whereas the teacher is positioned as the facilitator during the entire lesson. The lesson aligns with the BOTH model (at the beginning of the lesson for motivation) and the constructivist model (throughout the whole lesson for fostering metacognition). Although the substitution level of integrating the SMARTBoard to display information and prompt sharing is not considered a constructivist approach, Hailey's broader pedagogical design, including students' responding to prompts and critical questions, fosters and enriches students' interactions and understanding.

Jade: Designing a Learning Environment for Constructive Use of Technology

Jade's lesson was collaboratively developed with another pre-service teacher. In their lesson plan rationale, Jade and her partner stated that "students will demonstrate understanding of the life cycle by creating their own visual representation and sharing it with the class." This is a 45-min lesson designed for first grade students. The topic of the lesson is the life cycle of caterpillars to butterflies. At the beginning of the lesson, students ask introductory questions about the topic. As a whole class, the teacher and students "create a chart using Popplet and ThingLink" to build background knowledge and inform what the class wants to learn about. Next, students read a book as a class about caterpillars, then watch a video together on the life cycle of butterflies on Vizio to answer interactive questions and discuss questions that are embedded into the video together as a class. Students can further draw a certain part of the life cycle on SMARTboard after the teacher presents infographic material through PiktoChart to visually display the butterfly's life cycle as a resource and reminder for students to recall/remind target knowledge. Afterwards they start to work in pairs and create/illustrate their own life cycles using the Moma Art App. Finally, teachers share/project students' work with the class on the SmartBoard.

There are six technology-integrated components of this lesson plan which Jade and her partner call "technology supports." In one of their lesson presentation slides, "Why We Are Incorporating Different Technology Tools," they identify four reasons for integrating technology:

- To provide a variety of different ways that the students will be able to acquire knowledge about the life cycle,

- Present the material in a variety of ways to allow for students to be engaged in the content in different ways and give them more experiences with different technology tools,
- Offer many different ways of learning so that there is greater opportunity for students to find a way that interests them,
- They may learn from one method more effectively than another. (Jade and her teammate, excerpt from lesson plan presentation slides)

Through the lesson analysis using the ISTE Standards, I found that students function as empowered learners, knowledge constructors, and creative communicators. The teacher's role is as a designer. For instance, students in this lesson construct and evaluate their knowledge together by creating charts on Popplet and ThingLink, and by drawing life cycles on the SmartBoard. They have opportunities to create original work and use technology as a medium for communicating and sharing their understanding. At the same time, the teacher designs authentic learning activities by integrating digital tools that enrich/deepen students' learning experiences. The learning environment for students is provided in the constructivist model throughout the whole lesson for building materials, transferring knowledge, fostering cooperation, and allowing multiple intelligences among students. The BOTH (such as generating motivations and optimizing material resources) and the constructivist model (through increasing knowledge transfer) are reflected in the teacher's role.

Summary

In the chapter I first described the data analysis results of the questionnaires to overview and examine 69 participants' conceptual changes of technology integration. The majority of participants showed greater interest for new teaching possibilities with technology and a greater capacity to reflect the purpose of technology integration. Next, I illustrated three focal participants' thinking and their practical approaches at the beginning, middle, and the end of course to demonstrate how they conceptualize technology integration and translate it into instructional designs. These findings will further be discussed in the next chapter along with the implications of this study.

CHAPTER 5

CONCLUSIONS

In this chapter, I provide a short summary of my dissertation and an overview of the findings. Next, using the results of the study, I (re)connect with contemporary technology integration theories and provide suggestions for applications by pre-service teacher educators and in teacher education programs. Finally, the limitations of this study are outlined as well as possible directions for future research.

Summary of Research Study

The purpose of this dissertation study was to gain further insights into the conceptual changes of pre-service teachers' perceptions of technology integration during their teacher preparation. This study was guided by two research questions: (1) In what ways do pre-service teachers' perceptions about technology integration change over time?, and (2) How does pre-service teachers' learning influence their use of technology in their digital creations or instructional plans?

This retrospective study examined pre-service teachers' learning trajectories within an educational technology course. First, 69 participants completed questionnaires at the beginning and the end of the course to reflect on and identify their perceptions of technology integration. The results from the questionnaire analysis informed the selection of three focal participants: Emma, Hailey, and Jade. A deeper analysis of these focal participants' learning artifacts from different phases of the course was completed to better understand and document changes in their perceptions and practices of technology

integration. Learning artifacts included assignments from the beginning of the course (e.g., teaching philosophies in Week 4), throughout the course (e.g., digital tool exploration assignment in Weeks 1, 3, 5, and 7), and from the end of the course (e.g., technology integration lesson plans from Week 14).

Overview of Findings: Pre-Service Teachers' Conceptual and Practical Changes

In this case study, most pre-service teachers enrolled in the educational technology course had a background of rarely using technology in their own K-12 learning experiences. They could only recall certain technological objects (e.g., overhead projectors, computers, and SMARTboard) being used as (a) instructional devices by their teachers for course material presentations; (b) a keyboard to learn how to type, or (c) simply a reward where they played games and watched videos. At the beginning of the course, the majority of the pre-service teacher participants recognized that their own perceptions of technology integration were mostly about valuing its advantages for increasing efficiency in the classroom. Their initial responses on the pre-course questionnaire also demonstrated a spectrum of technology integration perceptions from limited use, to conservative use, to constructive use. However, by the end of the course, the majority of pre-service teachers began to value the constructive use of technology by students, became aware of the purpose, and brainstormed pedagogical approaches that complemented constructive uses of technology. Their post-course questionnaires presented another spectrum of technology integration perceptions from *separated-from-instruction-uses* to *integrated-with-instruction-uses*. Additionally, the pre-service teachers with the integrated views and inclusive beliefs of technology expressed more

transformative pedagogical ideas —like redesigning the classroom environment or adjusting assessments—compared to the pre-service teachers with separated-from-instruction-use views.

The three focal participants exemplified these trajectories, and provided in-depth insights into any shifts in perceptions that occurred during the semester. In particular, Emma, Hailey, and Jade demonstrated how over the duration of the semester they shifted from hesitation to confidence in the purposeful integration of educational technology. These shifts reflected constructive-use of technology with focuses on creative expression, critical use of technology, differentiation, and authentic assessment. Their conceptual changes were further examined through how they made decisions and designed a technology- integrated lesson plan. In this final course activity, all three of them expanded their thinking and professional learning of recognizing various teaching ideas and learning possibilities of using technology. However, only two of them (Emma, Jade) ultimately demonstrated integrated-use of and inclusive beliefs about technology in their lesson plans. Emma and Jade expanded the teacher's role into a collaborator or a designer along with learners becoming creative communicators. On the other hand, Hailey chose to use technology for instructional uses only for the limited purposes of displaying information on a SMARTboard between multiple constructive, non-technology- based activities for students.

Overall, this study illustrated how pre-service teachers' mindsets about technology integration changed and were reconstructed during their experiences in the course such as exploring new digital tools and learning about tech-infused pedagogical

strategies. The participants demonstrated a wide range of perspectives such as viewing technology as more inclusive/integrated or separated/isolated in teaching and learning activities. When it came to the practical design of lessons using technology integration, some of them were willing to integrate technology that was more inclusive of students' active roles and others preferred more conservative uses of technology by the teacher. In other words, for the pre-service teachers in this course, learning about technology integration did not automatically lead to substantial conceptual changes in their thinking or beliefs about teaching and learning.

Implications

Previous research on technology integration has emphasized teachers' development of beliefs, perceptions, knowledge (Burden et al., 2016; Ertmer et al., 2015; Hew & Brush, 2007), versatile strategies and approaches (Santori & Smith, 2018), and uses of technology as a learning environment (Sawyer, 2014). These studies document teachers (re)constructing their perceptions of using technology and developing their ability to transfer self-taught digital experiences into instructional design. To continue deepening teacher beliefs and technology integration practice research, my study contributed by echoing "process over product" in the next/current evolution of technology integration (Kopcha et al., 2020, p. 729). According to Kopcha et al. (2020), having teachers reflect on their decision making with technology is essential because educational technology integration is "(1) value-driven, (2) embedded in a dynamic system, and (3) a product of a teacher's perception of what is possible" (p. 729). Based on my research findings, I offer implications for teacher educators and teacher education

programs to continue supporting pre-service teachers' development in implementing technology into teaching and learning.

First, it is important to recognize that teachers, including pre-service teachers, are learning many new things at the same time, including knowing how to use technology for educational purposes. Even pre-service teachers who are from younger generations are not always as technologically savvy as we assume them to be (Kirschner & De Bruyckere, 2017). Although the pre-service teachers in my study had exposure to a variety of technological devices and/or environments when they were K-12 students themselves, most could not demonstrate they knew how to translate the use of smartphones into teaching/learning practices (at the beginning of the course). While many younger people know how to navigate social media or use a spreadsheet, they may not know how to use specific educational technology tools as well as how to use the teacher-side of tools they may have used as K-12 students themselves (e.g., course management systems). In addition, pre-service are not only new to pedagogical design, they may be new to content-specific methods or content-specific educational technology tools.

Reflecting, Redesigning, and Reconstructing: Identities and Pedagogy

To help pre-service teachers make sense of and make connections between all of this interrelated learning, they should continuously reflect on their learning as they move through their teacher programs. Pre-service teachers should take up the responsibility to serve as "paradigm shift communicators" who engage in critical inquiries of their own teaching and learning. I borrow and repurpose this term from Maisha Winn who

originally coined it as a way to call for teachers' critical role in restorative and transformative justice within schools (Winn, 2018). As "paradigm shift communicators", their reflections could be supported by digital tools that foster creative learning to help them (re)construct their teaching identities (Loveless & Williamson, 2013) — including how they can become facilitators of technology-enhanced environments rather than an instructor using technology for substitution or replacement.

As part of this reflection, I suggest encouraging pre-service teachers to constantly revisit the role of technology in learning in conjunction with (re)thinking the role of teachers and students in technology integration. One way to do this is to utilize existing models and frameworks as reflection tools. For example, my study demonstrates how to utilize ISTE standards (2016) and the TI strategy model (Roblyer & Hughes, 2018) as analytic rubrics to evaluate pre-service teacher's TI practices. The use of these tools provided me with a more holistic and specific understanding of a students' ideas related to technology integration that, if I shared this analysis with them, could foster the development of their possible and expanded roles and identities (specific and not specific to technology integration). Using the ISTE Standards for Students and Educators along with the TI strategies could be part of possible reflection tools applied in teacher education programs by both teacher educators and pre-service teachers themselves. Pre-service teachers could engage in self-reflection through evaluating their technology integration practices using various tools. Through this process, pre-service teachers would have opportunities to reflect on how they position themselves in a technology-integrated learning environment, prompting questions such as *Will technology replace*

teachers' roles? If not, then what learning can be leveraged through technology? How can teachers design a learning environment to meet students' needs? By engaging in this type of reflection, pre-service teachers can move from merely "adopting" a technology to "adapting" a technology, and subsequently start "redesigning" pedagogy with technology.

In addition, processes of thinking with digital tools encourages and challenges pre-service teachers to think through their uses of technology and their beliefs about their pedagogical purposes (the why) and approaches (the how). Activities such as inviting pre-service teachers to explore diverse uses and various purposes of different digital tools helps prompt teachers to ask themselves, *To what extent is this digital tool providing new learning opportunities for my learners? Am I using it only because of its features and affordances for efficacy? Can I (re)design purposeful and meaningful learning experiences with this digital tool?* I used this type of activity myself as a teacher educator within the technology integration course included in this study (e.g., the digital tool exploration assignment). Ultimately, this process of cultivating new teaching identities related to technology integration, through revisiting the role of technology and redesigning pedagogy with technology, will impact pre-service teachers' knowledge, self-efficacy, intentions, and practice (Ottenbreit-Leftwich et al., 2018).

Facing Uncertainty by Strengthening Pedagogical Reasoning

Developing digital literacy and the capability to learn new features of different technologies has become a lifelong learning process for all educators, thus it is very important to address pedagogical reasoning when integrating technology into teaching

and learning. Ertmer and Newby (2016) encouraged teachers to reflect on the reciprocal relationship between learning theory, technology, and instructional practices because teachers should "take advantage of the affordances of the tools" and consider how to "create new types of learning experiences" (p. 72). Similarly, Hughes et al. (2020) provided results of teachers' most valued technology integration practices and highlighted the importance of pedagogical reasoning, suggesting that teachers be encouraged to continue to develop deeper justifications for the use of technology during the instructional design process in order to broaden their perspectives to focus on student-centered learning.

Given the results of my study and these ideas from other scholars, reflections that support developing conceptual changes in pre-service teachers' new identities and pedagogical reasoning should be included in pre-service teacher courses and programs. These reflections should include four aspects or prompts (Loveless & Williamson, 2013): (a) learning with agency, (b) learning with tools, (c) learning in contexts, and (d) [making room for] improvisation. I argue that including these four aspects in reflections could support several identity developments for all teachers, pre-service and experienced. For example, in the aspect of learning with agency, teachers can be prompted to become active learners that engage in the social and cultural contexts around themselves and around students. In the learning with tools category, teachers can be prompted to not only learn new digital tools but also rethink their roles when engaging themselves and transforming students' learning. For learning in contexts, teachers can be prompted to consider their own perspectives and students' contexts through developing culturally-

relevant and critical pedagogy in digital learning environments. Finally, in order to face uncertainty, teachers can be prompted to be open to new possibilities for digital creations and participation, and for moments of improvisation in technology-enhanced learning environments.

Guiding Pre-service Teachers' Growth Through Learning Sciences Approaches

In the past five years, TI research has focused on topics extending from LS approaches. Different perspectives on understanding technology integration have become the main challenge for teachers' readiness (Ottenbreit-Leftwich et al., 2015; Laine & Nygren, 2016). Current LS research considers elemental components (e.g., learning spaces, learning contexts, beliefs, mindsets and attitudes, or supportive resources) that provide interconnected directions to unpack the internal and external factors that affect technology integration (Hur et al., 2016; Liu et al., 2017; Ottenbreit-Leftwich et al., 2018). Through my conceptual framework, my study was an attempt to apply learning sciences research focuses (thinking and knowing, learning processes, learning environments) for building a roadmap to guide pre-service teachers' development in technology integration (see Table 3 in Chapter 3).

I encourage teacher education programs to apply LS approaches as guides to review and reimagine the interwoven components of courses, curriculum, and the broader program itself as a learning environment that influences pre-service teachers' learning trajectories. For instance, LS research supports anchoring pre-service teachers' prior knowledge and beliefs, documenting their conceptual changes to identify what constrains their thinking, and further providing different opportunities (e.g., field experiences with

in-service expert teachers' expert) for pre-service teachers to exercise new TI teaching identities and pedagogical reasoning. As LS researchers in teacher learning research have noted (Fishman et al., 2014), extended duration (instead of a one-time workshop) of activities with a broader connection to teacher collaboration and social support sustains and nurtures teacher development. Examples of this type of activities are "allowing teachers space and time" to explore technology (Mouza, 2019), creating online communities as continuous support systems, and coaching pre-service teachers to continue sharing technology integration ideas, mentoring others/peers, and reflecting on their own practices.

Limitations

This study addressed a gap in the literature by documenting the conceptual changes pre-service teachers experience during a technology integration course, but there were limitations to this study. The first limitation is the retrospective nature of this research. All data used were learning artifacts that pre-service teachers completed during a semester-long course, and were already completed at the time this study was initiated. Course assignments and activities were designed to support learning rather than to serve as data in a research study, including the artifacts directly used in this study (pre-and post-course questionnaires, digital tool exploration activities, and lesson plans). These course activities were designed to have pre-service teachers express their ideas related to the course topics, reflect on digital citizenship, engagement in 21st-century learning and assessment, tinker with educational technology tools and learning management systems, and design technology-infused lessons for use in their future classrooms.

While these artifacts were useful in helping address my research questions, as both the instructor of the course and the research of this study, I would have liked to design course activities with the research purposes in mind as well as include and extend to participants research-only activities. For example, it would have been valuable to interview the three focal participants to engage them in deeper reflections about how their perceptions of technology integration shifted over the course of the semester. In addition to referencing experiences in our course together, they may have made connections to experiences outside of the course that also informed their thinking, such as practicum experiences in real classrooms that may have been occurring parallel to this course. Interviews would have been useful in providing insights and following up with their on-site teaching practices after the end of the course.

Next, while this may not be a limitation, but rather a reality of this study that should be acknowledged again, is the fact that I served as the course instructor for all pre-service teachers included in this study. After the courses were over, and I decided to study the learning that happened in these classes (5 sections), I shifted from my instructor role to a researcher role. This shift required me to reorient myself to the course activities and the students themselves. Given the length of time between teaching these students and researching their conceptual changes, which was approximately three years, my personal connections to the students (including Emma, Hailey, and Jade) faded and I was able to connect more with their learning artifacts. As a researcher, I engaged in research analytic memos to help me create awareness of and document my shifting orientations to the study, which became less as a teacher and more as researcher as the analysis

processes progressed. My role in this dissertation study contributes to its dependability (reliability for quantitatively-oriented researchers) and the process of the study consistently followed my research design and was completed with integrity (Miles et al., 2019).

The final limitation to this study is that focal students did not review my analysis of their learning artifacts. Due to the study's retrospective nature, I did not reach out to them to review and comment on my analysis. Member-checking would have contributed to the study's dependability as well as provided me with additional insights into their thinking processes while engaging in the activity.

Future Research

Future research can address the limitations of this study and build on the decades of technology integration research. One idea is for future research to use different research approaches. For example, using design-based research methods would invite and engage pre-service teachers' involvement in designing activities using their developing pedagogical reasoning related to technology integration (Fishman et al., 2014). By doing so, participants would have active roles in their learning which would hopefully also provide researchers with additional insights about their conceptual changes. Additionally, discourse analysis and time-series analysis could be considered as analytic strategies to investigate sociocultural and contextual factors that influence and sustain conceptual changes.

Building on one of my findings which revealed (a) two levels of beliefs about technology and instruction: separated or connected to others, and (b) new possibilities in teachers' role/teaching identities that can expand with technology integration, I suggest additional research on teacher beliefs that investigates these attributes within a longitudinal study to document the ongoing shifts in TI beliefs and roles (Tondeur et al., 2017). In addition, given that internal factors (including knowledge, beliefs, attitudes) along with external barriers (school resources, supports) are socially constructed in K-12 classrooms, there are ongoing challenges related to technology integration. Contemporary research continues to focus on ways to sustain/develop pre-service teachers' knowledge, self-efficacy beliefs, intentions and practices in different contexts (Ottenbreit Leftwich et al., 2018). Finally, applying learning science research focuses as conceptual frameworks (as I did in this dissertation) in future research could provide researchers with a revised roadmap and clear direction for guiding and designing for pre-service teachers' development of technology integration perceptions and practices.

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APPENDICIES

Appendix A

University of Minnesota IRB Approval

yuHui Chang <chan1173@umn.edu>

1505E70421 - PI Chang - IRB - Exempt Study Notification

irb@umn.edu <irb@umn.edu> Fri, May 15, 2015 at 9:14 AM
To: chan1173@umn.edu

TO : scharber@umn.edu, chan1173@umn.edu, niels561@umn.edu,

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #1 INSTRUCTIONAL STRATEGIES IN EDUCATIONAL SETTINGS.

Study Number: 1505E70421

Principal Investigator: Yu-hui Chang

Title(s):
Investigating the pedagogical beliefs of technology integration in teaching and learning among pre-service teachers

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This e-mail confirmation is your official University of Minnesota HRPP notification of exemption from full committee review. You will not receive a hard copy or letter. This secure electronic notification between password protected authentications has been deemed by the University of Minnesota to constitute a legal signature.

The study number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

For research in schools: Any changes to this research must be approved by the IRB and school district involved before initiation.

If you requested a waiver of consent or documentation of consent and you received this email, approval for the waiver has been granted.

This exemption is valid for five years from the date of this correspondence and will be filed inactive at that time. You will receive a notification prior to inactivation. If this research will extend beyond five years, you must submit a new application to the IRB before the study's expiration date.

Upon receipt of this email, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

You may go to the View Completed section of eResearch Central at http://eresearch.umn.edu/ to view further details on your study.

The IRB wishes you success with this research.

We value your feedback. We have created a short survey that will only take a couple of minutes to complete. The questions are basic, but your responses will provide us with insight regarding what we do well and areas that may need improvement. Thanks in advance for completing the survey. http://tinyurl.com/exempt-survey

Appendix B

EDU 100 Coursework Syllabus, Course Description, Pre and Post Questionnaire

Course Description and Outcomes

This course is designed to prepare you to become knowledgeable and comfortable in the use of current technology in education. You will learn about the operation of technology and the ways in which it might be integrated into the classroom in support of learning. Upon completion of this course you should be able to:

● Use a variety of software applications applicable to a classroom setting

● Use various technologies effectively to deliver a lesson

● Discuss how technology allows students to represent and communicate what they learn

● Plan classroom instruction that integrates technology that students understand

● Prepare a lesson that demonstrates your knowledge of successful technology integration in PreK-12 classrooms

Course Structure

Mindset stage [Teaching & learning theories & tech-integration frameworks]

- Session 1: (F2F)
  - Introduction (e.g., course overview, course resources and support)
  - 21st-century learning discussion (e.g., OET, ISTE)
  - Digital portfolio (set up individual's Google Site)
  - Explore and share one digital tool (1st) (based on individual's selection)
- Session 2: (F2F)
  - Tech-integration frameworks (e.g., TPACK, SAMR, Digital Bloom's Taxonomy)
  - Mind mapping on lesson plan ideas
  - Lesson plan workshop
  - Review learning theories & draft individual's Technology Teaching Philosophy
  - Explore and share one digital tool (2nd) (based on individual's selection)

Practice stage [Tech-integration application]

- Session 3: (online)
  - Learning Management System exploration (e.g., Schoology, Seesaw, Classdojo, Edmodo, Google Classroom)

- Discussion: Flipped classroom, blended learning, personalized learning.
- Special interest in tech-integration: Interview a teacher OR research on a topic related to individuals' inquiry or quests

- Session 4: (F2F)
  - Educational Apps / Websites / Softwares exploration
  - Apps Smash Project (create individuals' mini-instructional media product by using at least two software applications)

Lesson Plan Prep Stage [Assessment, Diverse Learners]

- Session 5: (F2F)
  - Educational technology for assessment (e.g., Kahoot, Socrative, Quizizz)
  - Performance-based assessment--explore assessment tools and create rubrics for purposeful tech-integration
  - Makerspace workshop
  - Explore and share one digital tool (3rd) (based on individual's selection)
- Session 6: (Online)
  - Diverse Learners & Differentiation in tech-integration
  - Lesson plan preparation
  - Explore and share one digital tool (4th) (based on individual's selection)

Presentation Stage [Lesson Plan Showcase]

- Session 7: (F2F)
  - Submit the final lesson plan with tech-integration design
  - Get ready for a 5-min lesson plan presentation
  - Peer-assessment & self-assessment on lesson plan
  - Final course reflection

State Standards of Effective Practice for Teachers

This course address the following State Standards of Effective Practice for Teachers centered on technology integration in at least one course reading, activity, and/or assignment.

Standard 2, Student Learning, 3H: A teacher must understand how students learn and develop and must provide learning opportunities that support a student's intellectual, social, and personal development. The teacher must demonstrate knowledge and understanding of concepts related to technology and student learning.

Standard 3, Diverse Learners, 4D: A teacher must understand how students differ in their approaches to learning and create instructional opportunities that are adapted to students with diverse backgrounds and exceptionalities. The teacher must understand how to recognize and deal with dehumanizing biases, prejudices, and institutional and personal racism and sexism.

Standard 3, Diverse Learners, **4R:** A teacher must understand how students differ in their approaches to learning and create instructional opportunities that are adapted to students with diverse backgrounds and exceptionalities. The teacher must identify and apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.

Standard 4, Instructional Strategies, 5K: A teacher must understand and use a variety of instructional strategies to encourage student development of critical thinking, problem solving, and performance skills. The teacher must use educational technology to broaden student knowledge about technology, to deliver instruction to students at different levels and paces, and to stimulate advanced levels of learning.

Standard 4, Instructional Strategies, 5L: A teacher must understand and use a variety of instructional strategies to encourage student development of critical thinking, problem solving, and performance skills. The teacher must develop, implement and evaluate lesson plans that include methods and strategies to maximize learning that incorporate a wide variety of materials and technology resources.

Standard 5, Learning Environment, 6D: A teacher must be able to use an understanding of individual and group motivation and behavior to create learning environments that encourage positive social interaction, active engagement in learning, and self-motivation. The teacher must how to help people work productively and cooperatively with each other in complex social settings.

Standard 6, Communication, 7K: A teacher must be able to use knowledge of effective verbal, nonverbal, and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom. The teacher must use a variety of media and educational technology, to enrich learning opportunities.

Standard 7, Planning Instruction, 8H: A teacher must be able to plan and manage instruction based upon knowledge of subject matter, students, the community, and curriculum goals. The teacher must plan for the management of technology resources within the context of learning activities and develop strategies to manage student learning in a technology-integrated environment.

Standard 8, Assessment, 9N: A teacher must understand and be able to use formal and informal assessment strategies to evaluate and ensure the continuous intellectual, social, and physical development of the student. The teacher must use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning.

Standard 9, Reflection and Professional Development, 10M: A teacher must be a reflective practitioner who continually evaluates the effects of choices and actions on others, including students, parents, and other professionals in the learning community, and who actively seeks out opportunities for professional growth. The teacher must understand the role of continuous development in technology knowledge and skills representative of technology applications for education.

Standard 10, Collaboration, Ethics, and Relationships, 11M: A teacher must be able to communicate and interact with parents or guardians, families, school colleagues, and the community to support student learning and well-being. The teacher must understand the social, ethical, legal, and human issues surrounding the use of information and technology in PK-12 schools and apply that understanding in practice.

Coursework Description - Lesson Plan

Tech-integration lesson plan & presentation (50 points):
This will be the main product you create on your own in this course. You are expected to integrate at least one digital tools into your lesson plan for teaching and learning in appropriate and meaningful use. In the final session (Module 7), you are requested to submit the tech-integration lesson plan and present a 5-min showcase to share with class about your lesson plan design. We will start to work on your lesson plan creation in Module 2. See more details and resources on the Canvas website.

Open-End Questions in Pre and Post Questionnaire

Questions in Pre-Questionnaire

Notions in the TI framework	Educational process	Technology resource
Open-end questions	1. Please share your belief on the role of technology in classrooms (pedagogy, learning, instruction, assessment, etc)	3. Please share real-life examples, random thoughts, or some keywords to describe your connection with technology when you were a K-12 learner.
	2. Please share what you hope to learn in our Technology for Teaching and Learning course.	4. What is your favorite technology tool? Why?

Questions in Post-Questionnaire

Notions in the TI framework	Educational process & technology resources	Use and assess of TI
Open-end questions	1. Describe your personal mindset (pedagogical approach) and decision-making process for	4. Describe your "takeaways" and the technology integration implications within lesson plans for your future practice

	planning technology integrated instruction	
	2. What is your favorite technology tool? Why?	5. Articulate your connections between pedagogical approach, technology integration decision-making process and specific experiences within our course.
	3. What other topics that you may wish to explore on a deeper level in the future about technology Integration?	6. Communicate a clear plan for managing and integrating technology resources to strengthen learners' critical thinking, problem solving and performance skills.

Appendix C

A List of Open Coding/Categories

Categories	Open coding
Tech should be limited	in-vivo ● I do not think it's necessary ● not let technology take over children's lives as it can be dangerous ● in some ways take away from hands on learning ● I believe it should be utilized, but not overdone. At this age, I believe children learn best with hands on activities. ● it can be distracting ● technology should not be necessary to communicate the main point of the lesson ● Technology should enhance not impede learning
Tech as efficient add-on	● technology can be used to support and supplement the classroom teachers and their instruction ● a positive addition to a lesson if utilized appropriate ○ technology can play an important role in the classroom if used correctly ○ Technology needs to be used with intention ○ tech must be used in moderation and available to all students ○ I believe that it can assist in learning but needs to be used correctly in moderation. ○ only it is adding to the learning ○ Students should only use technology for learning purposes ○ Technology can be very useful in teaching and assessing students but can also hinder the learning environment if not used correctly. ● to keep material connected to student lives out of school ● Technology is another alternative tool for teaching and active activities ● It's an assistive and integrative tool ● Technology benefits both instructors and students when

	implemented effectively ● made it very efficient for teachers to teach lessons, display students work, and collect data ● providing different ways for the information to be taught ● a time-saving way to present to student ● sharing documents with other colleagues ● help to analyze Ss answers faster ● look up ideas online ● to teach more efficiently while keeping the students interested ● to enhance the educational experience of student ○ It is a great resource to use in a variety of ways to enhance the learning experience. ○ It can be used to enhance learning for the students, make it more interactive and easier for students with special needs, and make the teachers life easier. ● serves as an additional mode of instruction ○ it is important for us to use this to teach different lesson to our students. ● provide extension activities to test for understanding ● Ss will need to be proficient in it ○ Students today are exposed to more technology than previous students. ○ get students familiar with finding resources by using technology ○ it's an important part to daily life that we should prepare out students for. ○ t's something that is very prevalent in society today, and why wouldn't it be implemented into school today if it's something that will be seen more and more in the future for kids in today's generation ○ we as educators should prepare our young citizens now by teaching some of the instruction in the classroom using technology. Young students will have the opportunity to learn how to utilize technology outside of the classroom and thus become proficient later in life. ● to grasp the attention of student ● Technology is a tool

	○ it is a good tool to have especially if you have students who are learning English as a second language or students with disabilities. ○ It can be a very helpful tool.
Tech for engaging and personalizing	● incorporate technology into our curriculum ● Technology allows for more styles of learning to be showcased in the classroom ● earning can be stimulated through a variety of medium ● benefits students with special needs greatly if used correctly ○ I must first recognize the use of assistive technology for students with special needs ● differentiate instruction based on the needs of individual student ● to enhance learning in the classroom ● can be engaging and interactive to teach concept ○ I believe that technology should be used in classroom for educational activities to help students understand the concepts. ● to streamline various activities in the classroom ○ We should try and incorporate this for the students, and they will like the variety of activities. ● teaching technological literacy ● a tool to enhance and enrich the curriculum (videos, academic iPad apps, projector ● to be used for specific purpose ● increasing parent-teacher communication ○ technology is also helpful for increasing parent-teacher communication (email, teacher websites, apps like Seesaw ○ Technology plays a huge role in communicating with other teachers and parents. ● take the instruction one step further ○ teachers can change up how students are required to demonstrate their understanding ● Support students teaching themselves ● meet students at their specific level ○ There is lots of room for personalization for the students

	○ I think technology is huge for any classroom. It can be used to enhance learning for the students, make it more interactive and easier for students with special needs, and make the teachers life easier. ○ I think technology plays an essential role in classrooms, especially in my special ed classrooms we use technology for pretty much everything. ○ Technology in everyday instruction, for assessment, and as AT devices benefits students with special needs greatly if used correctly.

Appendix D

An Overview of Lesson Plans Analysis

Note. Numbers in parentheses indicate frequency

	Emma	**Hailey**	**Jade**
Students' roles			
ISTE Standards for Students (ISTE, 2016)	Knowledge Constructor 3d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. (1) Creative Communicator 6a. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. (1) Global Collaborator 7a. Students use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways	Knowledge Constructor 3b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources. (2) 3d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.(2)	Empowered Learner 1b Students build networks and customize their learning environments in ways that support the learning process. (1) Knowledge Constructor 3b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources (1) Creative Communicator 6b Students create original works or responsibly repurpose or remix digital resources into new creations. (1) 6d Students publish or present content that customizes the message and medium for their intended audiences. (1)

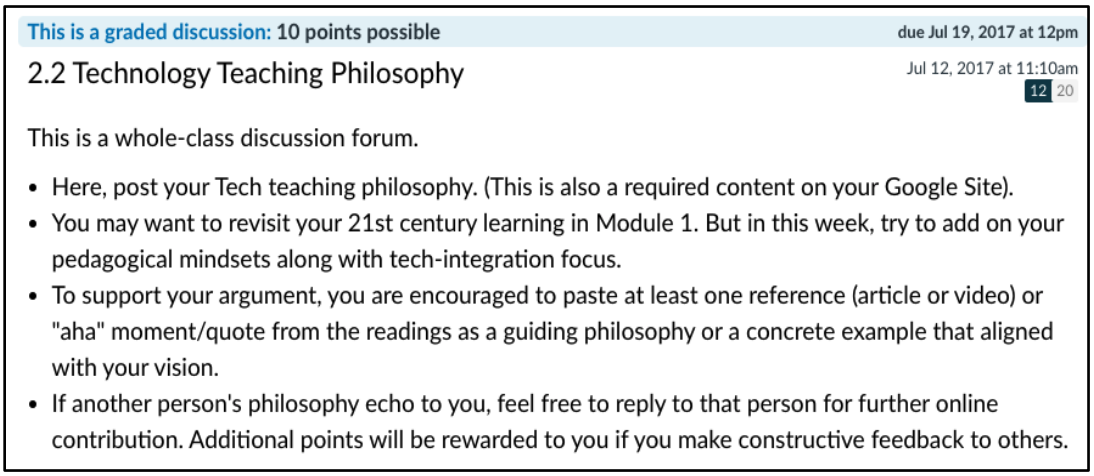
	that broaden mutual understanding and learning. (1)		
Directed, Constructivist, or BOTH Models (Roblyer & Hughes, 2018)	<u>BOTH + Constructivist</u> BOTH - TI to generate motivation to learn (1) BOTH - TI to optimize scarce personnel and material resources (1) C - TI to allow for multiple and distributed intelligences (1) C - TI to help build material models and increase knowledge transfer (1)	<u>BOTH + Constructivist</u> BOTH - TI to generate motivation to learn (1) C - TI to foster creative problem solving and metacognition (3)	<u>Constructivist</u> C - TI to allow for multiple and distributed intelligences (2) C- TI to foster group cooperation (1) C- TI to foster creative problem solving and metacognition (2) C- TI to help build material models and increase knowledge transfer (2)
Teachers' roles			
ISTE Standards for Educators (ISTE, 2018)	Collaborator 4c. Use collaborative tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and globally.(1)	Facilitator 6a. Foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings. (1) 6b. Manage the use of technology and student learning strategies in digital	Designer Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability. 5b Design authentic learning activities that align with content area standards and use

	Designer 5a. Use technology to create, adapt and personalize learning experiences that foster independent learning and accommodate learner differences and needs (1) Facilitator 6a. Foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings. (1)	platforms, virtual environments, hands-on makerspaces or in the field. (1) 6c. Create learning opportunities that challenge students to use a design process and computational thinking to innovate and solve problems. (1) 6d. Model and nurture creativity and creative expression to communicate ideas, knowledge or connections. (1)	digital tools and resources to maximize active, deep learning. (2)
Directed, Constructivist, or BOTH Models (Roblyer & Hughes, 2018)	<u>BOTH + Constructivist</u> BOTH - TI to generate motivation to learn (1) BOTH - TI to optimize scarce personnel and material resources (1) C - TI to help build material models and	<u>BOTH + Constructivist</u> BOTH - TI to generate motivation to learn (1) C - TI to foster creative problem solving and metacognition (3)	<u>BOTH + Constructivist</u> BOTH - TI to generate motivation to learn (1) BOTH- TI to optimize scarce personnel and material resources (1) C- TI to help build material models and increase knowledge transfer (2)

	increase knowledge transfer (2)		

Appendix E

Coursework Description – Technology Teaching Philosophy



This is a graded discussion: 10 points possible — due Jul 19, 2017 at 12pm

2.2 Technology Teaching Philosophy — Jul 12, 2017 at 11:10am

12 20

This is a whole-class discussion forum.

- Here, post your Tech teaching philosophy. (This is also a required content on your Google Site).
- You may want to revisit your 21st century learning in Module 1. But in this week, try to add on your pedagogical mindsets along with tech-integration focus.
- To support your argument, you are encouraged to paste at least one reference (article or video) or "aha" moment/quote from the readings as a guiding philosophy or a concrete example that aligned with your vision.
- If another person's philosophy echo to you, feel free to reply to that person for further online contribution. Additional points will be rewarded to you if you make constructive feedback to others.

Appendix F

Coursework Description – Digital Tool Exploration Assignments

Digital tools exploration (20 points)

Based on your own choice, you are requested to find a digital tool (i.e. an App, a website, an online community or a software) that can facilitate teaching and learning. Students will post one finding on their digital portfolio about their favorite app, website or technology tool and share their notes on its affordances (positive or negative), features, age/grade/subject (if any) for teaching/learning. You are going to share your findings during in-class discussion.

See Module 1, 2, 4 & 5 for this assignment.

Digital Tool A - 5 points

Digital Tool B - 5 points

Digital Tool C - 5 points

Digital Tool D - 5 points

Appendix G

Lesson Plans Activities

Emma, Lesson Plan

In this lesson students will create a video story to share about their favorite food with classmates and students around the world. To tell this story students will include basic facts about themselves (where they are from, hold old they are), their families (did someone in their family make this food?), and their customs (is this food served on a particular holiday?). After creating these videos with Skitch and Vidlab students will have the chance to share these videos over WeChat with students from across the world and reflect on how their stories about food were similar or different. This is intended to strengthen students' speaking and reflection skills, as well as familiarize students with a range of media platforms. This lesson helps students to develop a more integrated sense of self while simultaneously encouraging them to interact with other diverse perspectives.

Launch:

Students will view Buzzfeed video "School Lunches Around the World" https://www.youtube.com/watch?v=Po0O9tRXCyA

- Following the video teachers will facilitate a class discussion about different foods and cultures.
- Students will be asked to reflect on their own favorite food and tell the class a story about this food

Exploration:

During this time students will work to create drawings that represent themselves and their families, they will then turn these drawings into a short video using Skitch and Vidlab to share with the class and international partners.

Throughout this time teachers will work to scaffold learning and assist students. They will also engage with students pushing them to reflect on how this food interacts with their family, culture, and self. As much as possible teachers will help students build language to describe these ties in their videos.

By the end of this work time students will have a final product to share with the class and their international partners.

Closure:

Students will have the chance to view each other's' videos and international students videos.

Teachers will facilitate a discussion about food and culture, students will share their reflections from the day and their ideas about all the foods and stories they learned about that day.

Hailey, Lesson Plan

Early elementary students learn best when collaborating with peers, creating an open, exploratory environment to express ideas. By reading aloud the poem to the large group, then turning to "rooftop partners," students are given various opportunities to connect and share with their classmates. The independent practice of writing in their journals allows them to concentrate and deepen their thinking, demonstrating their thought process through writing and creating original illustrations to help share their idea. Closing as a large group again allows students to share what they have created, which is an important aspect of learning for many students--it adds importance to their work and builds pride in their learning.

Launch

- Anticipatory Set:

Display illustration of poem from "Where the Sidewalk Ends" on the SmartBoard, ask students what they notice about the picture/pattern of writing and what they think the poem might be about.

Remind Students of poetry elements by showing table of definitions and examples on SmartBoard, ask for and provide examples

Explore

- Direct Instruction:

Read poem, with illustration displayed on SmartBoard

Critical thinking questions: "What patterns do we notice in this poem?", "Does this poem remind you of other poems we have read in class?", "What does this poem make you think about?"

Review reasons why authors include poetry elements--ask if certain poetry elements that the author included make the poem more interesting/likeable; "I liked the regular beat, because it made it more fun to read out loud because I can clap my hands to it"

- Guided Practice (5 mins)

Students will turn to "rooftop partners" and share one thing they liked and one thing they did not like about the poem(s). They will be encouraged to share

something different than what their partner shares.

- Check for Understanding

Ring bell to signal the end of sharing--call on partner pairs to share one thing they talked about, and encourage other students to form connections by signing "same" or "connection"

- Independent Practice

Students will write a short (1-2 sentence) journal entry finishing the writing prompt "Something I liked/did not like about [poem title] was..." and depict their sentence with a picture in the provided box above their sentence(s).

Teachers will walk around room providing support for students who need help and reading/commenting on journals with statements and questions like, "Oh, I can see from your picture that you liked... I noticed that [____] also wrote about that!" and "You wrote about.... What details could you add to help show what else you thought?" Ask handful of students if they would like to share their sentences and pictures with the large group.

Closure

Return to large group, with selected students standing in front of the class. Go down line having students share their work. Ask class to think about similarities they heard from their classmates and connections that they noticed.

Write list of likes and dislikes shared by the class--have students look at the differences and make connections; relate common likes to other books they have read as a group and discuss what kinds of books we liked based on what they have in common.

Jade, Lesson Plan

Students will demonstrate understanding of the life cycle by creating their own visual representation and sharing it with the class.

Launch

- Teacher will ask students introductory questions on butterflies such as: can

anyone come up and draw a picture of a butterfly (draw butterfly on smart board). Raise your hand if you have ever seen a butterfly before. Where might you see a butterfly? What color of butterflies have you seen? How does it get to be a butterfly?

- As a class we will create a chart using Popplet and Thinglink to show what we already know about butterflies and what we want to know about butterflies.

Explore

- Read book
- Simulation video of life cycle of butterflies with interactive questions
- Write the life cycle of caterpillars to butterflies on the smart board with pictures and drawings
- Teacher create a infographic using PiktoChart to visually display the life cycle of butterflies to students, keeping it in the room as a resource/reminder

Closure

- Students will work in pairs to create their own life cycles using the app Moma Art Lab on an iPad where they can draw the life cycle
- Students will then share their life cycle with the class on the smartboard

Appendix H

Lesson Plan Analysis with Analytic Rubric Descriptions

Lesson Plan Analysis on Emma's Lesson Activities

Ss use	ISTE-students	*Directed, Constructivist, or Both Models*	T use	ISTE-educators	*Directed, Constructivist, or Both Models*
Students will view Buzzfeed video "School Lunches Around the World" Students will be asked to reflect on their own favorite food and tell the class a story about this food	3d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.	BOTH - TI to generate motivation to learn BOTH - TI to optimize scarce personnel and material resources	Students will view Buzzfeed video "School Lunches Around the World" Following the video teachers will facilitate a class discussion about different foods and cultures.	6a. Foster a culture where students take ownership of their learning goals and outcomes in both independent and group settings.	BOTH - TI to generate motivation to learn BOTH - TI to optimize scarce personnel and material resources
students will work to create drawings that represent themselves and their families,	6a. Students choose the appropriate platforms and tools for meeting the desired objectives	C - TI to allow for multiple and distributed intelligences	teachers will work to scaffold learning and assist students. They will also engage with	5a. Use technology to create, adapt and personalize learning experiences that foster independen	C - TI to help build material models and increase knowledge transfer

they will then turn these drawings into a short video using Skitch and Vidlab to share with the class and internationa l partners.	of their creation or communica tion.		students pushing them to reflect on how this food interacts with their family, culture, and self. As much as possible teachers will help students build language to describe these ties in their videos.	t learning and accommod ate learner differences and needs.	
Students will have the chance to view each other's videos and internationa l students' videos. students will share their reflections from the day and their ideas about all	7a. Students use digital tools to connect with learners from a variety of background s and cultures, engaging with them in ways that broaden mutual understandi	C - TI to help build material models and increase knowledge transfer	Students will have the chance to view each other's videos and internationa l students' videos. Teachers will facilitate a discussion about food and culture	4c. Use collaborativ e tools to expand students' authentic, real-world learning experiences by engaging virtually with experts, teams and students, locally and globally.	C - TI to help build material models and increase knowledge transfer

the foods and stories they learned about that day.	ng and learning.				

Lesson Plan Analysis on Hailey's Lesson Activities

Ss use	ISTE-students	*Directed, Constructivist, or Both Models*	T use	ISTE-educators	*Directed, Constructivist, or Both Models*
Display illustration of poem from "Where the Sidewalk Ends" on the SmartBoard, ask students what they notice about the picture/pattern of writing and what they think the poem might be about.	3b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.	BOTH - TI to generate motivation to learn	Display illustration of poem from "Where the Sidewalk Ends" on the SmartBoard, ask students what they notice about the picture/pattern of writing and what they think the poem might be about.	6b Manage the use of technology and student learning strategies in digital platforms, virtual environments, hands-on makerspaces or in the field.	BOTH - TI to generate motivation to learn
Remind students of poetry elements by showing table of	3d. Students build knowledge by actively	C - TI to foster creative problem solving and metacognition	Remind students of poetry elements by showing table of	6a Foster a culture where students	C - TI to foster creative problem solving

definitions and examples on SmartBoard, ask for and provide examples	exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.		definitions and examples on SmartBoard, ask for and provide examples.	take ownership of their learning goals and outcomes in both independent and group settings.	and metacognition
Review reasons why authors include poetry elements--ask if certain poetry elements that the author included make the poem more interesting/likeable	3b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.	C - TI to foster creative problem solving and metacognition	Read poem, with illustration displayed on SmartBoard. Critical thinking questions: "What patterns do we notice in this poem?" Does this poem remind you of other poems we have read in class?", "What does this poem make you think about?"	6c Create learning opportunities that challenge students to use a design process and computational thinking to innovate and solve problems.	C - TI to foster creative problem solving and metacognition
Write list of likes and	3d. Students	C - TI to foster creative	Write list of likes and	6d	C - TI to foster

dislikes shared by the class on SmartBoard--have students look at the differences and make connections; relate common likes to other books they have read as a group and discuss what kinds of books we liked based on what they have in common.	build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.	problem solving and metacognition	dislikes shared by the class on SmartBoard--have students look at the differences and make connections; relate common likes to other books they have read as a group and discuss what kinds of books we liked based on what they have in common.	Model and nurture creativity and creative expression to communicate ideas, knowledge or connections.	creative problem solving and metacognition

Lesson Plan Analysis on Jade's Lesson Activities

Ss use	ISTE-students	Directed, Constructivist, or Both Models	T use	ISTE-educators	Directed, Constructivist, or Both Models
- As a class we will create a chart using Popplet and Thinglink to show what we already know about butterflies	1b Students build networks and customize their	C- TI to help build material models and increase knowledge transfer	- Simulation video of life cycle of butterflies with interactive questions	5b Design authentic learning activities that align with content	BOTH - TI to generate motivation to learn

and what we want to know about butterflies.	learning environments in ways that support the learning process.			area standards and use digital tools and resources to maximize active, deep learning.	
- we will draw the life cycle on the SmartBoard and have the students fill in the missing parts.	1c Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.	C- - TI to foster creative problem solving and metacognition C- TI to help build material models and increase knowledge transfer	- we will draw the life cycle on the SmartBoard and have the students fill in the missing parts.	6b. Manage the use of technology and student learning strategies in digital platforms, virtual environments, hands-on makerspaces or in the field.	C- TI to help build material models and increase knowledge transfer
Students will work in pairs to create their own life cycles using an the app Moma Art Lab on an ipad where they can	6b Students create original works or responsibly repurpose or remix digital resources	C - TI to allow for multiple and distributed intelligences C- TI to foster group cooperation	-Teacher create a infographic using PiktoChart to visually display the life cycle of butterflies to students,	5b Design authentic learning activities that align with content area standards	C- TI to help build material models and increase knowledge transfer B- TI to optimize

draw the life cycle	into new creations.	C- - TI to foster creative problem solving and metacognition	keeping it in the room as a resource/reminder	and use digital tools and resources to maximize active, deep learning.	scarce personnel and material resources
Students will then share their life cycle with the class on the smartboard	6d Students publish or present content that customizes the message and medium for their intended audiences.	C - TI to allow for multiple and distributed intelligences			