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A Mixed Methods Comparison of the First Principles of Instruction in Flipped and Face-to-Face Technology Integration Courses

Jacob Hall
Syracuse University

Abstract

This dissertation examines the impact of the First Principles of Instruction (FPI) model when applied to face-to-face (F2F) and flipped technology integration courses. Through this investigation, I demonstrate how the FPI inform the design of problem-centered environments, their impact on participants' technological, pedagogical, content knowledge (TPACK), and the essential aspects of experiencing these FPI-based courses. Using an embedded quasi-experimental mixed methods design, the quantitative analyses of pre- and post- TPACK outcomes were examined and related to the interventions' mechanisms via the descriptive phenomenological analysis of participants' course learning experiences. Participants were 32 preservice teachers enrolled in the second of three required technology integration courses during the 2017 spring and fall semesters. Data included surveys, technology-integrated lesson designs, prompted course reflections, and semi-structured interviews.

In the flipped group, preservice teachers' self-perceptions of TK, PK, TCK, TPK, and TPACK statistically significantly increased and had large effect sizes. Except for TK, the F2F group's self-perceptions of all TPACK domains statistically significantly increased with medium to large effect sizes. The non-significant growth in the F2F group's TK, an unexpected outcome of a technology integration course, was illuminated by the qualitative analysis. Participants' experiences unique to the flipped section indicated that exposure to new technologies prior to the physical class contributed to their increased perception of TK. As for application of TPACK to technology-integrated lesson designs, both groups demonstrated statistically significant growth with large effect sizes (F2F $p = .000$, $d = 1.17$; Flipped[a] $p = .000$, $d = 1.97$). The magnitude of the results strongly demonstrates the FPI's positive impact on TPACK-related learning outcomes in the F2F and flipped courses. Further analysis revealed no statistically significant differences

between groups' perceptions and application of TPACK. These non-significant differences suggest the FPI were equally effective when applied to designing flipped and F2F courses.

The phenomenological analyses revealed that the participants experienced technology integration often in class and noted the importance of purposefully selecting and using technologies. Participants described learning new technologies in the course as proceeding from practicing technological skills to evaluating digital tools' potential for future integration. While iterative component tasks were experienced by some as redundant, participants valued the problem progression corollary's task variation and scaffolded nature for focusing their learning and keeping them confident when challenged. Experiencing incongruous moments between design and implementation prompted participants' contemplations of persisting barriers to technology integration and appraisals of in-class experiences as designed for the ideal. The FPI-based elements experienced by participants, when viewed through the perspective of constructionism, facilitated preservice teachers' TPACK construction as they designed and shared tangible artifacts with an authentic audience. The study's implications endeavor to inform future approaches to technology integration preparation, directions for FPI-based research and design, and the development of TPACK measures.

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By

Jacob A. Hall

B.S. University of Central Florida, 2008
M.A. Teachers College, Columbia University, 2012

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Chapter 1: Introduction

Background

How do we begin to educate learners whose world of information is predicted to double every twelve hours (Coles, Cox, Mackey, & Richardson, 2006)? Consider the technological world this year's incoming college class has always lived. Television programs have been viewable on their schedule, eBay has always existed, texting has eclipsed e-mail, books have been available as audio files, and Bluetooth technology has kept them unattached yet in synch with their world (Beloit College, 2016). It is overwhelming to consider how different the world will be when today's kindergartners are college freshman. Gardner and Davis (2014) referred to the current generation as the "app" generation; young people who immerse themselves in apps and think of life as one overarching app. The dichotomy of app-dependent and app-enabled offers two perspectives on the merits of embodying this moniker. Their work encourages one to consider how to promote a technologically-enabled learner. Teachers have been tasked with this weighty responsibility (Office of Educational Technology, 2016). It takes the form of technology standards for students and teachers, over 100 mentions of technology skills in the Common Core standards, and popular frameworks such as 21st Century Learning (International Society for Technology in Education, 2008; Office of Educational Technology, 2016; Partnership for 21st Century Learning, 2015). All this beckons the teachers of today to prepare the leaders of tomorrow through the effective integration of technology.

Statement of the Problem

Unfortunately, a failure to prepare teachers to effectively integrate technology was one of the key charges from the recently published National Educational Technology Plan (NETP) (Office of Educational Technology, 2016). It points to the critical need for better preparation to teach with technology and to select engaging and appropriate content (Rogers, 2016). The plan also discusses a shift in attention from the digital divide to the digital use divide. This refers to a shift in focus from gaining digital access to leveraging the tools afforded to teachers and students (Herold & Doran, 2016). Leaders should turn their attention to helping teachers and students make the best use of the digital devices available and to leverage their potential for learning and instruction.

The relationship between teachers and technology, however, is not as straightforward as it may seem but rather is influenced by many factors. Self-efficacy (Banas & York, 2014; R. J. Chen, 2010), digital competence (Lei, 2009), attitudes toward technology (Cullen & Greene, 2011; Koszalka, 2001), resistance to change (Keengwe, Onchwari, & Wachira, 2008), accessibility of technology and support (Gray, Thomas, & Lewis, 2010), and pedagogical beliefs and epistemology (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; C. Kim, Kim, Lee, Spector, & DeMeester, 2013) have been established as critical factors related to technology integration (Basak & Govender, 2015). Teacher preparation programs need to account for these factors when working with preservice teachers and preparing them for the K-12 environment.

Further complicating this relationship are erroneous yet persistent assumptions about technology's role in schools. Some have viewed teachers and technology as having a hierarchical relationship rather than a complementary one, and this has led to mistaken beliefs that technology can supersede teachers (Zhao, Zhang, Lei, & Qiu, 2016). Amidst admonitions that technology should not be seen as a magical wrench to fix education and countless media comparison studies supporting the pivotal nature of instruction (Kozma, 1994; Shrock, 1994; Tennyson, 1994), educational technology purchases are now measured in billions of dollars and are rising (Catalano, 2015; Schaffhauser, 2015).

Confounding assumptions of technology's instructional supremacy are school district's emergent technology purchases that regularly create a need for teachers to design their own resources and activities for the technology to be integrated purposefully (Laurillard, 2012; Svihla, Reeve, Sagy, & Kali, 2015). In fact, the adoption of widespread technological plans, such as one-to-one initiatives, flipped classrooms, and mobile learning have displayed unanticipated negative consequences such as reduced cognitive capacity (A. F. Ward, Duke, Gneezy, & Bos, 2017), fear of students' reliance on technology (Lei & Zhao, 2008), and the overuse of video lectures (Cargile & Karkness, 2015). More than ever, teachers need the knowledge and skills to judiciously determine whether digital technologies should be integrated into their instruction and if so, how to most effectively design such instruction.

Corresponding with broader technological availability and the near ubiquity of cloud computing, K-12 has begun to increasingly adopt various blended learning models (Cole, 2016). Blended instruction is the integration of face-to-face and online pedagogical approaches that merge the affordances of technology- and instructor-mediated environments (J. Lee, Lim, & Kim, 2017; Margulieux, McCracken, & Catrambone, 2016). The rise of technology companies supporting blended models (Hill, 2013; Smith & Mader, 2015; Tech Learning, 2014) and the New Media Consortium's (NMC) predictions that blended learning will highly impact postsecondary and K-12 education (Johnson, Adams Becker, Estrada, & Freeman, 2015b, 2015a) indicate a fresh and likely persisting area of technology integration development for preservice teachers.

Although blending and online learning have risen dramatically, these models remain a novelty to preservice teachers as they have not experienced them as a student nor taught using blended pedagogies (Gemin, Pape, Vashaw, & Watson, 2015; Marks, 2015; Oliver & Stallings, 2014). Moreover, Hao and Lee (2016) observed that preservice teachers displayed comparatively low levels of technological pedagogical knowledge in unfamiliar teaching models. Lack of teaching experience and technology integration practice for preservice teachers remain two areas of concern (K. S. Lee, 2014).

The NETP further highlights the need for teacher preparation programs to focus on developing preservice teachers for blended environments and improving their technology integration effectiveness. Programs are now being asked to develop preservice teacher's online pedagogies in addition to the traditionally developed face to face pedagogies (Office of Educational Technology, 2016). The rapid increase of blended learning models, prior gaps in the preparation of teachers to integrate technology, and a changing K-12 composition supply multiple rationales for exploring how to better develop preservice teachers technology integration knowledge (Archambault & Kennedy, 2014; Center for Digital Education, 2016). A reconsideration of how teachers are prepared may be needed to match this dramatic shift.

Rationale for Flipping Instruction in Teacher Preparation

One proposed method for preparing preservice teachers to plan effective, efficient, and engaging technology-integrated lessons is to model technology integration through the flipped classroom approach (Hao & Lee, 2016; Vaughan, 2014). This approach is a category of blended instruction and has been defined as a model of instruction that presents self-paced instruction to the learner online before the physical class meeting (Margulieux, McCracken, & Catrambone, 2016). This online instruction replaces the lecture, and face to face class time is spent applying concepts collaboratively in an active learning environment (Flipped Learning Network, 2014).

A flipped classroom may provide more in depth authentic learning experiences and effective modeling of technology integration through the use of emerging technology to reallocate the time and space of learning activities (Lage, Platt, & Treglia, 2000; Marks, 2015). While the flipped approach cannot address all barriers traditionally experienced by preservice teachers related to technology integration, Hao and Lee propose that having preservice teachers experience additional teaching models, such as flipped instruction, would allow for them to build mental models for future pedagogical development (2016). Furthermore, authentic learning experiences with technology, such as learning by design, may increase preservice teachers' technology, pedagogical, and content knowledge (TPACK) (Banas & York, 2014; Johnson, 2012; Koehler & Mishra, 2009). Since the flipped approach moves information delivery to the online space, more time can be allocated for these learning activities that have proven effective in the past. This restructuring may enhance the authentic learning experience by allocating more class time to these activities, and the modeling of technology integration can now occur in both the physical and virtual spaces (Vaughan, 2014).

Although modeling technology integration has been used in face to face teacher preparation (Brenner & Brill, 2016; Lu & Lei, 2012; West & Graham, 2007), modeling online or blended pedagogies has yet to become commonplace (Hao & Lee, 2016). Modeling has typically been relegated to the face to face classroom in teacher preparation, but this modeling may not be adequate for the changing landscape of K-12 education, given the rise in blended learning (Office of Educational Technology, 2016). Vaughan states, "The flipped classroom creates alignment between what the teacher educator models and what the teacher educator expects preservice teachers to be able to do (2014, p. 28)." Thus, modeling via a flipped approach can better prepare preservice teachers by demonstrating effective technology integration in multiple environments (Hao & Lee, 2016).

While flipped models have risen in K-12 contexts and may be an effective approach for preservice teachers' technology integration development, research has revealed gaps in the pedagogical integrity or the model, inadequate empirical support (O'Flaherty & Phillips, 2015), and a lack of theoretical foundation for flipped instruction (Abeysekera & Dawson, 2015; M. K. Kim, Kim, Khera, & Getman, 2014). There have been a dearth of studies that investigated robust educational outcomes such as critical thinking and problem solving (O'Flaherty & Phillips, 2015), and within teacher preparation, there are limited studies investigating a flipped approach.

This study addresses this gap by applying an instructional design model, the First Principles of Instruction (FPI; Merrill, 2002), to a face-to-face (F2F) and flipped technology integration course for preservice teachers. While the FPI, discussed in the next section, have been posited as promoting learning in both flipped and F2F environments, this premise has not been adequately tested. The study, therefore, will inform the flipped course designs, application of the FPI, and technology integration development of preservice teachers.

Theoretical Framework

Digital technologies have introduced extensive and rapid change (Beloit College, 2016; Coles et al., 2006). In the past, there was consistency to how digital technologies were evolving, but even the era of predictable change in technology is forecast to end ("After Moore's Law: The future of computing," 2016). The FPI, grounded in decades of prior research in learning and instruction, claim to still promote learning in emerging environments such as flipped, blended and online settings (Merrill, 2012). While the flipped approach may be different than how the principles were implemented upon their initial conceptualization, this should not dilute their effectiveness. Rather the first principles should provide a sound theoretical basis for a flipped strategy that is often oversold, misunderstood, poorly delivered, and ill-defined (Bull, Ferster, & Kjellstrom, 2012; Hoffman, 2014; O'Flaherty & Phillips, 2015).

As this study aims to compare face-to-face (F2F) and flipped course sections designed according to the FPI, it is vital to discuss the FPI and their theoretical foundation. Merrill developed the FPI through a synthesis of instructional design models and theories. The principles and their corollaries stem from what Merrill claimed to be components of all the theories and models he analyzed. His premise, therefore, is that the overlap indicates principles of effective and engaging instruction regardless of context, approach, or audience. It is this premise, and the model itself, that this study seeks to further examine.

The following were highlighted in Merrill's seminal article as being representative of the FPI: Star Legacy (Schwartz, Lin, Brophy, & Bransford, 1999), 4-MAT (McCarthy, 2000), Instructional Episode (Andre, 1997), Collaborative Problem Solving (L. M. Nelson, 1999), Constructivist Learning Environments (Jonassen, 1999), Four Component Instructional Design Model (4C-ID; Merriënboer, Clark, & Croock, 2002), and Learning by Doing (Schank, Berman, & Macpherson, 1999). These conceptual frameworks, although related to the two theories discussed in the next paragraphs, will not be used as the theoretical framework for this study. First, several of these are not theories but instructional design models (e.g. 4C-ID and 4-MAT). Secondly, this study will attempt to root itself in theoretical perspectives that have informed the work of the scholars Merrill cited and their contemporaries. Finally, the grounding in expectancy value theory and the theory of constructionism seeks to clarify the study's intent and the intervention design's assumptions.

Expectancy-value theory. Researchers in a variety of disciplines have used expectancy-value theory (EVT) as a basis for designing interventions, examining and predicting behaviors, and exploring interactions in courses (Foley, 2011; Guo, Marsh, Parker, Morin, & Dicke, 2017; Myrold & Ullrich-French, 2017; Picciano, 2002). EVT, also referred to as simply expectancy theory (Vroom, 1964) or social learning theory (Keller, 1983), is a theory of human motivation that has informed the field of instructional design and grouned motivational design models and guidelines (Keller, 1987).

EVT posits that the effort a learner will ultimately exert depends on their perception of the expectancy of success and value they assign. There is additional discussion in the literature about the interaction between expectancy and value, whether it is absent, additive, or multiplicative, but this study will not focus on the nature of this relationship (Nagengast et al., 2011). Critical to this study though, are definitions for the essential components of EVT.

Hancock (2001) defined expectancy as “an individual's subjective estimation of the likelihood of successfully performing a particular behavior (p. 285).” There may be many factors considered by an individual when estimating their likelihood of success, and some of these factors can be attended within the instruction. For example, the problem progression corollary in the FPI attempts to promote an individual’s perception of success by presenting an appropriately challanging task via a scaffolded approach.

While value has been viewed as a multi-faceted construct, this study and the intervention design will emphasize intrinsic value and utility value. Intrinsic value, identified as a robust predictor of engagement, refers to the magnitude an individual enjoys performing the task or activity based soley on the nature of the activity (Guo et al., 2017). Guo et al. define utility value as the perception of “how useful a task is for facilitating an individual's long-range goals and helping an individual obtain long-range external rewards (2017, p. 83).” The FPI’s guidelines seek to promote utility value via the problem-centered and integration principles. This principle situates the learning within an authentic setting, promotes learners' integration of skills in a real-life scenario, and challenges them to reflect on how they might further apply the learning. The theory of construnctionism offers an additional perspective on how people learn that informs how the FPI were applied to the course designs to promote expectancy, value, and learning.

Theory of constructionism. Evolving from and building upon previous ideas such as Piaget's and Vygotsky's constructivism and Dewey's learning by doing, Papert and colleagues proposed a theory of learning that stressed the construction of knowledge while simultaneously constructing a tangible artifact (Dewey, 1923; Papert & Harel, 1991). In its simplest form, Papert states that theory of constructionsim can be thought of as "learning by making" (1991, p. 7). In his article introducing this theory of learning, he playfully distinguishes between constructionism and the preceding and closely related constructivism.

> Constructionism--the N word as opposed to the V word--shares constructivism's connotation of learning as "building knowledge structures" irrespective of the circumstances of the learning. It then adds the idea that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sand castle on the beach or a theory of the universe (Papert & Harel, 1991, p. 1).

There are several ideas to highlight in this sentence that differentiate the two theories of learning. First, the cognitive foundation of both constructivism and constructionism are evident in the phrase "building of knowledge structures." The emphasis in both, though, is seen not as reception, storage, transmission, and retrieval but rather learning through negotiation, sharing, and construction (E. Lee & Hannafin, 2016). Constructionism furthers this through its addition that learning also occurs through the design process of a tangible artifact and sharing the artifact with the public.

In their use of constructionism to frame their guidelines for student-centered learning environments, Hannafin and Lee wrote of several activities that can provide rich contexts for learning such as teaching and designing lessons or programming and building (2016). While computers or digital activities are often assumed to be necessary for a constructionist environment, Papert counters this idea by detailing two non-digital examples of constructionist learning: soap carving and knot tying (1991). Based on the belief that the process of designing and constructing are critical to learning and that the external product is a representation of the cognitive negotiation, constructionism theorists would support the idea the reflection and iterative design promote further learning. The FPI's problem progression corollary and the way it was applied to a learning by design strategy in this course are supportive of this view of learning.

Aligning with expectancy-value theorists' prioritization of affect, the theory of constructionism stresses that learning should be personally meaningful. In other words, the learner should see the value of the learning experience. The process of making, constructionism theorists posit, is how learning can be meaningful. Papert descriptively recounts an observation of a meaningful experience of learning by making, "And because they were making something, they could mobilize their whole person: their aesthetic sense, their sense of a meaningful project, their sense of it being related to who they were as individuals and what their most important values were (Papert, 1988, p. 14)." This observation mentions several ways learners perceive *making* as a meaningful experience: aesthetically, related to personal values, and the task itself.

Papert's language in the above quote mirrors EVT's intrinsic value and utility value. "Sense of a meaningful project" seems to indicate a project that learners would intrinsically value for the process and the experience. Secondly, "sense of it being related to…their most important values" would align with EVT's utility value. This is not to say however, that all projects or constructions of artifacts will be perceived to have intrinsic or utility value. Rather, the design of the learning environment should consider these components when identifying a complex problem and facilitating learners' constructions of knowledge and artifacts.

The theory of constructionism advocates the use of a complex problem that learners engage through the construction of a personally meaningful and tangible product. Through this process, learners may invest personally and construct knowledge. The FPI support these environments through the activation of prior experiences, the problem-centered principle, sharing and working with peers, and the integration of knowledge into authentic settings.

Applying the theoretically grounded design guidelines. There has been a call for additional direct empirical support of the principles (S. Lee & Koszalka, 2016; Tiruneh et al., 2016). Specifically, scholars noted that additional research is needed to test the application of the FPI in situated and varied disciplines and to incorporate emerging learning environments (e.g., online, blended, flipped) (Cheung & Hew, 2015). What has been done empirically thus far has substantiated Merrill's claim that the integration of these principles have significant impacts on learning (Frick, Chadha, Watson, & Zlatkovska, 2010). To test Merrill's claim that these principles are equally effective in emerging learning environments as they are in face to face instruction, course sections in this study were designed by applying the FPI to both face to face and flipped versions.

Although the design of the F2F and flipped course sections in this study were informed primarily by the FPI, Bloom's Revised Taxonomy (BRT) of learning also helped frame the learning outcomes (Flipped Learning Network, 2014; Krathwohl, 2002). In the remainder of this paper, the Flipped Model will refer to a course delivered via a flipped pedagogical approach that was designed using Merrill's FPI and guided by BRT.

As demonstrated in the flipped model of instruction shown in Figure 6, the first two phases of Merrill's Principles of Instruction in the Flipped Model of instruction primarily occur online during the time prior to the physical class meeting. Activities and learning outcomes are focused at the initial domains of Bloom's Taxonomy of learning. The goal is for preservice teachers to arrive at class with foundational knowledge of the content. During class, active learning and scaffolded, collaborative activities guide students during the application and integration phases of instruction that are focused on the higher order thinking levels of the taxonomy. All of these phases of instruction within the flipped framework are couched within a problem-centered approach that Merrill describes as making the learning more authentic, efficient, engaging, and effective (Merrill, 2002). Additional details for how both sections of the course were designed are provided in Chapter 3.

Purpose of the Study

This mixed methods study compared the design and implementation of a flipped and F2F technology integration course in a teacher preparation program. An embedded mixed method design was used. This design utilized quantitative and qualitative data with one data set serving a secondary and supportive role to the other. The primary purpose of this study used the Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT) and the Technology Integration Assessment Rubric (TIAR) to test the FPI's impact on preservice teachers' technological, pedagogical, content knowledge (TPACK) in two course settings, flipped and F2F (Hofer & Grandgenett, 2012; Merrill, 2002; Schmidt et al., 2009). The FPI predict that the problem-centered, activation, demonstration, application, and integration principles will positively influence learning for preservice teachers in both F2F and flipped courses.

The secondary purpose was to gather qualitative interviews and reflections on learning experiences to explain how preservice teachers interacted with course elements and to detail how they described their learning in the two different course settings. The reason for collecting the qualitative data was to inform the primary research question by explaining how participants interacted with the principles of instruction in both course versions and by expanding upon the outcomes of the primary question.

Research Questions

1. Does a flipped course based on the First Principles of Instruction impact preservice teachers' differently than a face-to-face course?
    a. How do preservice teachers' self-perceptions of TPACK understandings compare between the flipped and face-to-face course sections?
    b. How do preservice teachers' application of TPACK compare between the flipped and face-to-face course sections?
2. How do preservice teachers experience face-to-face and flipped technology integration courses designed according to the First Principles of Instruction?
3. How do the preservice experiences with the FPI explain their self-perceptions and application of TPACK?

Chapter 2: Literature Review

The purpose of this dissertation was to compare the impact of the First Principles of Instruction (FPI) when applied to face-to-face (F2F) and flipped course sections. This study took place in the context of teacher preparation. The context for the study was selected for two primary reasons. Primarily, as the literature review will demonstrate, a flipped approach has been shown to have potential for improving learning, and secondarily, the researcher had access to the population and to designing the course in a flipped format. This literature review will synthesize the need to examine the flipped approach, gaps in preservice teacher preparation, and why the First Principles of Instruction (FPI) are precisely suited for designing this intervention.

This literature review is organized into three main sections: (1) technology integration development in teacher preparation, (2) frameworks for flipped instruction (3) and the theoretical foundation for this study. The first section sets the stage for the context of the study, technology integration development in teacher preparation. It details the history of technology integration development in teacher preparation by looking at influential models for technology integration. This section also analyzes past interventions to identify their strengths, limitations and key findings. Finally, critical factors of technology integration are examined to identify current barriers in this context. These barriers and research gaps help to situate the current study in the context of teacher preparation.

The second section synthesizes the literature surrounding flipped instruction. This section outlines its history and theoretical foundations and sifts through the many variations of “flipped” in the literature to operationalize this design. Next, research on flipped approaches in higher education and K-12 will be amalgamated, with a concentration on flipped designs in teacher preparation. To conclude the three sections, research on current design principles for flipped instruction are dissected. This concluding subsection highlights the importance of this study as it exposes the need for the integration of empirically substantiated instructional design principles in flipped course designs.

Finally, the remaining section analyzes the instructional design model underlying the design of the courses in this study. Merrill's FPI were selected for their strong support in the literature, well validated principles, and wide applicability. The literature review synthesizes prior research on these principles and discusses their connection to teacher preparation. This section also evaluates the literature tying Merrill's first principles to flipped instruction to identify their potential application to this pedagogical approach.

Technology Integration Preparation for Preservice Teachers

Technology integration preparation in TED has evolved over time due to novel approaches (Dorner & Kumar, 2016), research into best practices (Bakir, 2016), and in response to changing needs in the K-12 environment (Christensen, Horn, & Staker, 2013). In response to the K-12 growth in online and blended courses, research in teacher preparation has extended to possible methods for developing pre- and in-service teachers' knowledge of online and blended instructional design principles (Hao & Lee, 2016; Shepherd, Bolliger, Dousay, & Persichitte, 2016). These new teacher preparation methods would also need to account for barriers such as preservice teachers' tendency to disregard teaching models considered unfamiliar (K. S. Lee, 2014; Lu & Lei, 2012) and the lack of knowledge reinforcement found in placement experiences (Whitacre & Peña, 2011). The rest of this section will examine literature related to the evolution of technology integration preparation in TED, models of technology integration, critical factors to consider, and gaps in the research.

A brief history of technology integration preparation. The first instances of technology training for preservice teachers date back to the early 1900s with the introduction of visual instruction (Betrus, Molenda, & Saettler, 2002). A visual instruction course offered in 1918 at the University of Minnesota was the first technology integration course offered for official credit. An entire movement toward audiovisual instruction ensued shortly after. Syracuse University, Don Ely and the Department of Visual Instruction were significant forces in this arena (Ely, 1998). By the 1960s, IDT had its archetypal form of an educational technology course. This format is still seen as a template today in some of the "classic" introductory courses. There was an "emphasis on the skills of utilization, selection, operation, evaluation, and production of audio and visual materials (Betrus et al., 2002, p. 19)." Note, however, that these courses were primarily informed by theories of communication and systems theory, not instructional design theory or theories of learning.

Since the mid-1900s, there have also been various external factors and practices that have shaped technology integration courses (Bakir, 2016). Federal initiatives, national education technology plans, funding initiatives, technology standards, and business collaborations have all played a part (International Society for Technology in Education, 2008; National Center for Education Statistics, 2003; Office of Educational Technology, 2016; Rowley, Dysard, & Arnold, 2005). Much of their role has been to emphasize the growing need for more and better technology preparation for preservice teachers (Johnson et al., 2015b). Unfortunately, this increased emphasis has not resulted in adequately prepared educators (Office of Educational Technology, 2016).

Our current system’s topics for preparing preservice teachers was most influenced by the dawn of the information age in the 1980s and 1990s (Betrus et al., 2002). This, of course, also marked the period of individual access to the microcomputer and its increased availability in schools. At the turn of the millennia, there were primarily two groups of educational technology courses; one focused on the breadth of digital tools, and the other focused solely on the microcomputer. Most were developed after the microcomputer boom and thus were focused entirely on how teachers' development of computer skills. The courses that preceded the microcomputers spread their focus to skills across digital technologies; they did not abandon visual and audiovisual components.

In the early part of the new millennia, the field began to consider more closely what knowledge preservice teachers need to think critically about technology integration as opposed to teaching primarily about the digital devices. This framework theorized that the integration of technological, pedagogical, and content knowledge (TPACK) were all needed for effective integration; any of these in isolation was insufficient (Mishra & Koehler, 2006). Although additional research is needed, TPACK has shown great promise in helping to rethink what the learning outcomes should frame technology integration courses (Hwee & Koh, 2013).

A survey conducted at the turn of the century revealed that a majority of course topics were still focused on technological skills. Instructional design was seen in 60% of courses, and technology integration was taught in 72% (Betrus et al., 2002). This survey, however, pre-dated the TPACK framework (Koehler & Mishra, 2009). A technocentric focused curriculum was evidenced via 80% of deans responding that technology skills were taught as a standalone in a course separate from methods courses (Betrus et al., 2002).

A more recent look at the trends in technology integration preparation presents a dynamic era in terms of course topics. 15/31 topics mentioned by survey respondents in 2010 were not present in the 2002 responses (Betrus, 2012). These new devices and technological skills encountered in the responses may yet be the tip of the dynamic nature of this field. The author further predicted that he expects mobile devices such as tablets and touch screen, hand-held devices to be a more common response found on the 2020 survey. Given the vantage point of over halfway to the 2020 survey, it is likely to be an accurate prediction (Cavanaugh, Maor, & McCarthy, 2014; Dolan, 2016).

A limitation to many of the conclusions drawn in this analysis of instructional technology in teacher preparation was both the small number of respondents and the 65% decrease in number of respondents between the first and second iterations (Betrus, 2012; Betrus et al., 2002). Further limiting these studies, was that the author did not report how many of the instructors responded. The design of the study was for the deans to point the researchers to the instructors, and the instructors would complete the survey. This limitation was most noticeable in key numbers highlighted by the author. An example is that the median number of years of experience rose from 5 to 10. It could be that given the small number of respondents, those with more years of experience tended to respond. Other notable numbers were a 19% decrease in the use of textbooks and a 24% increase in compiled electronic materials. Again, given that the respondents to this survey had double the years of experience than the previous iteration, this number could be representative of those with greater degrees of teaching experience and not programs as a whole. Those with greater teaching experience may not rely as much on a textbook and may feel they have compiled a more effective set of electronic materials.

These limitations, however, are lessened when considering the nearly doubled number of topics covered in these introductory courses. Given a small number of respondents, it would be anticipated that the diversity of topics would not be as great, yet, it provides evidence for the vastly changing face of topics covered in technology integration courses in teacher education over the last decade. Looking at reports from professionals who analyze these trends annually (Johnson et al., 2015b), one could argue that this pattern will continue or perhaps escalate.

Makerspaces, online learning, blended learning, tablets, cell phones, and collaborative authoring may all see a significant increase in the next survey (Cavanaugh et al., 2014; Horn & Staker, 2011; Roffey, Sverko, & Therien, 2016).

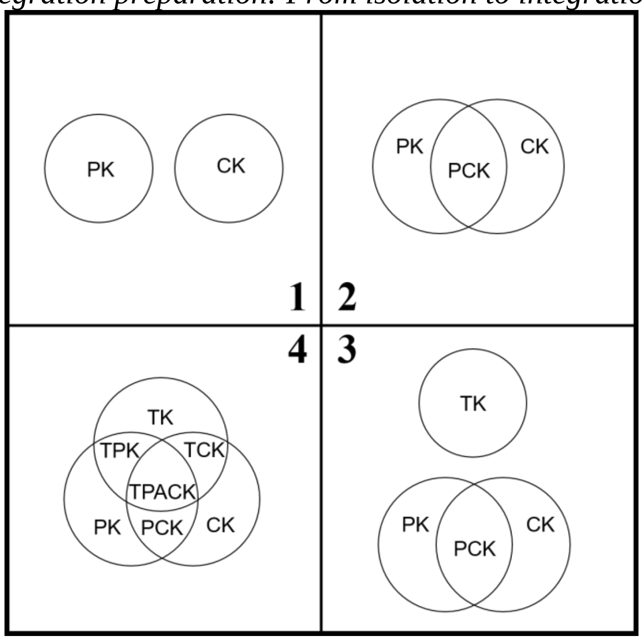
There is yet much to be learned about how to develop preservice teachers who are prepared to enter the profession and effectively manage their relationship with technology. While the history of technology integration courses began with a largely technocentric focus that ignored some of these critical factors (Betrus et al., 2002), the current trends have been largely impacted by theoretical frameworks such as TPACK. This framework, as will be explored in the next section, describes the domains of knowledge that one needs to most effectively integrate technology.

Conceptual frameworks for technology integration. Grounding these technological topics are conceptual frameworks detailing what is important to know and how a preservice teacher can critically navigate integration decisions. These technology integration frameworks each have unique qualities, and some build on one another. Although TPACK is the conceptual framework that will be used in this study to view preservice teachers' technology integration knowledge, an overview of other frameworks will offer insights into why TPACK was selected.

TPACK. TPACK's history in teacher preparation can be summarized by four movements. These movements are depicted in Figure 1. Box 1 depicts a separation of content knowledge (CK) and pedagogical knowledge (PK). Prior to Shulman's (1986) seminal work, most teacher preparation focused on these domains of knowledge separately. Content knowledge was developed in courses focused on a specific subject area, such as geology. Pedagogical knowledge refers to what one knows about the audience, learning theories, and classroom management. These concepts were covered in separate courses as well.

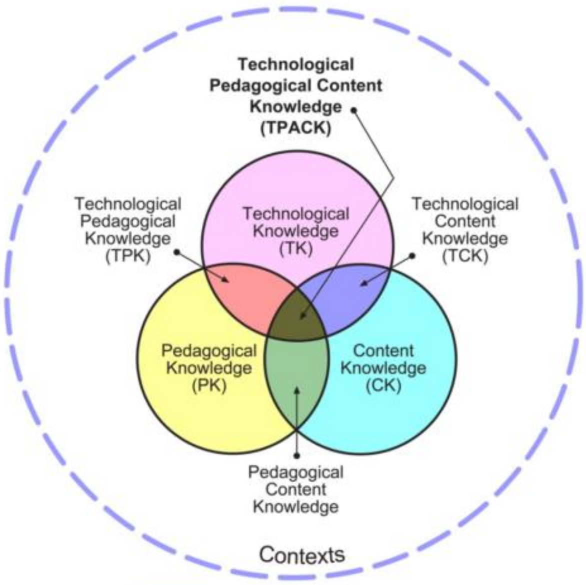
Shulman (1987) argued for the merger depicted in box 2. Pedagogical content knowledge (PCK) was a special type of knowledge that needed its own attention in the development of educators. It is the integration of content and knowledge in such a way that one considers how to most effectively organize, present, and adapt the content to a specific audience. This led to a transition in many preparation programs as they merged content and pedagogy into methods courses. These courses developed PCK by instructing preservice teachers about content-specific strategies.

Figure 1
Evolution of technology integration preparation: From isolation to integration



Next, box 3 depicts a stage in the evolution when emerging technologies began to find their ways into teacher preparation programs. Although technology is not depicted in Shulman's framework as shown in box 2, the technology available may have been considered as part of pedagogical knowledge. At the time of Shulman's work, technology was primarily available via "transparent" means. Chalkboards, pencils, and rulers may all have been considered technology, but their use was commonplace and may not have required a unique skill set. Box 3 refers to the rise of microcomputers and other digital artifacts that were not found in the mainstream. During this time, training in technological knowledge (TK) was conducted in workshops and standalone courses. These courses did not incorporate content-specific technologies or discuss pedagogical considerations. This is the movement depicted in box 3.

Figure 2
TPACK framework



Note. Reprinted from "What is Technological Pedagogical Content Knowledge", by Koehler, M., & Mishra, P., 2009, *Contemporary Issues in Technology and Teacher Education*, 9(1), p. 63.

The final box shows what became known as the TPACK framework. Ideas similar to the TPACK framework were discussed in the literature prior to Koehler and Mishra (Angeli, Valanides, & Christodoulou, 2016), but this framework became especially popular for developing teachers after Mishra and Koehler's first article detailing TPCK (2006). A couple years later, Mishra and Koeler (Mishra & Koehler, 2008) had changed the framework to TPACK as this was simpler to say and it comprised the Total PACKage of what was needed for teachers to know in order to effectively integrate technology. The TPACK framework, as shown in Figure 2 (Koehler & Mishra, 2009, p. 63), extended Shulman's framework from three to seven domains of knowledge; three distinct domains (TK, PK, and CK) and four domains (TPK, TCK, PCK, and TPACK) formed from the overlap. Chai, Koh, and Tsai (2013, p. 33) define each of these domains and provide an example that can be seen in Table 1.

Table 1
TPACK definitions

TPACK Constructs	Definition	Example
TK	Knowledge about how to use ICT hardware and software and associated peripherals	Knowledge about how to use Web 2.0 tools (e.g., Wiki, Blogs, Facebook)
PK	Knowledge about the students' learning, instructional methods, different educational theories, and learning assessment to teach a subject matter without references towards content	Knowledge about how to use problem-based learning (PBL) in teaching
CK	Knowledge of the subject matter without consideration about teaching the subject matter	Knowledge about Science or Mathematics subjects
PCK	Knowledge of representing content knowledge and adopting pedagogical strategies to make the specific content/topic more understandable for the learners	Knowledge of using analogies to teach electricity (see Shulman, 1986)
TPK	Knowledge of the existence and specifications of various technologies to enable teaching approaches without reference towards subject matter	The notion of Webquest, KBC, using ICT as cognitive tools, computer-supported collaborative learning
TCK	Knowledge about how to use technology to represent/research and create the content in different ways without consideration about teaching	Knowledge about online dictionary, SPSS, subject specific ICT tools e.g. Geometer's Sketchpad, topic specific simulation
TPACK	Knowledge of using various technologies to teach and/represent and/ facilitate knowledge creation of specific subject content	Knowledge about how to use Wiki as an communication tool to enhance collaborative learning in social science

Note. Reprinted from "A Review of Technological Pedagogical Content Knowledge", by Chai, C.-S., Koh, J. H.-L., and Tsai, C.-C.., 2013, Educational Technology & Society, 16(2), p. 33. TPACK research: Past, present, and future.

The technological, pedagogical, content knowledge (TPACK) framework has significantly impacted IDT. As of 2014, over six hundred articles had been published based on TPACK, and over one hundred forty instruments had been devised to measure its constructs (Koehler, Mishra, Kereluik, Shin, & Graham, 2014). Its use has ranged from reimagining practice in K-12 and higher education (Chai, Koh, & Tsai, 2013) to reforming teacher preparation programs' methods for developing preservice teachers (C.-J. Lee & Kim, 2014). Studies looking at TPACK have been primarily conducted in the United States, but have begun to include global perspectives more recently (Chai et al., 2013). TPACK has been studied in a great variety of content areas being taught: mathematics (Patahuddin, Lowrie, & Dalgarno, 2016), engineering (Jaikaran-Doe & Doe, 2015), social studies (Curry & Cherner, 2016), educational technology (Jaipal & Figg, 2010), science (Kramarski & Michalsky, 2010), and interdisciplinary studies to name a few. A majority of studies have been interventions (Chai et al., 2013), but methodologies have also included case studies (Özgün-Koca, Meagher, & Edwards, 2011), surveys (Johnson, 2012), observation (Wetzel & Marshall, 2011), document analyses (Hammond & Manfra, 2009), and instrument validation (Chai et al., 2013; Harris, Grandgenett, & Hofer, 2010).

Chai et al. (2013) conducted an extensive literature review consisting of 74 articles between 2003 and 2011. It provided basic descriptive information about the articles, a summary of their research methodology, and a content analysis of articles that clearly referenced a component of TPACK. Out of 54 papers analyzed, 51 were written from a constructivist pedagogical approach. This is not surprising, given the strong constructivist orientation traditionally espoused in technology integration circles (Howland, Jonassen, & Marra, 2011). Their conclusions, however, aligned with other limitations evidenced in TPACK research (Graham, 2011).

Limitations of TPACK. TPACK research is plagued by weak definitions and construct confusion. A comprehensive conceptual analysis of TPACK published in 2008 found 89 different definitions for the TPACK construct alone (Cox, 2008). The year is critical in this statement, since Chai, Koh, and Tsai (2011) note a more sharply increasing trend in the number of articles published about TPACK after 2008. It is likely that even more definitions are now present in the literature further exacerbating the problem of consistency. Graham (2011) affirms that if TPACK is to serve as a stronger conceptual model, it needs to have tighter definitions of constructs, be more prescriptive, and there should be measurable distinctions among domains. He argues that researchers struggled to differentiate constructs of Shulman's PCK, and this ambiguous foundation may be a key factor to TPACK's troubles.

Attempts have been made to better define the TPACK constructs (Chai et al., 2013) as the weak definitions attribute to the difficulty researchers encounter when measuring these constructs. Instrument validation studies have not always yielded the targeted number of factors when conducting a factor analysis (Archambault & Barnett, 2010; Chai, Koh, & Tsai, 2011). For example, in one study (Archambault & Barnett, 2010), CK, PK, and PCK loaded as one factor while TK formed a single factor, and the remaining four (TPK, TCK, and TPACK) loaded as the final factor.   More work is needed to further discriminate TPACK's constructs if it's conceptual merit is to be improved.

Kimmons highlights the limitations of viewing TPACK as a theory by using Thomas Kuhn's five characteristics of an "good" scientific theory: accuracy, consistency, scope, simplicity, fruitfulness (2015). Regarding accuracy, he builds upon some of the previously documented limitations. It is difficult to verify the accuracy of TPACK constructs when there exists a tremendous ambiguity among constructs. Not only are the singular constructs often defined differently, but the overlapping domains are not easily measured. Further complicating the accuracy is that all the instances of TPACK need to be assessed within a contextual bubble. Therefore, the same enactment of TPACK may be evaluated differently given external factors.

Furthering his argument, Kimmons (2015) notes that the internal consistency of TPACK is lacking. For example, the overlapping circles among the seven domains presume a logical relationship. That is, if one has technological and pedagogical knowledge, then technological pedagogical knowledge is an epiphenomenon. However, this is counterintuitive because one may be well versed in creating a digital video and have excellent knowledge of how to teach advanced physics, but this person may not have the TPK to teach elementary science effectively. Further Mishra and Koehler discuss TPK as a type of knowledge that is more than the sum of its constituent parts. Given the simplicity of the TPACK image, however, this conceptualization is illogical and problematic. As Kimmons states, "The issues of illusory simplicity and logical consistency do not seem to be readily solvable, and any attempt to address one of these issues would further problematize the other (2015, p. 75)." Regarding Kuhn's factor of simplicity, TPACK yet again meets a limitation. The often-perceived simplicity of TPACK, Kimmons points out, is merely illusory (2015). Given the contextual factors that need to be considered in each TPACK instance and domains of TPACK that may be missing from the current image, the model illusion of simplicity may be more problematic than it is helpful.

Scope is yet another limitation discussed by Kimmons (2015). He notes that by definition, TPACK is a technocentric framework for integration and questions whether the use of technology is indeed always appropriate. Answering negatively to his own question, he then poses whether one can have TPACK without using technology. He cites that this seems contradictory as well. While the argument can be made that TPACK may have a technocentric focus, it was a welcome reprieve from the initial educational technology courses that focused solely on technology (Betrus et al., 2002). As Kimmons (2015) identifies as well, in the context of technology integration courses, TPACK works well, because the end result is for student to develop some form of TPACK. However, it may be necessary for other researchers outside of teacher preparation to consider carefully the scope of TPACK. I would also counter Kimmons (2015) in that the absence of technology in a lesson does not equate to an absence of TPACK. It may have taken a measure of TPACK for the teacher to think through reasons not to include a technology. It is one thing to not use technology due to lack of skill, knowledge, or confidence, and quite another thing to intentionally not use technology due to knowing the instruction would be more effective without it. As has been aptly stated, “The absence of evidence is not evidence of absence (Goodwin & Miller, 2013, p. 79).”

The final component that Kimmons (2015) used to analyze TPACK’s theoretical potential was its fruitfulness in the scientific community. This is what may have provided the strongest counter to the other limitations. He cites a deluge of research that has be generated in the relatively few years since TPACK’s conception. It’s popularity in research and practice may be attributed to it being one of the early frameworks bridging academics and theory with technology integration (Kimmons, 2015). Although it has been quite fruitful, some have argued for dismissing it altogether due to its limitations accuracy and consistency (Brantley-dias & Ertmer, 2013). Others have called for keeping the framework and improving its accuracy through more consistent operationalization of its constructs and better measures (Chai et al., 2013; Graham, 2011).

Although the limitations of TPACK do exist and have been well documented, there are several advantages to selecting it as a conceptual framework for viewing technology integration understandings and application in this study. As Kimmons (2015) noted, the context of a technology integration course in a teacher preparation program is aptly suited to the scope of TPACK. Further, given the past fruitfulness of TPACK research, I concur with the research community that is seeking to revise TPACK to improve its consistency and accuracy rather than to toss it out altogether. Researchers have further noted a need to move beyond mere self-perception measures of TPACK and to correlate these measures with the actual application of

TPACK in the design of instruction (Abbitt, 2011). Although researchers have identified difficulties in measuring and fleshing out the "fuzziness" of the TPACK domains, even with validated instruments, it is the goal of this study to take into consideration these factors and seek to limit their negative impact on the validity of the study. The selection of instruments and the steps taken to improve the validity and reliability of the results will be detailed further in Chapter 3. TPACK's focus on the knowledge needed for effective integration, its application to designing teacher preparation courses, and its impact on the field support it being a well suited conceptual framework for analyzing preservice teachers' outcomes in this study. The rationale for TPACKs use in this study is further supported by next presenting the limitations of alternative technology integration frameworks.

SAMR. The substitution, augmentation, modification, and redefinition (SAMR) framework for technology integration developed by Puentedura has gained popularity in recent years as noted by a rise in conference presentations (Hamilton, Rosenberg, & Akcaoglu, 2016; Puentedura, 2015). It has been proposed as a way to frame professional development in K-12 settings and as a potential framing for research into mobile learning (Romrell, Kidder, & Wood, 2014). Its premise is that additional learning happens as technology is integrated at higher levels of the framework:

1. Substitution: The technology provides a substitute for other learning activities without functional change.
2. Augmentation: The technology provides a substitute for other learning activities but with functional improvements.
3. Modification: The technology allows the learning activity to be redesigned.

4. Redefinition: The technology allows for the creation of tasks that could not have been done without the use of the technology. (Romrell et al., 2014, p. 82)

While this framing for technology integration has been adopted by some (Brubaker, 2013), it has met with stark criticism by others (Linderoth, 2013). In a recent critical review of the SAMR model, Hamilton et al. (2016) listed three key reasons why researchers and instructional designers should be leery of its use: (1) absence of context, (2) product over process, (3) hierarchical structure. First, it is necessary to consider the ecosystem of instruction when making technological integration decisions (Zhao et al., 2016). Decisions made in a vacuum can be problematic, yet the SAMR model does not account for context. It merely suggests that using technology in these increasingly sophisticated ways will lead to learning gains.

Secondly, it’s focus on product over process is problematic. Hamilton et. al (2016) stated that "When integrating technology, the purposes of this integration should be on enhancing and supporting student learning rather than using a particular technology (p.438)." Designing and developing student learning is enhanced through an instructional design process. This design process is systematic and accounts for complexities informed by theories of learning and instruction (Reiser, 2001). It is a critical weakness to focus on educational products at the expense of educational processes as this espouses a techno-centric focus. This focus is what teacher preparation programs are attempting to shift from as they look toward a more holistic model of technology integration (Betrus, 2012; Betrus et al., 2002).

Lastly, hierarchical structures are based on the assumption of lesser and greater levels of the concept of interest. However, when analyzing SAMR, there is not a clear rationale why a teacher should feel the need to always be at the redefinition phase of technology integration. In an integrated approach, such as TPACK, one may determine that a substitution level of technology integration is the most effective given the content, pedagogical, contextual, and technological factors. The hierarchical approach to integration may mislead preservice teachers to discount effective approaches inherent to lower levels of the SAMR hierarchy.

Finally, in stark contrast to TPACK, SAMR has yet to have peer-reviewed publication explaining its theoretical basis. There is little empirical evidence for the framework, and almost no connection to theory or prior research. The focus of SAMR is almost solely on the technology. When Puentedura (2015) attempts to show an increasing effect size of interventions as they use technology in rising levels of his SAMR hierarchy, he analyzed studies that were not focused on the technology but rather pedagogical interventions (Hamilton et al., 2016). Therefore, while the use of technology in these studies may correlate to SAMR as an effective framework, this was not the intent of their study. The authors designed the studies and reported results as related to metacognitive-guidance and student-teacher interactions with the technology among other pedagogical strategies. This lends itself to supporting a framework that accounts for pedagogical knowledge as well. Puentedura (2015) is guilty of redefinition, the highest level of SAMR; he redefines pedagogical focused interventions that integrate technology as purely technological interventions. This lack of theoretical grounding and empirical support serve as the final reasons for passing by SAMR as a framework for the current study. While these frameworks have offered perspectives and beneficial debates for what constitutes effective technology integration, neither guarantees effective integration will occur. Even preservice teachers aware of these frameworks, barriers to technology integration discussed in the next section influence their selection and implementation of digital technologies.

Select critical factors to technology integration. As the topics in technology integration preparation evolved, the attention given to relevant factors shifted. Hew and Brush identified one hundred twenty-three barriers to technology integration in their study (Hew & Brush, 2007). These barriers were then placed into six broad categories: resources, knowledge and skills, institution, attitudes and beliefs, assessment, and subject culture. This study is primarily concerned with the critical factors of knowledge and skills as they constitute the dependent variables being measured. However, it is necessary to discuss some of the other factors to better understand the context for this study and the relationships among the factors.

Two recent studies highlight the importance of the relationships of the Hew and Brush (2007) barriers and the critical role that knowledge and skills play (R. J. Chen, 2010; Hur, Shannon, & Wolf, 2016). Both studies revealed that teacher's attitudes and beliefs had a direct effect on their technology use. However, the training that teachers received to increase their knowledge and skills affected the attitudes and beliefs, thereby indirectly affecting technology use. To help preservice teachers value the role of technology and to see the benefits of integration, programs should provide strong development of related knowledge and skills (Hur et al., 2016). The next paragraphs will describe some of the research that has been conducted to explore these factors.

Attitude has been shown to be a significant factor related to technology integration (Koszalka, 2001). Several studies have discussed its impact on teachers' intention to use technology (Teo, 2012) and their intrinsic and extrinsic motivation toward using technology (Cullen & Greene, 2011). Another study showed that a positive attitude may be a prerequisite to adopting technological innovations and explored how computer-mediated communication and interactions with peers affected attitude (Koszalka, 2001).

Self-efficacy, sometimes referred to as confidence, is yet another significant factor in how or whether teachers integrated technology into their instruction (Cullen & Greene, 2011; Hew & Brush, 2007). According to Bandura (1977), self-efficacy is a person's belief about whether they can reach a certain standard of performance. In the field of educational technology, the term computer self-efficacy is used to discuss a person's belief in their ability to use computers to reach a desired performance measure. An investigation of a model for the use of technology to support student-centered learning demonstrated that computer self-efficacy had the greatest influence on technology use by preservice teachers (R. J. Chen, 2010). Perceived self-efficacy was also included in a model exploring the internal and external factors affecting technology integration (Hur et al., 2016). Among the results of this study, was that teachers with a high degree of confidence about their technology use tended to view technology integration more positively. Self-efficacy was also shown to correlate with both intrinsic and extrinsic motivation to use technology. Furthermore, Cengiz (2015) noted the importance of computer self-efficacy among preservice physical education teachers, and studied an intervention designed to improve this construct. The intervention did not statistically, significantly impact participants' self-efficacy, but this affords new research opportunities to explore how preservice teacher preparation can best mitigate barriers and increase factors such as computer self-efficacy.

A recent review of TPACK literature substantiated prior claims that teachers' pedagogical beliefs and their technological knowledge and skills are deeply interconnected (Joke Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). It has often been believed that teachers' access to resources and supportive environment were highly influential of their technology integration practices. Ertmer et al. (2012), however, showed that teachers' pedagogical beliefs may be even more significant.

A case study of twelve highly recognized technology proficient educators revealed that they perceived their own beliefs to be facilitative of their integration of technology (Ertmer et al., 2012). These same teachers, however, believed the beliefs of their peers to be the strongest barrier to their integration of technology. Note that while the teachers being studied believed their access to technology could be improved or that curriculum requirements may at times be burdensome, these factors did not overcome their pedagogical beliefs. Three teachers in the study brought in personal technology to facilitate student-centered learning environments. Some of the teachers noted that they ignored superfluous curriculum requirements so they could focus more in depth on student-centered strategies with technology. These findings are consistent with Pierson's (2001) views on technology integration and the results of her study on technology integration and pedagogical expertise:

> Technology in the hands of a merely adequate teacher will lack the experienced and thoughtful motivation necessary to embed it within a context of sound teaching practice. Conversely, technology in the hands of an exemplary teacher will not necessarily result in integrated and meaningful use. Unless a teacher views technology use as an integral part of the learning process, it will remain a peripheral ancillary to his or her teaching. (p. 427)

The statement that "unless a teacher views" points to an educator's pedagogical beliefs. What do they believe about the learning process, and how do they perceive technology to fit within that process?

This is not to say that one's pedagogical beliefs can be so strong as to surmount any other barriers to technology integration. In fact, Ertmer et al. (2012) discussed what may be seen as a barrier threshold. One case in their study espoused pedagogical beliefs inconsistent with their enactment of technology integration. It was discovered that the school was experiencing significant updates to their technological infrastructure that were not conducive to the enactment of the teacher's beliefs. In this sense, the external barriers may have been too cumbersome. This idea of a barrier threshold may explain a previous study that showed no connection between pedagogical beliefs and technology integration practice (Judson, 2006). As the study was completed over a decade ago when access to digital technologies was less consistent that today, the available technology may have been an insurmountable threshold for even the strongest pedagogical beliefs concerning technology.

Barriers of access and resources, thankfully, may continue to diminish as the ConnectED initiative plans to provide next-generation broadband to 99% of students by 2018 (The White House, 2013). Since this connection will not directly translate to meaningful technology integration (Pierson, 2001), many scholars are calling for increasing teachers' knowledge and skills related to technology as this can positively impact their pedagogical beliefs (Hew & Brush, 2007). This, in turn, may then facilitate an enactment of technology-integrated practices consistent with pedagogical beliefs that view technology as a key component in educating the 21st century learner (Ertmer et al., 2012).

While TPACK may define the types of knowledge needed for effective technology integration and provide a framework for educational technology courses, variations among courses and strategies remain. Macro level strategies are evident in institutional strategic plans and foci that make available technology resources and raise expectation for faculty to integrate technology effectively (Bowen, 2012). The current movement has focused largely on mezzo level strategies or program level approaches that have been adopted by schools of education (Kennedy & Archambault, 2013; Lux & Lux, 2015; G. Ward & Overall, 2011). There is a need, though, for more research on the micro level strategies for increasing TPACK and preparing preservice teachers (Darling-Hammond, 2006). These micro level processes are the instructional decisions of how courses are designed, developed, and taught. The next section describes three mezzo level strategies affecting technology integration preparation; namely how technology integration courses should be sequenced, whether they should be wholly integrated into methods courses, and the role of field experiences in technology integration preparation.

Mezzo level approaches to technology integration preparation. To help mediate critical factors and overcome barriers to effective teaching practice with technology, much research has been conducted on how to structure a teacher preparation program in ways that best integrates technology integration development. A national survey of all teacher education programs was conducted to determine perceptions of technology experiences and topics used to prepare teachers to use technology (Gronseth et al., 2010). At least 80% of programs required a standalone technology course in some of their programs, and 60% of those required it in all of their licensure programs. 30% of faculty focused on how technology needs to support instructional goals, and over half of the faculty would like to see more systemic integration, especially in methods course and field experiences. Another report found that all of the teacher licensing programs reviewed incorporated the topic of integrating technology into instruction in some way (Kleiner, Thomas, Lewis, & Greene, 2007).

Most of these pathways for developing TPACK among preservice teacher are stand-alone technology courses (Mouza, 2016). This method of preparation was instituted as early as the 1990s but may not be the most effective pathway for TPACK development. As noted by the survey of faculty responsible for their program's technology experiences, a majority of these respondents felt the need for systemic integration of technology experiences (Gronseth et al., 2010). By this, the participants were referring to incorporating the integration of technology in methods courses and field experiences. A limitation to Gronseth et al.'s (2010) study, however, is that they only survey faculty responsible for technology course experiences. It is probable that these faculty members are not aware of all the technology integration that occurs in the courses taught by peers or the focus that is placed on these competencies. It is further possible that if the survey incorporated the perceptions of all education faculty, the perceptions of needs regarding technology experience may reveal different priorities.

In looking at this topic through a different perspective, it becomes evident that while a systemic focus on technology integration is not the norm, there have been various methods for developing TPACK among preservice teachers. In her review of TPACK development pathways, Mouza (2016) notes that there have been three primary avenues the far: (1) a stand-alone technology course, (2) instructional strategies integrated in methods courses or an educational technology course, and (3) instructional strategies for technology integration embedded throughout entire programs. Clearly, there is a range of systemization represented by these three pathways, yet among these routes there are further distinctions via the way each type of pathway may be constructed.

Cross program integration. One paradigm shift in teacher technology integration preparation is to involve methods faculty in the integration process through modeling in their content specialty (Hur, Cullen, & Brush, 2010; Mouza, 2016). In a multiple case-study of teacher education faculty, Bakir (2015) uncovered troubling attitudes toward modeling technology integration within their courses. Statements by faculty suggested they did not model technology integration, because it would be a waste of time considering what needed to be covered and the school contexts their preservice teachers would be entering for field placements. This attitude is problematic as research has shown that preservice teachers exhibited lower levels of TPK in unfamiliar teaching models and also had a higher degree of concern when presented with an innovative approach using technology, flipped instruction (Hao & Lee, 2016). These researchers proposed that teacher educators could address these concerns by modeling flipped instruction and student-centered approaches with technology in their courses. Modeling strategies for technology integration across a program aligns with the proposition that tighter coherence among courses in teacher preparation is a hallmark of strong programs (Darling-Hammond, 2006).

An investigation of factors supporting the transfer of technology integration practices in early career teachers aligned with prior research on the importance role of faculty in this process. In both interviews and surveys, participants stated that the modeling of technology integration by faculty, their guidance, and their support to integrate technology in the field were foundational to their success (Brenner & Brill, 2016). It involves faculty intentionally and effectively integrating technology into their teaching, but this may also mean that teacher educators need to develop their own TPACK as well (Yilmazel-Sahin & Oxford, 2010). Currently, when faculty do attempt to incorporate a focus on technology into their course, it is often by merely adding it onto the side or including a separate week or two to focus on it (Bullock, 2004). This conveys that technology use is a separate entity; a similar message is conveyed when technology integration is taught only by a specialist (Pierson & Thompson, 2005). A different message can be communicated by how the field experience is structured and what role technology integration is given within that learning environment.

Field experiences. Field experiences have been identified as a feature of highly successful teacher preparation programs, but these experiences need to be structured intentionally to increase their impact on learning (Darling-Hammond, 2006). Unfortunately, this has not always been the case in teacher preparation nor specifically in field experiences for learning how to integrate technology (Whitacre & Peña, 2011). Darling-Hammond (2006) writes,

> Often, the clinical side of teacher education has been fairly haphazard, depending on the idiosyncrasies of loosely selected placements with little guidance about what happens in

> them and little connection to university work. And university work has often been "too theoretical"—meaning abstract and general—in ways that leave teachers bereft of specific tools to use in the classroom. (p. 308)

The field experience fits within Merrill's integration phase of instruction and is a critical component of this study as will be discussed in later sections (2002). It is the critical nature of the field experience that has given it center stage in teacher education (Darling-Hammond, 2014), the development of preservice teachers' technology integration in face to face environments (Brenner & Brill, 2016), and the development of their online pedagogies (Archambault & Kennedy, 2014).

Field experiences for general teacher education. Teacher education researchers continue to promote the importance of extensive field experiences as part of preservice teacher preparation (Darling-Hammond, 2010; Grossman, Hammerness, & Mcdonald, 2009), even referring to it as the "holy grail of teacher education" (Darling-Hammond, 2014). However, they are not blind to the challenges presented by the traditional field experience. Zeichner proposes a new hybrid or third space that better incorporates the experiences and input of the community and practicing teachers (Zeichner, 2010). All too often, he notes, academic knowledge is prioritized to the detriment of practical knowledge and the school to university partnership. A third space is one that values the perspectives and experiences of the P-12 educators and seeks create a more balanced partnership. Strategies developed from a third space perspective seek to counteract what Darling-Hammond (2006) so vividly describes as a counterproductive, traditional field experience that does not integrate theory into practice and link arms with the P-12 community. With the realization of the power that these experiential lessons may have, studies have shifted to features of effective field experiences. These features include such things as the direct application of specific principles in a field experience that are learned from a course in the same semester. Another factor is the degree of oversight the program has over the quality of the field experience (Darling-Hammond, 2010).

Zeichner's (2010) strategies for forging a third space are to bring proficient teachers onto the university for a 2-year residency. They benefit from the experience and interaction with faculty and students, but the preservice program profits from the immense experience in the classroom and insights into current practices. Following this time at the university, the teacher's return to their districts with greater insight in the process of teacher preparation and stronger leadership skills. Another strategy Zeichner (2010) mentions is that of a hybrid teacher educator. Although this position differs, one example would be a person on staff for both a district and the university. The hybrid educator would need to be knowledgeable of the coursework required and the application being done in the classroom. This liaison position would contribute to the third space where both theory and practice are thought of simultaneously.

Integrating technology in the face-to-face field experience. Learning how to teach with technology must include a consideration of context and provide opportunities for the enactment of TPACK (Rosenberg & Koehler, 2015). This is most often accomplished through a field experience; one that has a technology-integrated practice component. Unfortunately, faculty attitudes toward teachers use of technology in K-12 schools can be negative, as they express that since they don't see it being used, they don't plan to spend time teaching about it (Bakir, 2015). Preservice teachers cited the lack of mentor teacher technology use as a reason why they also did not use technology in their teaching (Whitacre & Peña, 2011). While this may be the case in a select number of classes, this necessitates a greater need for effective modeling by faculty and the important task of finding teachers who can be effective mentors through their proficient technology integration (Bakir, 2016).

In their synthesis of literature, Brenner and Brill (2016) identified attributes that are needed for the transfer of technology integration practice in early career teachers. Many, if not all of the features, can be structured into field experiences: collaboration with peers, hands-on, authentic incorporation of technology, reflection, practice, modeling, and mentoring. A qualitative study of early childhood preservice teachers confirmed the impact that a technology rich field experience can have on preservice teachers' teaching practices (Lux & Lux, 2015). Findings from this study showed that preservice teachers had changed beliefs about the role of technology in teaching and learning. Important to note, however, that the setting for this study was a laboratory school on a university campus that incorporates teaching, research, and service into its mission. The mission of the school is to model best teaching practices, and it has an established relationship with the university researchers. This is consistent with the third space framework espoused by Zeichner (2010) and has proven a profitable way to model technology rich teaching practices. Amid finding teachers who exhibit strong commitments to teaching, it may be necessary to find teachers who also exhibit high degrees of TPACK.

Finally, access is another aspect to consider in a field experience designed to develop technology integration practices. Chen documents the role of content in the structural equation model of factors affecting preservice teacher's integration of technology (R. J. Chen, 2010). Preservice teachers' perception of instructional resources had a moderate effect on their use of technology. However, their technology skills and their teacher education experience related to their perceptions of the resources available. This relates to the previously discussed idea of a threshold barrier. The resources may not be as significant a barrier for a preservice teacher with pedagogical beliefs espousing technology supported student-centered learning and strong technological knowledge. Yet, even the lack of resources can become substantial enough to counter effective integration skills and strong beliefs in technology's educational potential.

Since preservice teachers are often developing these skills and TPACK, it may behoove teacher preparation programs to provide adequate logistical support (Whitacre & Peña, 2011). Preservice teachers are tasked with many learning activities during field placement and arranging access to devices may prove to be too overwhelming. To conclude, research in technology integration focused field experiences has resulted in the following recommendation: find a mentor teacher who will model effective technology integration, supply technological resources if they are not readily available at a school, and don't expect students to use technology unless it is an explicit requirement in the field (Whitacre & Peña, 2011). Building on the last suggestion, it should be a requirement for preservice teachers to practice using technology in their instruction as part of their development.

Online and blended field experiences. The preceding sections highlighted the important that a field experience has played in teacher education and the development of TPACK through technology integration practice. What, though, is the role of a field experience in preparing preservice teachers for online and blended learning environments? Several national surveys have been conducted to study the relatively new phenomena of a virtual school field experience (Kennedy & Archambault, 2013). Kennedy and Archambault (2012) report from their survey that 1.3% of teacher preparation programs are specifically preparing teachers for non-traditional settings, but about half felt they should begin offering virtual field experiences. This could be a much needed change, because a separate survey of practicing K-12 online teachers yielded disparaging results about how these unprepared these teachers felt for their online teaching position (Archambault, 2011). Open-ended responses revealed that teachers sensed their preparation programs did nothing to prepare them for online environments. Closed-ended responses aligned with this sentiment as all technology domains within the TPACK constructs were significantly lower than domains only focused on pedagogy or content. Archambault (2011) realized that a limitation of this work could be that many of these online teachers completed their preparation programs prior to the focus on technology integration preparation. Separating responses by those with fewer than three years of teaching experience resulted in similar findings as the mean of the response to their perception of being prepared to integrate technology was 2.17, or not very prepared. Amidst the rise in blended and online learning in K-12, something must be done to mitigate this lack of preparation (Kennedy & Archambault, 2013).

Developing competencies and skills for online and blended instruction should be something all preservice teachers develop, not just those who plan to teach online as these environments are becoming more pervasive (Archambault, DeBruler, & Freidhoff, 2014). One way to do this is by completing coursework or field experiences in online and blended environments. In their survey of education faculty, Kennedy and Archambault (2012) encountered positive attitudes toward the idea of a virtual school field experience, but there were also negative sentiments expressed. Themes emerged such as online teaching is not real, we only prepare student for traditional classrooms so we’re not going to worry about online education, knowing how to teach well face to face will translate to an online environment, and online and blended learning are not in elementary settings yet so there is no need to concern those majors with it. Amidst these sentiments, online and blended environments in K-12 increased by 6,566% between 2000 and 2009 (Horn & Staker, 2011), Florida alone enrolls 220,000 students in virtual schools, all 50 states have online courses in K-12 (Kennedy & Archambault, 2012), teachers who did not expect to teach outside of a F2F environment are employed by virtual schools (Archambault, 2011), and there are organizations such as the International Association for K-12 Online Learning (iNACOL) dedicated to outlining differences among online and F2F instructional competencies of K-12 teachers (Powell, Rabbitt, & Kennedy, 2014). According to Archambault et al. (2014), the inclusion of online and blended teaching models in a teacher preparation program is long overdue. A field experience within this setting may be a good place to start.

Segmenting integration. During the earliest decades of teacher preparation, technology training was most often relegated to a single course (Bakir, 2016). There are researchers who believe that breaking apart the customary, stand-alone, three-credit technology integration course has the potential to be more effective (Bakir, 2015; Pierson & Thompson, 2005). Pierson and Thompson (2005), when discussing why they divided the single course at their institution, stated that it helped to situate the learning of technology skills into students' field placements. It also helped them as technology integration experts to collaborate with methods teachers as they had three semesters of potential collaborations with different content areas. Finally, they were afforded more time by dividing it into three courses and were able to sequence the course in a more developmentally appropriate way (Pierson & Thompson, 2005).

In Bakir's (2015) study, she noted that several programs struggled to identify where to most effectively place the single course within the program. Taking the course too early in the program, students had limited pedagogical knowledge and often forgot skills that were not repeated. Alternatively, waiting until the end of the program could also be detrimental as students were not provided with potentially essential technological skills. Thus, breaking the stand-alone, three-credit course into multiple courses has many potential benefits including increased flexibility. Although researchers have begun to reach some consensus regarding the chunking of technology integration courses, a singular approach has not yet proven superior (Bakir, 2016; Kay, 2006).

While the following shifts in teacher preparation are important to discuss, they will serve merely as a backdrop for the instructional focus of this study. Note that these topics do not deeply root themselves in the day to day or course level teaching decisions. Within the literature focused on mezzo level strategies, there is a need to research how teacher educators should best design and implement a course for optimal impact on preservice teachers' technology integration knowledge and design practices. If researchers such as Koh and Frick (2009) are correct, it is these micro level processes such as the structure of student teacher interactions that need additional attention to help teacher educators better design courses to impact those important technology integration factors. This focus within the educational technology community mirrors the research emphasis in the broader community of teacher education; a research response to reforms initiatives that discussed and analyzed the frameworks of programs while overlooking the content of the programs (Darling-Hammond, 2006). The course series in which this study is situated takes advantage of several of the aforementioned factors such as collaboration with methods faculty, building upon prerequisite knowledge, and analyzing specific technological skills the students may need as they progress through their program. Zooming the analytical lens past how the course is situated in the program, the next section focused on how a flipped classroom model may be an effective approach to teaching technology integration.

Flipped Classroom Approach

Flipped instruction has been defined as a model of instruction that presents self-paced instruction to the learner online before the physical class meeting. This online instruction replaces the lecture, and face to face class time is spent applying the concepts collaboratively in an active learning environment in the physical classroom (Flipped Learning Network, 2014). The openness of the definition for flipped lends itself to many diverse applications. What should the online instruction be, and what does an active learning environment include? How much should of the instruction should online versus in the classroom? How does one connect the two environments?

This research does not intend to answer all these questions, rather the intent is to show that there is yet much to be answered about what may be effective about this type of instruction. Sometimes the answer may be that it all depends. It may depend on the learner, the content, the learning objectives, and the context. In the following section, common assumptions of flipped approaches will be discussed, but it is critical to note the potential for variations among flipped models possible within the above definition that may counter the commonly held assumptions (Waldrop & Bowdon, 2015a).

As one example, proponents of discovery learning may challenge the common assumption of presenting material to learners online prior to an active learning experience in the classroom (Richey, 2013). Creating videos for instruction in the online space is a typical in a flipped model, but too much in the literature has been made of flipped being about the videos or about turning lectures into videos (Bull et al., 2012; Cargile & Karkness, 2015). Yes, videos can be an effective method for delivering content, but in a post-industrial education system many would argue that we want our student to do more than passively absorb information as if they were empty vessels (Reigeluth, 2013; Zhao et al., 2016). Additionally, the definition for flipped models in this study does not mandate a content dichotomy between the online and physical classes spaces. Given the emerging technologies available online, it is possible to leverage the online space consistent with discovery learning and supportive of active learning strategies. The next sections will further examine the assumptions of flipped instruction, its history, the underlying research, and the persisting gaps in related research and application.

Assumptions of flipped instruction. To identify and articulate characteristics of a flipped approach, several assumptions need to be clarified, such as the role of the teacher and student, benefits of technology, and pedagogical preferences. Before delving into these assumptions, the differences between a flipped and traditional approach will be discussed. This study does not base its comparison group on a so-called traditional approach, but many studies of flipped classroom have been conducted through such comparisons (J. Anderson, Young II, & Franklin, 2014; McGivney-Burelle & Xue, 2013; Simpson & Richards, 2014). This represents a weakness in the literature, as it does not add a great deal to our knowledge base to compare an approach based on principles of instruction with an approach already shown to be less effective. Therefore, this study seeks to compare a face to face version of the course with a flipped version that have both been designed using the same instructional design model. In doing so, goal is to compare two instructional approaches that are based on sound instructional principles.

Francl, one of over 14,000 members of the Flipped Learning Network, published the following five steps that he claims are characteristic sequences of a traditional approach (2014).

1. Visual and verbal presentation of topics in class
2. After or throughout the lecture, questions will be posed for students to answer
3. Students will complete “homework”; typically, this will be practice exercises
4. Correct answers are explained after homework has been submitted
5. To test retention, students will complete additional exercises or a quiz

An initial glance at this list reveals critical assumptions made about a traditional class. First, it is teacher-centered. This is evidenced by the presentation of content to the students, and the explanation of "correct" answers. Secondly, there is little interaction of students with the content, teacher, or peers. Third, assignments in a traditional classroom have "correct" answers. Lastly, the goal of a traditional classroom is retention and not transfer, application, etc…While these characteristics may have been observed in many classes for many years, it may be necessary to ask for whom is this traditional and in what contexts. There are many teachers who have been conducting their work in a radically different manner for some time. In fact, many of the assumptions of effective flipped instructional practices are much older than often believed (Svinicki, 2013).

Noted as one of the greatest assumptions of the flipped classroom is that students learn best when they are actively engaged in the learning process and applying what they know (Svinicki, 2013). While this is often viewed as a tenet of a flipped approach, it is arguably not unique to a flipped approach (Schank et al., 1999). Dewey (1943) wrote that the natural impulses of a child are to inquire about the world, use language as a means of communication with the world, construct things, and to express feelings and ideas. These natural impulses reveal an active nature of a child and an inclination to learn.

A second assumption of the flipped approach is that learner's require less support when engaged in lower order thinking (McGivney-Burelle & Xue, 2013). According to BRT, lower order thinking would constitute memorization of facts, explanations, and demonstrations of routine procedures (Krathwohl, 2002). The second half of this assumption follows logically. Students need more support when engaged in higher order thinking. The flipped approach would then place the engagement with higher order thinking within the physical classroom space where the teacher can support students immediately. The students would engage in memorization and basic procedures online where there is less direct instructor support.

A third assumption of the flipped classroom is that student and teacher roles will shift (Francl, 2014). The teacher will move information transmission outside of the classroom via text, multimodal presentations, and audio posted online (Abeysekera & Dawson, 2015). The teacher's role then is knowledge curator as these relevant media are found or created (Bowen, 2012). The teacher will also assess student knowledge before class. This pre-class assessment serves as an accountability check for students' online interactions, and it also gives the teacher data to work with when planning for activities in class. The teacher may choose to make last minute teaching decisions based on this data or to use the data to differentiate class activities. Therefore, the role of the teacher is much more of a facilitator than a lecturer. Finally, the role of the teacher is one of coach. Feedback is a critical element of a flipped classroom. As students engage in active learning activities targeted at higher levels of cognitive engagement, the teacher's feedback and guidance become essential.

Compared to the traditional characteristics listed above, the student's role changes from passive recipient of information to active participant in the learning process (Francl, 2014). The assumption is that students will engage in this process. Reasons cited for this assumption are that flipped classrooms often incorporate emerging technologies that are relevant to students' interests (Miles & Foggett, 2016). Another assumption is that students are naturally drawn to this type of course structure. The expectation for students is that they will spend time preparing to come to class by completing the "lectures" and activities beforehand. In the physical class space, students are expected to engage with their peers socially and collaboratively as they learn in an active environment.

The above paragraphs present several assumptions of a flipped approach, and the comparison that is often made to a traditional approach. Research into flipped teaching is yet in its infancy, and has been plagued by inadequate comparisons to poorly designed comparison group (Lo, Lie, & Hew, 2018). Often, blended courses do not have a well-articulated theoretical grounding and are rather based on the instructor's intuitive beliefs (Means, Toyoma, Murphy, & Baki, 2013). Further, some of the assumptions of a flipped approach are being questioned (Shih & Tsai, 2017). For instance, the assumption that students will be naturally drawn to this approach as it is student-centered and often incorporates emerging technologies. If the course is not well designed to support student's learning, research has shown that students may become frustrated by flipped classroom, may not understand it's purpose, or the role of the instructor (Krahenbuhl, 2017). The next section will discuss how the flipped approach came to be widely known followed by what research has revealed about flipped classrooms.

Contextualizing the flipped approach. The flipped approach to instruction is often attributed to two high school science teachers who began recording their lectures, providing them to students, and using class time for additional student-centered learning activities (Bergmann & Sams, 2012). Bergmann and Sams began flipping their classes in 2007 and by the time they published their first book on the topic in 2012, the approach had been adopted globally. Although they are commonly thought of as founders of this idea, they and others have identified that a prior piece was written about inverted instruction in a university economics course (Lage et al., 2000; Noonoo, 2012). Still others attribute widespread adoption of the flipped approach to Salman Khan's creation of an expansive video repository and his TED talk on using videos to transform education that has nearly 4.5 million views (Khan, 2011). His site, Khan Academy, now incorporates practice exercises, individual learning pathways, and has teacher and parent accounts (Khan Academy, 2016).

Bergmann and Sams also took their idea further by publishing what they termed flipped mastery learning (Jonathan & Sams, 2013). Both ideas are based on the notion that students can follow individualized pathways to achieving the required learning objectives. This type of competency based education is consistent with Reigeluth's new paradigm for education (Reigeluth, 2013). Although higher education largely ignored the original article produced in their midst, they are now incorporating the model to a large degree. Entire colleges have flipped, citing that one can become a doctor without listening to a single face to face lecture (Straumsheim, 2016)! Yet amidst this optimism there are skeptics and critics (Straumsheim, 2013), and researchers have written about the need to modify flipped approaches depending on the context (Y. Chen, Wang, Kinshuk, & Chen, 2014).

Since the flip approach was popularized in the K-12 context, there were modifications proposed to the model in order to adapt it for higher education. The original pillars were the following: flexible environment, learner centered, intentional content, and professional educators (Flipped Learning Network, 2014). Researchers then added to this model the pillars of progressive networking activities, engaging and effective learning experiences, and diversified and seamless learning platforms (Y. Chen et al., 2014).Progressive networking activities build upon generative learning theory in that students are expecting to be engaged in hands on minds on learning or learning by doing (Wittrock, 1990).

Engaging students in an effective way is increasingly important in a class incorporating aspects of distance education due to transactional distance. According to transactional distance theory, certain activities increase the distance between the learners, the learner and the instructor, or the learner and the content (Y. Chen et al., 2014; Reyes, 2006). Conversely, other activities may decrease this distance. The trick is to navigate the tension among these activities and keep learners engaged. Another factor to consider when planning to decrease transactional distance through activities such as synchronous meetings, discussion boards, and group work it that it decreases the learner's autonomy. Since certain learners may value their autonomy, and since self-paced and flexible environments are core feature of the flipped model, this is another tension to reflect upon when designing a course (J. Anderson et al., 2014; Bristol, 2014; Simpson & Richards, 2014).

Thirdly, diversified and seamless platforms need to be selected and operated in such a manner that contributes to the flexibility and distinctiveness of the learning environment. Deciphering which technology or platform to use is as important as a painter selecting the appropriate brush for job (R. E. Clark, 1983, 2011; Dede, 2008; Kozma, 1994). Not a single brush was created for all paint related activities just as not every site or technology is fit for each learning situation. Equally important to recognizing the diverse strength of various platforms it to ensure the selected technologies fit seamlessly. The goal is not to overwhelm students with tools for the sake of diversification, but to intentionally select tools for the potential benefit to learning and their fit amongst the course structure and other tools.

Research on the flipped approach in higher education. Since the design of flipped environments in higher education is still a rather new concept, several exploratory studies have been undertaken in a variety of contexts including nursing, mathematics, and business (J. Anderson et al., 2014; McGivney-Burelle & Xue, 2013; Simpson & Richards, 2014). These studies primarily report on students' perceptions of the flipped classroom as compared to a traditional approach. In all three studies, students were very positive about their experiences in the flipped course. The nursing students appreciated how relevant the active learning strategies were to what they were supposed to be learning and noted the increased flexibility. They noted the ability to pace themselves through the content as they prepared for class (Simpson & Richards, 2014). The business students generally perceived it to be effective, yet felt the videos to be repetitive (J. Anderson et al., 2014). The calculus students preferred the flipped course and greatly liked the availability of the videos and the use of class time to work through problems (McGivney-Burelle & Xue, 2013).

The dichotomy of reactions to the videos may be explained by the design of the videos. When discussing thoughts on the flipped classroom approach, Bull, Ferster, and Kjellstrom (2012) wrote, “You can't magically transform an ineffective lecture by transferring it to video (p.10).” The goal of flipping is not to fix what is not working in a lecture-centered classroom by recording it on a video. Design principles need to be considered for the course and for the media created to support the course. As for the positive perceptions of the nursing students, this may be explained via self-determination theory. The researchers spoke of both relevance and autonomy provided by the course. These are two of the three psychological needs that can lead to increased motivation (Deci & Ryan, 2008). This may support Abeysekera and Dawson’s (2015) proposition that flipped environments support these psychological needs and increase motivation.

Relating the flipped approach to teacher preparation. A flipped course design has potential for improving development of preservice teachers’ TPACK as it allots more time for in-depth authentic learning experiences and can effectively model technology integration (Banas & York, 2014; Vaughan, 2014). Flipping a teacher preparation course could facilitate the connection of technological, pedagogical, and content knowledge by engaging preservice teachers through this design and prompting them to reflect on this experience. Previous studies of flipped classrooms have shown promising results as seen in increased motivation, course satisfaction, and learning outcomes (Hibbard, Sung, & Wells, 2015; Peterson, 2015; Swart & Wuensch, 2016). Although prior studies in teacher preparation have explored instructional strategies evidenced in a flipped approach, few studies have been conducted of flipped courses in teacher preparation. The next paragraphs will explore components of a flipped approach that have been previously studied in teacher preparation.

In a flipped classroom, time that is typically devoted to lecture can be allocated to authentic learning experiences (Baepler, Walker, & Driessen, 2014). Students can prepare for the authentic exercises prior to coming to class in a way that is measurable (Li, Jiang, Li, & Liu, 2015). The preparation and activities done prior to class occur online in this design, and in the remaining sections will be referred to as “pre-class” activities. Once arriving at class, more time can potentially be focused on facilitating authentic learning in a collaborative setting (Zainuddin & Halili, 2016). The learning events that take place during the face to face portion of the course in this design will be referred to hereafter as “in class” activities. Authentic learning experiences in teacher preparation may consist of designing lessons, creating digital artifacts, presenting lessons, reflecting on experiences, and peer critique (Banas & York, 2014; Chai, Hwee, Koh, & Tsai, 2011; R. J. Chen, 2010; C.-J. Lee & Kim, 2014). Taking part in these types of learning experiences are what Merrill would define as the application and integration phases of instruction. Incorporating these instructional principles are hypothesized to increase the effectiveness of instruction overall (Merrill, 2012). It is not, however, that authentic learning is unique to the flipped model, but rather it can be enhanced by the reorganization of content and the affordances of technology for information delivery, engagement, and assessment.

Research regarding effective strategies for preparing preservice teachers to integrate technology cite modeling technology-integrated practice as a key component (Figg & Kamini, 2011; Lu & Lei, 2012). The practice of modeling how to incorporate technology in a F2F setting has become part of the educational technology course typically offered, and there is a call for teacher educators to model effective technology integration in their methods courses (Hur et al., 2010). Further, researchers (Archambault & Kennedy, 2014; Oliver & Stallings, 2014) propose that teaching effectively and integrating technology in online and blended environment requires unique competencies. In exploring concerns of preservice teachers and practicing K-12 online teachers, a lack of confidence with a flipped pedagogical approach and a feeling that the teacher preparation program did not cover these topics were evidenced in the data (Archambault & Crippen, 2009; Hao & Lee, 2016). Using a flipped classroom in teacher preparation allows for modeling technology integration to occur in the F2F and virtual environment seamlessly. In her experience flipped a teacher preparation course, Vaughan (2014) details the central role modeling played in her decision to attempt this approach. She writes that each instructional practice modelled was identified, discussed with students, and documented for future use. Merrill's principles for instruction provide a theoretical basis for modeling, as it is the primary demonstration corollary applied when the learners are expected to complete an action (Merrill, 2012). Given that teaching involves a vast range of skills and the increase of these practices needed for digital spaces, it seems the time has come to begin modeling blended and online teaching practices.

Bloom's Revised Taxonomy

Perhaps Dr. Charles Spuches said it best when he wrote that "one might safely conclude that all educators (and everyone involved in education) are familiar with Bloom's Taxonomy

(2017, p. 8)." While the degree of the statement may be difficult to confirm, his sentiment that the taxonomy may be one of the "most pervasive tools in education (2017, p. 8)" is supported by the number of researchers citing the original or revised taxonomy as a conceptual framework for their work (L. W. Anderson et al., 2001; O'Flaherty & Phillips, 2015). The original taxonomy (Bloom, 1956), now celebrating its sixth decade, is still influential in emerging instructional approaches such as the flipped model (Callison, 2015; Francl, 2014; Khanova, Roth, Rodgers, & Mclaughlin, 2015; Krathwohl, 2002). This section will examine BRT and explore how this lens is being applied in the design of flipped classrooms.

Bloom's Taxonomy and its revised version are meant to describe domains of learning and to assist with the alignment of instruction and assessment when designing curriculum (L. W. Anderson et al., 2001). The original taxonomy focused much more on assessment, yet Bloom saw it as a way to bring about a common language for discussing learning across disciplines and persons (Krathwohl, 2002). Three domains of learning were proposed, affective, cognitive, and psychomotor. This study, however, is solely concerned with the cognitive domain. See Figure 5 for an example of the revised taxonomy.

One key distinction made by the revised taxonomy was replacing the nouns in the subcategories of the cognitive domain with verbs (L. W. Anderson et al., 2001). This was done to highlight the distinction between knowledge as a noun and knowledge as a verb. Krathwohl (2002) wished to better articulate knowledge's dual dimensions. That is, knowledge as a noun refers to the types of knowledge one may have about the content, and knowledge as a verb refers to the cognitive processes one undergoes in relation to this knowledge. The authors also wanted to make it simpler for teachers to craft learning objectives, as objectives are often written with a verb to describe what the learners will be able to do (L. W. Anderson et al., 2001).

The cognitive processes in the taxonomy are presumed to increase in complexity from remembering to creating (L. W. Anderson et al., 2001). Due to this proposed cumulative hierarchy of knowledge, much has been written about the critical nature of the taxonomy in the design of flipped instruction (Kvashnina & Martynko, 2016; Mennella, 2016; Thai, Wever, & Valcke, 2017). Supporting this logic, Little (2015) argues that the real strength of the flipped classroom is not in its use of emerging media, but in its opportunity to rethink the face to face class time. With the content delivered prior to class, all of class time can be utilized to support more complex cognitive processes and types of knowledge. This change in focus has resulted in positive results as seen in student's performance in courses (Kvashnina & Martynko, 2016), motivation (Hibbard et al., 2015), and satisfaction (Nouri, 2016).

BRT was the basis for what levels of cognitive processes would be foci of learning outcomes during the pre- and in-class portions of the flipped model used to design the intervention for this study. Lower levels of the taxonomy, remembering and understanding, were the primary focus of instruction prior to class time. The design of the in-class activities concentrated on higher levels of the taxonomy, applying, analyzing, evaluating, and creating. Merrill's FPI, discussed next, directed the design of instruction that facilitated learners' achievement of specified levels of BRT.

Merrill's First Principles of Instruction

The FPI, remarkably, developed from a conversation Merrill had with a former graduate advisee, Dr. Charlie Reigeluth (David Merrill, 2016). Per Merrill, the conversation ensued by his telling Reigeluth that the entire field of instructional design could be synthesized into a handful of principles. Doubting this comment, Reigeluth challenged Merrill to do just that if it were indeed possible. What followed was the publication of five principles of instruction that Merrill claimed to be universally applicable regardless of content or context (Merrill, 2002). Merrill proposed that learning would be promoted when (1) learners engage in solving real world problems, (2) prior knowledge is activated, and new knowledge is (3) demonstrated to the learner, (4) applied by the learner, and (5) integrated into the learner's everyday life.

Merrill's work has been widely accepted by the field, and is now seen as foundational knowledge for the training of instructional designers (Donaldson, 2017). They have been applied to empirical research in various settings (S. Lee, 2013; Tiruneh et al., 2016) and used to conceptually frame instruction as well (J. Gardner & Belland, 2012; K. R. Nelson, 2015). Amidst this extensive impact, Merrill's advisee proposed an alternative view to the universally applicable principles (Reigeluth, 2013).

"Situationalities" refer to situation that differ and may require additional guidance for implementing a method (Reigeluth, 2013). While having the first principles available may provide a solid, general summary of how quality instruction can be produced, Reigeluth (2013) argues that the principles do not account for the plethora of nuances instructional situations may generate. This supports the view that there is a fundamental tension between flexibility and precision. What one gains through flexibility they may lose in detail and fidelity and vice versa. Gustafson and Branch (2002) posit a similar argument for the role of the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) framework in the field of instructional design and the rationale for why there are so many instructional design models. ADDIE is helpful for remembering what components constitute a rigorous design process, but it does not provide the prescriptions or specificity needed in many situations. Further, they refer to the granular specificity of the Interservice Procedures for Instructional Systems Development (IPISD) model as a "blessing and a bane" (Branch & Gustafson, 2002, p. 68). That level of prescription makes it incredibly suitable for its intended audience and context, while simultaneously preventing its use in other settings. Merrill's principles can be thought of similarly. Many have found them useful in varied settings, because of their general prescriptions, yet they may not offer the level of prescription to account for the many "situationalities" a designer will encounter (Merrill, 2012; Reigeluth, 2013).

Theoretical camp of the FPI. The generality of the FPI affords them the flexibility of being applied by instructors and designers from many theoretical perspectives (Merrill, 2012). No specific philosophy or learning theory need be adopted to implement these principles. Regarding theories of learning, it has been said that theoretical eclecticism is a strength of the field (Ertmer & Newby, 1993). Although some may express concern for this remixing of instructional strategies advocated by theoretical eclecticism (Bednar et al., 1991), proponents argue that the instructional strategies derived from learning theory A are often the same as those derived from learning theory B. It is the theoretical rationale for each instructional move that differs. In practice, the implementation of the instruction may not be distinguishably different by supporters of one theory versus the other.

Overlaying Ertmer and Newby's critical features of learning theories from an instructional design perspective onto Merrill's FPI clarifies the premise that these principles of instruction are not inherently tied to a specific learning theory (Ertmer & Newby, 1993; Merrill, 2002). For example, the problem-centered principle of instruction and its corollaries give credence to applications that may be attributed to behaviorist, cognitivist, and constructivist perspectives.

Beginning with a behaviorist perspective, Ertmer and Newby (1993) highlight that sequencing of instruction to help learners master initial skills and knowledge before moving to more complex skills as key instructional design applications. Problem progression is a corollary of the problem-centered principles that aligns with this application. It states that learners should solve a progression of problems that are compared to one another. Through the solving of increasingly complex problems, learners skills should improve until they can solve the problems of greatest complexity (Merrill, 2012).

Constructivist ID applications relevant to the problem-solving principle would be to situate the problem in a meaningful context, present the information in varied contexts, and support learners transfer of skills beyond the content provided to them (Ertmer & Newby, 1993). Merrill stresses that the learning should take place in the context of a real-world problem that is relevant to the learner (Merrill, 2012). Depending on the nature of the problem, there may be space for group negotiation of appropriate solutions. The problem-centered strategy involves the learner in many contexts, as component skills needed to complete the whole problem are taught within a unique context.

The show task and task level corollaries are examples of how the critical features of cognitivism are evidenced in the problem-centered principle. Principles and assumptions relevant to instructional design include the need to have the learner engaged in the learning process, facilitating the processing of information by effectively sequencing instruction, and using relevant examples to help learners make connections between what has been learned and what is yet to be learned (Ertmer & Newby, 1993). The show task corollary simply states that learning is improved if the learners are shown, from the beginning, the task or problem they will be able to complete by the end of the instructional sequence (Merrill, 2002). This is a way to facilitate the processing of information by providing structure. It may also help learner make connections between what has been learned from previous tasks and the new tasks or problems. Finally, the task level corollary speaks to engaging students in learning beyond operations and procedures. It focuses on how instruction should be organized and structured to facilitate the learners processing of information at various levels: problem, task, operations, and actions (Ertmer & Newby, 1993; Merrill, 2002).

The case for the theoretical eclecticism of the First Principles could be made using any of the principles. To further this point, consider the prominent role that feedback has been given in teacher and learning and the connection to both the behavioral and cognitive sciences (Ertmer & Newby, 1993; Hattie & Timperley, 2007; Shute, 2008). Feedback is included as a part of the diminishing coaching corollary of the application principle. Regarding feedback, Merrill states that all the instructional design theories and models he reviewed incorporated feedback as a necessary component of learning (Merrill, 2002). This reaffirms the position that an instructional strategy may be present in theoretically diverse instructional design theories and models as the implementation may be similar while the rationales will differ (Jonassen, 1999; Merriënboer et al., 2002). Given the theoretically diverse grounding of the FPI, the capacity to apply the principles with rationales from varied theoretical perspectives, and Merrill's own statement regarding their philosophical neutrality, this paper will make no attempt to place the principles in a single camp. They may move amongst and between each as they exemplify how the field of IDT links theories of learning with instructional practice (Bednar et al., 1991).

Evidence of effectiveness. The indirect support for the FPI is extensive and stems from the premise that all of these principles are based on previous instructional theories that have been empirically vetted (Merrill, 2012). Direct empirical support of the principles, on the other hand, has been limited (S. Lee & Koszalka, 2016; Tiruneh et al., 2016), and researchers have called for the additional research in situated in varied additional disciplines and to incorporate emerging learning environments, e.g., online, blended, flipped (Cheung & Hew, 2015). The little empirical work that has been conducted, though, has substantiated Merrill's claim that the integration of these principles can have significant impacts on learning (Frick et al., 2010).

Research on the FPI has found positive impacts on mastery of course objectives (Frick et al., 2010), deep cognitive strategy use (S. Lee & Koszalka, 2016), domain-specific critical thinking skills (Tiruneh et al., 2016). Furthermore, faculty designing a course using these principles observed an increase in students rating on course evaluations and positive student feedback related to engagement and relevance of course activities (Cheung & Hew, 2015; Hoffman, 2014). Given these initial positive findings, there is reason to continue exploring how this instructional design model can be applied and its role in learning outcomes.

In reviewing the literature of studies incorporating Merrill's FPI, two limitations emerged that could be accounted for in future research. First, there tends to be a weak articulation of how the principles are applied in an intervention or even misconceptions of the principles themselves (Cheung & Hew, 2015; Hoffman, 2014). In Hoffman's (2014) study, it is unclear how all of the principles were applied in the course; perhaps they were not. Furthermore, Merrill notes corollaries of his principles that are rarely accounted for in the existing research. Hew (2015) places the principles and corresponding instructional activities in a table to articulate how they were applied in the course. However, there seems to be inconsistencies between how Hew (2015) applies the principles and how Merrill describes them (Merrill, 2002, 2012). For the problem-centered strategy, Hew (2015) describe using real world example to illustrate good and bad design. Merrill talks about the problem-centered strategy are one in which component skills are taught in the context of a real-world problem; instructional activities for each skill are learned in a series of increasingly complex instances of the problem. The instructional activity Hew (2015) details aligns with Merrill's demonstration principle. It is not clear how Hew's course incorporated the problem-centered principle as Merrill describes.

The second limitation is based on recent research that is using student perceptions of Merrill's FPI and correlating it with various outcomes (Frick, Chadha, Watson, Wang, & Green, 2009; Frick et al., 2010; S. Lee & Koszalka, 2016). While these studies add to the literature and are able to incorporate a greater number of participants, courses, and instructors in their data, there is a limitation. Since these studies rely on students' self-reports, they do not explore how the first principles were applied, only the degree to which participants perceived their application. As evidenced above, there is a lack of clarity among instructional designers about how the principles are applied in practice, and future research needs to continue to explore how they are being applied, should be applied, and how this varies across disciplines and learning environments. Student perception data and correlations to outcomes can offer important insights, but it should not be to exclusion of these other studies.

Potential for guiding flipped course designs. One may wonder how and whether Merrill's FPI truly apply to a flipped classroom context. This question is not unfounded, given that the first principles are rooted in theories predating the emergent conceptualization of the flipped classroom by several decades: conditions of learning (Gagne, 1965) and component-display theory (Merrill, 1983). Conversely, the flipped classroom's modern popularization began in 2000 with an article referring to it as the inverted classroom (Lage et al., 2000). It's popularity greatly expanded over a decade later when Bergmann and Sams' (2012) published their book on the implementation of a flipped classroom in a high school science context. Does an instructional theory with deep roots preceding a modern application by over two decades still maintain its validity? Hasn't the world and education been radically changed by technology and isn't the flipped approach evidence of this change? Merrill (2012) reconciles this perceived gap in the introduction to his book on the first principles:

> While today's opportunities and contexts for learning are far more varied than they were only a decade or two ago, the underlying learning mechanisms of individual learners have not changed. It is important as we explore these different learning opportunities that we don't naïvely assume that because the landscape has changed dramatically the learners have also changed. There are fundamental instructional strategies, determined primarily by the type of content to be taught rather than by learning styles or by the form of instruction, that are necessary for effective, efficient, and engaging learning of specified knowledge and skill to occur. While their implementation may be radically different, those learning strategies that best promoted learning in the past are those learning strategies that will best promote learning in the future. (p. 7)

Change is inevitable and occurring at an increasingly rapid pace in this digital society (Zhao et al., 2016). The first principles, grounded in decades of prior research in learning and instruction, will still promote learning in emerging environments (Merrill, 2012). The flipped implementation may be radically different than how the principles were implemented upon their initial conceptualization, but this should not dilute their effectiveness. Rather the first principles should provide a sound theoretical basis for a flipped strategy that is often oversold, misunderstood, poorly delivered, and ill-defined (Bull et al., 2012; Hoffman, 2014; O'Flaherty & Phillips, 2015).

Utilizing a similar logic for merging the FPI with a flipped approach, Hoffman (2014) describes how she redesigned a qualitative methodology course. The results of her design met with resounding success as students expressed the highest level of satisfaction compared to all previous years offering the course. She notes several weaknesses cited about the flipped approach such as it can still be quite teacher-centered or merely a time-shifting scheme with little attention to instructional design. She calls for a return to instructional design principles and selects Merrill's first principles for their focus on problem-centered instruction as she views research as one giant problem.

While all of this aligns closely with the argument made in this study, her conceptualization and operationalization of the flipped classroom appears quite contradictory to the body of flipped literature (Hoffman, 2014). Her enactment of "flipped" was what others would term sequencing the content. Instead of presenting the practice of research in the customary sequence, she reversed the order and began by teaching analysis, verification, and conclusion. This "flipping" does not align with common definitions and characterization of what the flipped strategy is and how it should be applied (Y. Chen et al., 2014; Flipped Learning Network, 2014; M. K. Kim et al., 2014).

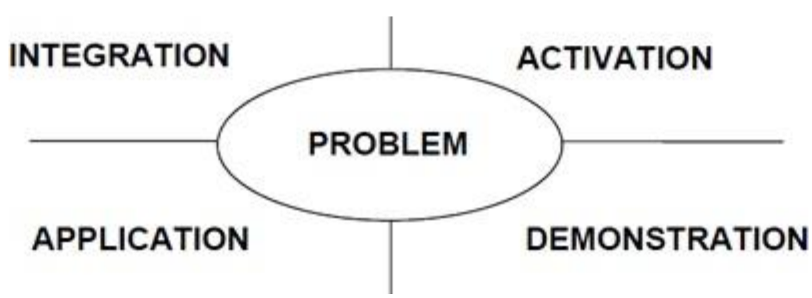
After reading the denunciation of flipped literature in the initial pages, it is not surprising that one would choose something different (Hoffman, 2014). Using Merrill's first principles may even have been an effective choice. However, one should not renegotiate a completely different "flipped" approach based on the assumption that the flipped strategy as discussed in the literature is entirely ineffective. It should first be noted that out of twelve citations in this article looking at the flipped classroom, only four were from peer-reviewed journals. Several were blogs and non-refereed publications sharing how the flip was poorly implemented or inadequate. Their lack of design principles and discussion of the rationale behind aspects of the strategy does not invalidate the strategy altogether, but it does provide evidence for the need to consider instructional design principles as a foundation.

The emphasis of Hoffman's (2014) initial attempt to use first principles with the flipped classroom is clear in the title: *Beyond the Flipped Classroom*. The author details how to use instructional principles to redefine and move past the flipped classroom in its entirety. The intent of the intervention in this study is not to move beyond the flipped classroom based on perceived inadequacies, but rather to confront these inadequacies through the application of the FPI. It is to detail how the FPI can inform the analysis, design, development, implementation, and evaluation of instruction via a flipped approach.

Theoretical Framework for this Study

Within this inversion of class time and space, the FPI (Merrill, 2002) have guided the flipped design of the course. The founding premise of the first principles is that they are applicable regardless of context or instructional program and necessary for effective, efficient, and engaging instruction. Merrill's goal was to identify principles of instruction that were fundamental to the majority of instructional design theories and models. According to Merrill (2002), a principle is a "relationship that is always true under appropriate conditions regardless of program or practice" (pg. 43). Briefly stated, the five first principles that resulted from his synthesis are that learning is promoted when: (1) learners solve real world problems, (2) prior knowledge is activated to serve as a foundation for new knowledge, and new knowledge is (3) demonstrated, (4) applied, and (5) integrated.

Figure 3
First principles of instruction

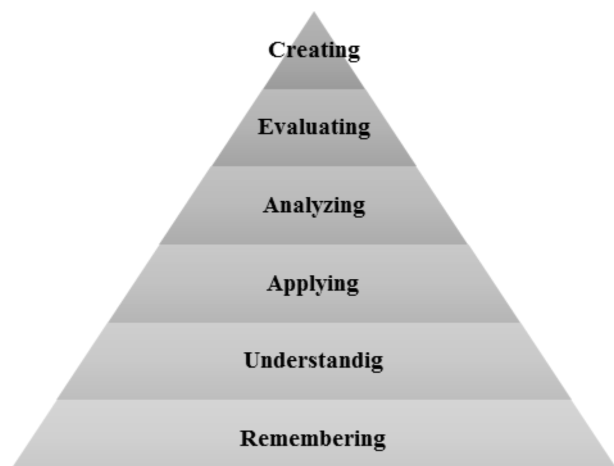


Note. Reprinted from "First Principles of Instruction", by Merrill, M., 2002, *Educational Technology Research and Development,* 50(3), p. 45.

Founding the study on these principles aligns with Bull et al.'s (2012) observation that the effectiveness of flipped instruction relates directly to the pedagogical strategies used. There are many ways to design a flipped classroom just as there are innumerable ways to structure online and F2F courses (Waldrop & Bowdon, 2015b). Merrill's principles (2002, p. 45) shown in Figure 3 provide a well-grounded model, and their focus on problem-centered instruction aligned with the primary learning outcomes of the course being discussed.

BRT, shown in Figure 4, was another critical dimension of the design of this course. This framework helps to provide a common language for statements of what students are intended to learn as the result of the instruction (Krathwohl, 2002). The six categories of the revised taxonomy, ordered from simple to most complex, are the following: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. These categories and the subsequent verbs and multidimensional matrices that incorporate the types of knowledge have been used widely for instructional design. A key component in this design was to determine how and when each learning outcome would be targeted in the phases of instructions, and the revised taxonomy provided the framework for this decision process.

Figure 4
Bloom's revised taxonomy



The first task during the flipped course design was to determine how first principles would inform the work completed prior to class and the in class instructional activities. Although the next sections detail when each principle was primarily implemented, it was evident that the principles were not entirely relegated to either portion of the class time. The content sequencing and delivery decisions were based on BRT's cognitive learning domain as this approach has been often used and argued as a hallmark of the flipped model (Gilboy, Heinerichs, & Pazzaglia, 2015; Khanova et al., 2015; Little, 2015; Touchton, 2015) and Merrill's problem-centered strategy. The lower levels of the cognitive dimension (Remembering and Understanding) were the foci of the pre-class activities. The higher order thinking levels of the domain (Applying, Analyzing, Evaluating, and Creating) were the foci of the in-class activities. This informed the targeted levels of instruction and what instructional medium would direct students thinking toward these cognitive levels. The sequencing of the learning outcomes was situated in the problem-centered strategy (Merrill, 2012). Students were shown the whole task during the first face to face session, and all subsequent learning outcomes built toward mastery of the task. The sequence of learning outcomes was determine based on the convergence the targeted cognitive level and specific component of the problem.

Figure 5
Flipped model of instruction

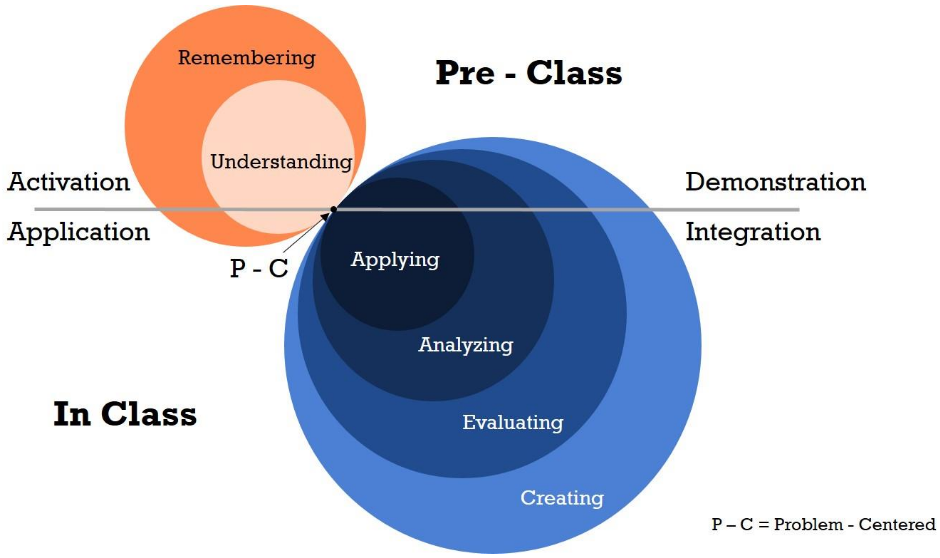


Figure 5 demonstrates how Bloom's Taxonomy and Merrill's FPI informed the design of this flipped course. First note the circles embedded within one another. The increasing connotes the increased emphasis each level of the taxonomy was given during the pre- and in-class portions of the course. A majority of instruction designed for pre-class activities is focused on the lowest level of the taxonomy, while instruction for in-class learning target increasingly higher levels of thinking. The delineation of pre- and in-class is seen by the horizontal line cutting across the figure. Note that while the majority of the Understanding and Remembering circles are above this line and Applying, Analyzing, Evaluating, and Creating are above, parts of all circles cross the line. This represents that while designing a flipped course using this framework, one would focus a majority of learning outcomes for the pre- or in- class portions on the levels of the taxonomy most represented in that section, these levels of thinking would not be entirely relegated to that portion of class time. Doing so would not allow for the flexibility that the design of effective instruction often necessitates (Morrison, Ross, Kalman, & Kemp, 2012).

Next, the framing of the FPI is seen in their placement in the figure on each side of the horizontal line denoting pre- and in-class portions. Activation and demonstration strategies occur primarily online to prepare students for the application and integration phases of instruction. This, again, does not mean these principles and their corollaries must be placed in either the pre- or in-class portions. It is that the affordances of technology leveraged by the flipped approach may be best utilized for those phases accordingly. However, the premature ending of the horizontal line is intended to communicate the potential fluidity of dividing these phases to pre- and in-class. As will be seen in this paper other factors such as the instructional goal need to be considered when designing instruction and implementing these principles.

Finally, the P-C visible near the center of the figure stands for problem-centered. Based a flipped approach on the first principles means that the instruction should engage learning in solving real world problems (Merrill, 2002). Showing the whole problem to the learners provides the context for the learning that will take place and can be motivational (Keller, 1987). Merrill argues that learning outcomes devoid of context may not be comprehensible to learners. A problem progression helps learners see the context and relate learning outcomes to one another. It is within this problem-centered strategy that the learning outcomes are written. The learning outcomes defined the learning that occurs within each component of the problem, and each component subsequently scaffolds learners toward mastery of the whole problem. The principles guide the design and development of the instruction for these outcomes and the problem.

Unsurprisingly, there is tremendous synergy between BRT, the FPI, and the flipped framework. Since the lower levels of Bloom's support higher order thinking, it is important to ensure that students have this knowledge to build upon (Touchton, 2015). Activating their prior experiences and schema and effectively demonstrating foundational concepts provides the necessary structures for the higher levels of thinking required in class. A study in a college calculus course (Sahin, Cavlazoglu, & Zeytuncu, 2015) concluded that activating students' prior knowledge online before class and demonstrating video content resulted in more confident and less anxious students, better preparation, and increased achievement. Opportunities for self-paced and independent preparation prior to class has also shown to increase participation and satisfaction among students (Gross, Marinari, Hoffman, DeSimone, & Burke, 2015). Once students arrive in class with this preparation, they are more equipped to succeed in the increasingly demanding phases of instruction; application and integration of learning.

Focusing on application and integration phases in class through active learning provides instructor support for the learners when they most need it (McGivney-Burelle & Xue, 2013; Merrill, 2012). An active learning environment is conducive to higher order thinking through timely instructor feedback, facilitation, and peer collaboration (Foldnes, 2015; Mangram, Haddix, Ochanji, & Masingila, 2015). In the traditional instructional paradigm, students are often sent home to apply concepts on a homework assignment. Integration of the learning may not ever occur as rote application of algorithms, memorization of facts, or the drafting of a potentially inconsequential written pieces are commonly assigned tasks. These tasks, regardless of relevance and integration, require more of students than listening to a lecture. It is at these critical moments, when students are required to awake from the stupor of passivity, that the traditional structure removes the scaffolds of support and sends them home to develop mastery in isolation.

Research Gaps

Flip, flipped, inverted, hybrid, and blended are terms often used interchangeably to describe ways in which classrooms diverge from a F2F only format to incorporating virtual activities in some form. What is rarely discussed is how these approaches build on what has been foundational in instructional design (O'Flaherty & Phillips, 2015). Authors would rather speak of its uniqueness and potential for widespread educational reform than to discuss how these approaches may be semantic differences for an emergent technology afforded mash-up of empirically grounded instructional design principles. Donaldson (2017) highlights the field's affinity for creating new words as names for old phenomena and calls for a shift toward using solid instructional design theory to sift through emerging trends.

Currently, this appears to be a gap in the literature on flipped classrooms (Goodwin & Miller, 2013). In their scoping review of this concept, O'Flaherty and Phillips (2015) cite a lack of robust scientific approaches being implemented to evaluate educational outcomes. They began with over 1,200 articles, and "only one study used empirical validation to show that a structured flipped classroom in comparison to the traditional one could effectively engage students in deep learning (O'Flaherty & Phillips, 2015, p. 94)." In their review, they narrowed the field of studies down to twenty-eight peer reviewed studies on the flipped classroom approach within higher education. A majority of these compared the flipped design with a traditional course by using student surveys. These studies showed an increase in attendance, final exam grades, and student satisfaction. The lack of robust evidence is disconcerting, yet it further emphasizes the need for a rigorous study of this concept.

Summary of the Literature Review

Amid the research on flipped approach and teacher preparation programs, tremendous effort should be made to detail the theories upon which it is built. Unfortunately, the literature appears to be producing beautiful a mosaic on an invisible wall. Much has been written for practitioners about tips for designing a flipped course, yet little has been published of rigorous empirical research or the development of sound instructional design models (Fulton, 2012; Gullen & Zimmerman, 2013; Ullman, 2013). The possibility for this approach to impact preservice teachers' TPACK is great, but the course must be designed well. In order for this to occur, it must be grounded in reliable instructional design principles and models such as the FPI. Rigorous empirical research should then be conducted that measures the impact beyond satisfaction levels input on course evaluations.

Chapter 3: Methodology

The purpose of this quasi-experimental mixed methods study was to compare the impact of First Principles of Instruction (FPI)-based flipped and F2F courses on preservice teachers' perceptions of their technological, pedagogical, content knowledge (TPACK) understandings and application of their TPACK to the design of technology-integrated lessons. This comparison was achieved by employing a nonequivalent control group design. Participants were from two versions of an Integrating Technology into Instruction II course for elementary and early childhood preservice teachers enrolled in the inclusive and special education program at medium-sized Northeastern university. Three sections of this course were utilized for this study – two F2F sections (2017 Spring), and one flipped section (2017 Fall). The research questions for the study were the following:

1. Does a flipped course based on the First Principles of Instruction impact preservice teachers' differently than a face-to-face course?
    a. How do preservice teachers' self-perceptions of TPACK understandings compare between the flipped and face-to-face course sections?
    b. How do preservice teachers' application of TPACK compare between the flipped and face-to-face course sections?
2. How do preservice teachers experience face-to-face and flipped technology integration courses designed according to the First Principles of Instruction?
3. How do the preservice experiences with the FPI explain their self-perceptions and application of TPACK?

It was hypothesized that the learning experiences in the both courses would have a positive impact on preservice teachers' TPACK. It was further anticipated that participants in the flipped course would perceive a greater increase in their own TPACK understandings as compared to the F2F group, and they would demonstrate an increased application of TPACK when designing technology-integrated lessons. Due to the focus on technological and pedagogical knowledge in the course, it was anticipated that the largest increases of students' self-perceptions would be their TK and TPK. Since PK was rarely discussed in isolation during this course, it was not anticipated to increase as sharply. Further, CK was a minor focus of the course, and as such, TPACK domains of knowledge including CK were expected to exhibit the least amount of positive change.

Research Design

In response to the research questions and recommendations from social science methodologists (Creswell & Plano Clark, 2006; Krathwohl, 1998), this study employed an embedded quasi-experimental non-equivalent comparison groups design (Figure 6). First, this section will discuss how the selected research design corresponds to the research questions and how the methods fit within the design. Secondly, this section will describe the strengths of the selected design. Finally, limitations to the design and the overall study will be considered.

Embedded nonequivalent groups design. The embedded quasi-experimental design figure below attempts to demonstrate the flow of this study and to highlight at what points the data will be generated. At the beginning and end of the semester, both groups completed the Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT) and designed a technology-integrated lesson (Schmidt et al., 2009). The first and third boxes in the top and bottom flow charts of Figure 6 demonstrate these points. The second boxes in each flow chart highlight the difference between the two groups. One group completed the course following a face-to-face (F2F) approach, and the second group completed a flipped model of the course. Both groups were prompted to reflect on their learning experiences, and these data were then analyzed for themes. Finally, the last box in both flow charts displays the interviews that occurred for each group. The interview questions differed slightly in order to probe participants for rich descriptions of their particular learning experiences and their interactions with the instructional activities in the course.

This research built upon an earlier study conducted during the spring 2016 semester (Hall, n.d.). That study examined the efficacy of the flipped model of instruction based in the FPI but employed a one group pre-test post-test design. The results of the study were promising, and the researchers documented the intervention and sought to make improvements. As Krathwohl notes, there is a considerable increase in protection against rival explanations by utilizing a non-equivalent comparison group design (1998). He goes on to argue that a non-equivalent comparison group is superior to a one group design in its potential to protect against history, maturation, testing, and instrumentation. The selected design appeared to be the most efficacious option, especially after ruling out the possibility of random selection and assignment.

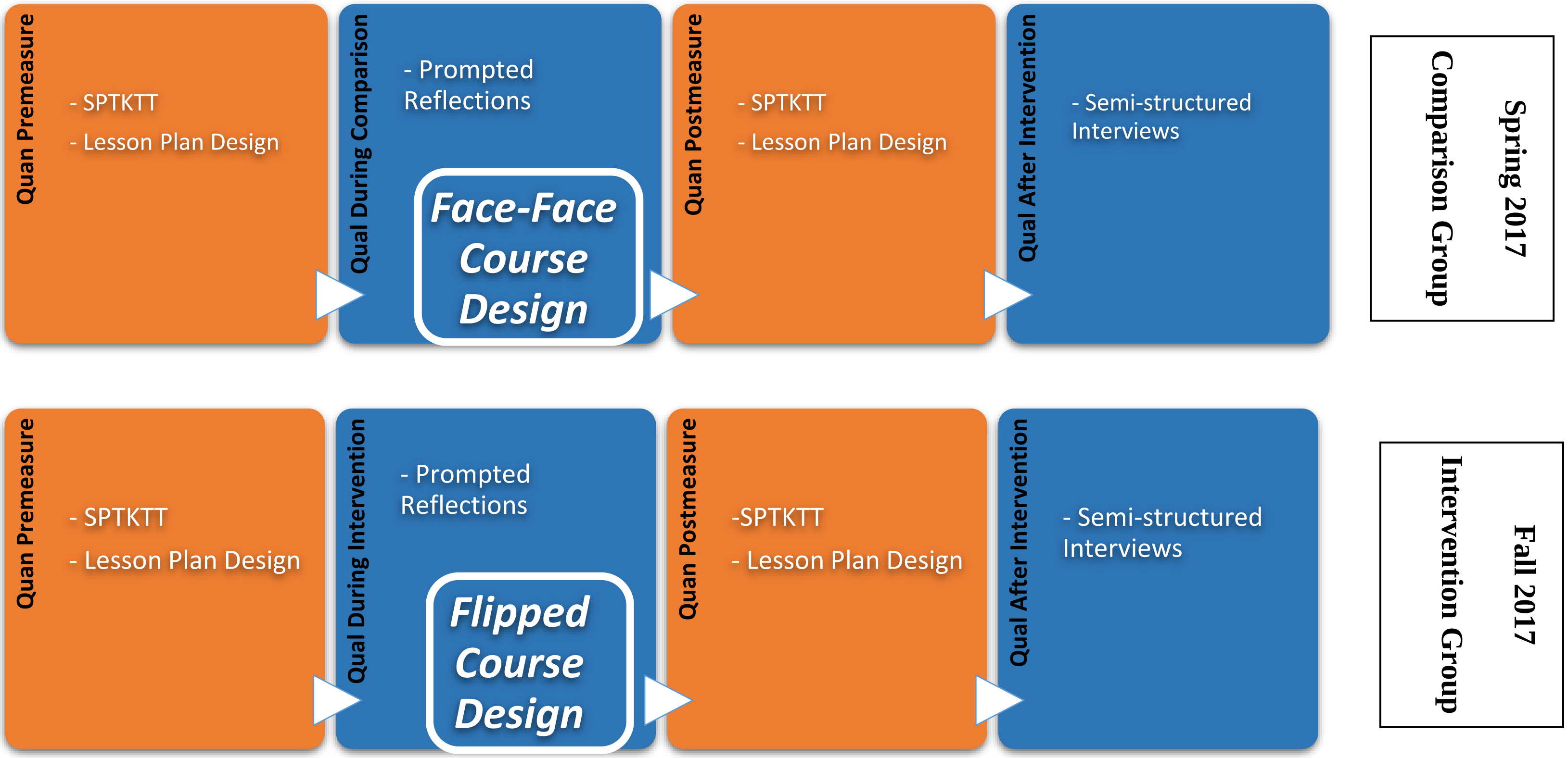
Randomization was not possible in this context with the participants of interest due to the nature of the teacher preparation program. By the time the preservice teachers reached this stage in their program, they have been placed in cohorts and completed classes with their peers. Even if the participants had been randomly assigned, this would have been entirely beyond the realm of their typical experience and considered obtrusive. Hence, the decision was made to utilize a quasi-experimental design.

The decision to incorporate a qualitative aspect in this design was based on Krathwohls' recommendation that every experiment should have an element of qualitative research (Krathwohl, 1998). This helped to better understand and incorporate the perspective of the participants and explored in more depth various aspects of the instructional approaches and participants' experiences. Krathwohl noted a personal experience when the results of an experiment were nearly the opposite of what was anticipated. During his interviews with participants, he discovered that they had perceived the intervention differently than intended, thus impacting the results. Krathwohl's experience considered, interviews following each course were incorporated to gather participants' in-depth descriptions of their experiences. Through these post interviews, it was hoped to better explain the outcomes of each FPI-based course (Creswell & Plano Clark, 2006).

Structuring the quantitative and qualitative components of the research design as an embedded design fit the study's goals. The primary research question comparing the impact of flipped and F2F approaches, designed according to the FPI, on preservice teachers' TPACK necessitated quantitative data. Hence the pre- and post-lesson plans and survey bookending the interventions.

Figure 6

Embedded quasi-experimental nonequivalent groups design



Regarding educational interventions, Dr. Tiffany Koszalka remarked on the great number that merely report outcomes as the result of the difference between pre- and post- measures without accounting for the learning process between these two points (personal communication, December 12, 2016). Learning and change, however, likely occurred throughout the intervention, and the opportunity was lost to capture these perspectives if one relied solely on quantitative measures of significance following the treatment. Hence the decision to embed a qualitative component in this quasi-experimental design - to "examine the process of the intervention" (Creswell & Plano Clark, 2006, p. 69). Prompted reflection journals generated data related to preservice teachers' descriptions of the course elements and their learning process. These data helped to better describe and substantiate claims about the mechanisms of the intervention that related to the variables measured. Table 2 outlines each data source and matches it to the corresponding research questions.

Table 2
Research questions and data sources

Research Question(s)	Data Sources
1. Does a flipped course based on the First Principles of Instruction impact preservice teachers' differently than a face-to-face course?	SPTKTT Lesson Plans
a. How do preservice teachers' self-perceptions of TPACK understandings compare between the flipped and face-to-face course sections?	SPTKTT
b. How do preservice teachers' application of TPACK compare between the flipped and face-to-face course sections?	Lesson Plans

2. How do preservice teachers experience face-to-face and flipped technology integration courses designed according to the First Principles of Instruction?	Reflections Interviews
3. How do the preservice experiences with the FPI explain their self-perceptions and application of TPACK?	SPTKTT Reflections Lesson Plans Interviews

Research Setting

The context for this study was an integrating technology into instruction course in a teacher preparation program at a Northeastern University. Inadequate integration of technology is often attributed to poor preparation by the undergraduate teacher training programs (Office of Educational Technology, 2016). A series of three one-credit courses was developed at this university to ameliorate this problem. These courses focus on developing preservice teachers' TPACK through the creation of digital learning objects and lesson plans. All three courses are required of all inclusive elementary and early childhood majors and must be taken in sequence.

The first course introduces students to the concept of technology integration and focuses on basic technology tools such as office tools and social media platforms. The second course shifts to the design of lessons, alignment of assessments with standards and instructional activities, and the integration of technology. Technology topics include web 2.0 tools, digital storytelling, assistive technologies, and Google apps for education. Finally, the third course spends a great deal of time on digital video creation, editing, and integration. Students are prompted to use digital video as a means of professional development and reflection.

Four graduate students are responsible for teaching these courses under the supervision of a faculty member. The courses meet in a lab containing seventeen Mac computers. An iPad and

PC cart are available for check out when needed, and a makerspace lab equipped with 3D printers is visited during the first course. Each course meets six times for two hours and fifteen minutes. Typically, students complete the first course during their freshman year, the third course during their senior year, and the middle course is completed sometime in between.

The course in which this study is situated was the second of the three required technology integration courses. During this course, students spent approximately half of the semester completing their field placements in a local elementary classroom. Therefore, the six class meetings were interspersed throughout the semester. The first three classes occurred during the first month of the semester, the next two classes occurred in the middle, and the final class met during the last week.

By the time students enroll in this course, they have been placed in a cohort. This cohort of students, known as “Block-2,” complete all courses together except for the technology integration courses. Due to the constraints of the physical space of the Mac lab, the cohort was split into two course sections in the spring semester. In the fall semester, enrollment numbers did not require more than one section. During this block of courses, the students also completed the following: a field experience in local kindergarten to third grade classrooms, Primary Grades Math Methods course, Social Studies Methods course, Inclusive Education Seminar, Differentiation for Inclusive Education course, and Creative Movement course. The culminating activity for the course coincided with their field placement. Students designed and implemented a lesson that integrated the technology available in their assigned classroom.

Participants

Preservice teachers participated in this study by completing a required technology integration course as part of their teacher preparation program. Per the IRB protocol, preservice teachers were informed of the study by a fellow graduate student who was not the course instructor. Participants were recruited at the end of the course. Of the 21 preservice teachers who successfully completed the course during the 2017 Spring semester, and the 12 who completed the course during the 2017 Fall semester, 32 participants were recruited for this study (F2F group n=20; Flipped n=12). One preservice teacher's major in the spring semester did not meet the inclusion criteria, and the data was not included.

The F2F and flipped groups were separated by a semester to limit the diffusion of treatment from the intervention to the comparison group. As mentioned previously, at this point in their program, students were grouped into a cohort. This meant that although the students were split into two sections for the integrating technology course, they still spent a great deal of time together in their other courses. To limit the potential diffusion of treatment that may have occurred through the sharing of resources, it was determined to provide the F2F course design to the entire cohort in the spring semester and to offer the flipped course design to a different cohort in the fall semester.

Intervention Design

Design process. The course in this study met six times over the course of a semester as the students spent approximately half of the semester completing their field placements in a local elementary classroom. The culminating activity for the course coincided with their field placement. Students were required to design and implement a lesson that successfully integrated the technology available in their assigned classroom. Students are typically in their second year of the teacher preparation program and have already completed a prerequisite introductory to teaching with technology course. The prerequisite course was not designed as a flipped course and was delivered face to face with enhancements on the learning management system. The following design decisions are discussed and detailed according to the design principles and model elaborated upon in the previous chapter. Table 4 specifies how the FPI were applied in both the comparison and intervention sections of the course, and the sections following it introduce the flipped model of instruction based on the FPI and discuss in more detail how this model was applied.

Table 4

First Principles of Instruction

Instructional principle	Explanation of the principle	Design and implementation of the face to face course	Design and implementation of the flipped course
1. Problem-centered	Learning is promoted when learners engaged in solving problems within an authentic context.	All the instruction was framed around the problem of integrating technology effectively in a lesson. Learners were expected to individually design and implement a lesson as a final assessment of the whole problem. Appendix D provides an example of the whole problem. Tasks, smaller components needed for the larger problem, were structured to support skill and knowledge development for this problem. Tasks included the creation of classroom-appropriate materials and the design of components included in their technology-integrated lessons. Each class meeting engaged students in developing appropriate instructional strategies that could be integrated into subject area teaching and learning through the creation of classroom-appropriate instructional materials. These instructional materials were situated within the context of a technology-integrated lesson that students would implement in their placement. Appendix D provides an example of the whole problem.	
		Learners were given the problems and component tasks to complete with their design team as “homework.” The instructor responded to questions via e-mail.	Learners were given 75 minutes to work on these problems and component tasks in class with their design team and instructor facilitation. Based on previous iterations of this design, most teams completed the given problem during this time frame.
1a. Show task	Learning is promoted when learners are shown the task or problem they will be able to complete after the instruction.	At the first-class meeting, students were presented with the whole problem. The instructor also showed the students a worked example of the problem. During each class, the instructor showed the component tasks to the learners through a model lesson that included worked examples of the component tasks.	
		The task was first shown to learners during class as the instructor models the specific component.	The task was first shown the learners online via a worked example, text-based explanation, or a short video segment.

1b. Problem progression	Learning is promoted when learners complete a series of associated problems whose connections are made explicit.	For each module, the instructor displayed a new version of the problem to the learners. The context of the problem varied, but the component tasks remained constant. For instance, the problem of designing a technology-integrated lesson plan always consisted of describing the scenario, identifying content and technology standards, writing learning objectives, creating instructional activities, and developing assessments. However, the context for this would change. Learners were asked to incorporate a specific type of technology, given a different subject area or grade level to teach, or asked to plan an activity for a school that only had access to devices via a bring your own device policy. To scaffold the learning, the first problem presented to the learners was complete except for one component task. Each successive iteration of the problem learners had to solve required them to complete the initial task and one additional task until they had demonstrated mastery on all component tasks. Both versions of the course incorporated problem progression. They differed as to when the learners engaged in solving the problem.	
		Learners completed a whole problem as an initial assessment. They then completed the next four problems with their design team as “homework.” The final version of the problem paralleled the original version in its structure and requirements, but the learners completed it individually.	Learners completed a whole problem as an initial assessment. They had 75 minutes per class to work on the next four problems as a design team. The final version of the problem paralleled the original version in its structure and requirements, but the learners completed it individually.
2. Activation principle	Learning is promoted when learners’ relevant prior experiences, knowledge, and skills are activated.	Various activities were implemented in class to facilitate the connection of new knowledge and skills with learners’ previous experience. These activities were generally allotted 30 minutes of class time and included learning experiences such as discussions, explorations of new material, and sharing prior knowledge through media creation.	Activation would typically occur twice. The first set of activation activities were online before class, and the second-time knowledge was activated was in class to connect the online and in class components. Online, learners would interact with the content and their peers. These interactions would be explorations of online resources relevant to the type of resource that would be created in class. Other times, learners would display what they already knew about the content by creating a slide or posting to a discussion board. Learners were also provided structures to help them organize new information for the module.

2a. Previous experience	Learning is promoted when learners discuss, explain, remember, detail, or apply previous knowledge as a base for new knowledge.	This corollary was applied when a discussion of past experiences took place with the instructor or peers. For examples, sharing about experiences with rubrics was done prior to a demonstration of using digital tools to create rubrics as an assessment. This discussion was held in-class for both course versions as it took place in the first class. Prior to the first class, there were no required online activities. Students shared what they thought a rubric was, its purpose, what would be characteristic of a good rubric, how they had seen rubrics used, and what they perceived about a specific rubric that may have helped or hindered their learning. At times, this corollary was applied differently between designs.	
		Learners in this context generally have prior knowledge of Universal Design for Learning (UDL) due to experiences in their program. As a way of connecting this prior knowledge to new knowledge of how technology can be integrated with universal design, students shared what they know in class by created a collaborative slideshow using Google Slides. Learners can represent what they know using text, images, audio, or video, and they can comment on their peers' slides.	As learners in this context generally have prior knowledge of UDL, this was activated via the creation of an online slideshow prior to the class meeting. Learners created a single slide within a class slideshow. For students who may have wanted to review UDL, resources were provided online such as a link to the UDL framework and videos explaining the three domains. Learners were also encouraged to view their peers' slides and leave comments. Upon arriving to class, the entire slideshow was presented, and a brief discussion held as a segue into a demonstration.
2b. New Experience	Learning is promoted when learners are given relevant new experiences that can serve as a base for new knowledge.	During class, the instructor provided opportunities to gain experiences with new technologies prior to using these technologies to create something new. For example, learners explored examples of Web 2.0 tools prior to a lesson on using Web 2.0 tools for instruction. There was a jigsaw discussion facilitated with an online post-it note board in class as another way to gain experience.	As this course focused on how to integrate technology, there were many relevant opportunities to give students experiences online. For example, prior to applying Web 2.0 tools for instruction, learners explored a Symbaloo (a Web 2.0 tool) of Web 2.0 tools. Learners also responded on an online post-it note board, another Web 2.0 tool. This same digital post-it note board was used in class for a jigsaw discussion. To provide experience with multimodal presentations, students also interacted with a VoiceThread presentation.

2c. Structure	Learning is promoted when learners are given a structure for organizing their new knowledge.	Attention, Relevance, Confidence, and Satisfaction (ARCS) (Keller, 1987)was a structural framework presented to students during class to help them recall strategies for motivating students. Another structural framework used was the Audience, Behavior, Condition, and Degree (ABCD) (Mager, 1997) mnemonic to help students remember the parts of a learning objective. Since this framework was taught in other courses in their program, the learners typically recalled its components and purpose. As such, the ABCD mnemonic helped them to recall parts of an objective prior to a lesson on integrating technology that aligned with the learning objectives. The learners worked with a peer write a learning objective using the ABCD framework and an assigned level of Bloom's Taxonomy for a specific content standard and context. Further, digital technologies were integrated into this practice objective as either the behavior or condition.	Using a VoiceThread presentation, the instructor presented the ARCS mnemonic to students online. Each component is explained, and an example provided to help students recall these strategies for motivation. In another lesson that focused on writing effective learning objectives, the instructor asked to recall the ABCD mnemonic. Videos were posted online for students who may not remember this framework. In both cases, an online quiz assessed students' understanding. Students could complete the quiz more than once if desired. In both cases, the students were expected to demonstrate an ability to recall the components of the frameworks, define each part, and recognize an example having characteristics of the framework.

3. Demonstration (Show me)	Learning is promoted when instruction shows the learner what is being learned rather than just talking about what is being learned.	Demonstration occurred regularly in this course. Rarely were the learners merely told information about what was being learned. The instructor provided worked examples of tasks, and presentations of content with video, audio, and text-based examples. Finally, the instructor modeled pedagogical behaviors and technological knowledge and explicitly attempted to draw out students' observations through course reflections. Approximately 30 minutes of class time was used for the demonstration about information with examples and non-examples. 45 minutes of class time was specifically devoted to modeling teaching behaviors with technology. While it was desirable to set an effective example of good teaching practice during the entire class time, there was an allotted time for demonstrating to the learners how effective teaching with technology might look when implemented in a lesson for K-5 students.	The demonstration principle was evident in both the online and face to face portions of this course. In the online space, the instructor demonstrated information about the content and examples of the content via videos, text, and images. Most of the content demonstrations were presented online. There were comparatively much fewer demonstrations of content during class time in this version of the course. Similar in both versions was that 45 minutes of class time was specifically devoted to modeling teaching behaviors with technology. This modeling demonstrated what pedagogical behaviors are effective when implementing a lesson with technology in a K-5 context. In this version course, however, the instructor modeled pedagogical behaviors in both the online and F2F portions of class time. The instructor prompted learners to reflect on these demonstrations in their journals. This was in addition to the instructor's attempt to explicitly state what behaviors were being modeled. Finally, the instructor provided demonstrations of procedures for the learners. Instead of using class time to talk about how to log into a new account such as Google Apps or Lynda.com, the instructor used a screen recording software to record the procedures. The instructor posted these procedural recordings online as a reference before class.

3a. Demonstration consistency	Learning is promoted when there is consistency between the learning goal and the demonstration.	Demonstration consistency was applied similarly in both sections of the course. Specifically, the instructor used examples and non-examples for concepts, and the instructor implemented modeling for demonstrations of behavior. In the lesson on writing learning objectives, the instructor showed examples and non-examples of effectively written objectives according to the ABCD framework. Before each time learners were assigned to apply their knowledge of a new digital tool, the instructor modeled how that tool could be effectively integrated into instruction.	
3b. Relevant media	Learning is promoted when media are integrated in a manner that does not distract the learner.	Each piece of media in this course the instructor selected purposefully and based on research recommendations for effective media integration (Mayer & Moreno, 2003). There were some videos used in both sections of the course. PowerPoint presentations, however, had a more prominent role in this course version as they were used to demonstrate content and directions for activities. The instructor carefully designed the presentations to incorporate relevant and intentional visualizations. Color choice and text size were also considered for accessibility. Presentations were available online on the day of the class meeting for students to download and use during class.	While the attention given to ensure media was relevant and of high instructional value was equally important in both course versions, the media played an important role during this version’s pre-class activities. Selection or creation of media required it to be less than six minutes in length and directly tied to a learning objective (Mayer & Moreno, 2003). Further, media with irrelevant text, audio, or visuals was not selected, as research has shown that extraneous information can interfere with the learning process. While some of the videos were used as stations in the other course version, students watched the videos online and completed the station graphic organizer in this version. Additional videos replaced the interactive lecture and PowerPoint presentations, however, the instructor still used PowerPoint presentations to manage the class and display directions for activities. These presentations were available for download at least one week before the class meeting.

4. Application (Let me)	Learning is promoted when learners apply their newly acquired knowledge and skills	Learners applied their new knowledge and skills primarily during the design of digital resources, learning activities, and lesson plans. Interspersed throughout the class were exercises requiring application of new knowledge. As examples of this, learners practiced writing learning objectives with a partner, a Kahoot quiz was completed to check for understanding, or during the last module students were given time to edit a video using EdPuzzle. However, the design team tasks had the highest concentration of the application principle. 4/5 of these tasks are assigned for students to complete after the class meetings.	The application principle was what guided the implementation of most the class time. Design teams had 75 minutes of class time to apply their new knowledge and skills within the problem-centered approach discussed previously. The team collaboratively designed parts of a lesson and selected accompanying resources. The lesson that learners designed during class required them to apply specific technological and pedagogical understandings from the module's lessons. Learners also applied their newly acquired knowledge online before class time. They completed quizzes to practice applying their knowledge and assess their learning.
4a. Practice consistency	Learning is promoted when the practice, posttest, and learning objectives are aligned.	As with demonstration consistency, this principle was evidenced similarly in both course versions. A core tenet of instruction held that practicing knowledge and skills inconsistent with the learning goals yields little improvement (Gagne, 1982). Therefore, these courses consistently utilized two forms of practice. When the learning goal was to know information about the content, the learners engaged in recalling or recognizing information. When the goal was to learn how to design lessons and digital artifacts, the learners engaged in applying the procedures for these actions.	

4b. Diminished coaching	Learning is promoted when appropriate feedback and scaffolding facilitate the problem solving.	Scaffolding was embedded within both courses using a problem progression. Although the instructor demonstrated the entire problem to the learners at the beginning of the semester, they were not expected to engage the whole problem until the end. Instead, the instructor scaffolded their learning by providing support for the unfamiliar tasks and gradually withdrawing support as the learners become more proficient. The final support was removed during the learners' final assignment as this was individually submitted. Until this final lesson, they were submitting tasks as a design team.	
		The instructor provided feedback to students on the course management system. Each design team task had a corresponding rubric. The instructor completed this rubric and annotated the submission with additional corrective comments. Further the instructor provided feedback on an as needed basis when learners e-mailed questions or prototypes.	Due to the flipped nature of this course version, the role of the instructor during class shifted to that of facilitator and feedback provider. During the time learners are engaged in their design team tasks, the instructor moved throughout the room providing corrective feedback or pointing out how the learners can extend their design beyond the minimum requirements. The instructor also provided feedback on the submitted assignments by completing corresponding rubrics and annotating the submissions in the course management system. Finally, the instructor sent feedback as needed when learners e-mail questions or prototypes.
4c. Varied problems	Learning is promoted when there is variation among the problems learners solve.	The problems were varied in several ways as a means of providing several examples of integrating technology into instruction. This variation was inherent to the problem and remained the same between course versions. The problems varied in the following ways: subject area, topic, content standard, learning objectives, grade level, context, ISTE standard, and digital tools to integrate into instruction. For problem number 5, learners were asked to complete parts of the problem with information gathered from the field experience. Thus, the variation in this problem was authentic as it represented the variation in their classrooms.	
5. Integration	Learning is promoted by supporting learners' transfer of learning.	Integrating new knowledge, potentially TPACK, into their teaching practice was the goal of both course versions. Thus, integration was implemented in the design and implementation of a technology-integrated lesson for their field experience. Both courses assigned this to students as a means of encouraging the transfer of new knowledge into practice.	

5a. Watch me	Learning is promoted when, given the opportunity, learners publicly show what they have learned.	During the final class, all learners presented what they learned from the design and implementation of their technology-integrated lesson plan. Each learner was asked to reflect on the experience, discuss their digital artifacts and the implementation, and share what they learned from the process.	
		After class 5, design teams posted their lesson designs and resources to a discussion board on the course management system. Each student was assigned another design teams' lesson to review.	At the end of modules 2-4, 15 minutes were allotted for a design team to display their lesson and share what they learned. During module 5, all design teams presented their final work to their peers.
5b. Reflection	Learning is promoted when learners are urged to discuss, defend, and reflect on their learning.	Throughout the semester, learners completed written reflections in response to prompts. The prompts were intended to guide learners thinking about a critical aspect of the lesson or to consider what new knowledge and skills they had acquired from the learning experiences.	

Problem-Centered. In this study, preservice teachers were engaged in solving real-world problems through the iterative design of increasingly complex, technology-integrated, lesson plans and digital artifacts. Merrill's problem-centered principle states that, "Learning is promoted when learners are engaged in solving real-world problems (Merrill, 2002, p. 45)." As indicated in the model in Figure 5, a significant portion of class time in the flipped course was dedicated to the Creating level of thinking per BRT (Krathwohl, 2002). This level was targeted through focusing on the overarching problem and components skills for the course. Students were expected to synthesize their knowledge for each module, and eventually the course, by constructing technology-integrated lessons. The problem of designing the lesson plan was broken into five distinct phases. The number of phases was based partly on contextual factors such as the number of class meetings and when the students would be in their field placements, but it was also related to components of a conventional lesson. The phases were content and technology standards, learning objectives, learning activities, assessment, and context. Each module focused on a technology tool and a specific phase or component of the whole problem.

In each module, the students were taught about a specific phase in a lesson planning process. For example, in the standards phase, the students analyzed the ISTE standards for teachers and students and compared them with standards for a selected content area. They looked for areas of synergy, and a discussion concentrated on what certain ISTE standards meant and how they might be evidenced in practice.

Following a lesson on the module's new component skill, an entire problem or instructional scenario was presented to the students. This aligns with the show task corollary. Learning is promoted when the task or problem that students should be able to complete as a result of the instruction is shown to them (Merrill, 2002). An example of the show task corollary can be seen in the first module when the focus component skill was assessment. All parts of the problem were provided for students except for the assessment component. They had to design an assessment that would measure the provided learning objective, fit within the given context, and align with the standards and learning activities. Additionally, there were requirements for integrating the technology focus of the module which was creating digital rubrics and using Google Forms to create quizzes.

In each module, the problem shifted to a different context, and the complexity of the problem increased as preservice teachers were required to apply more component skills each week. The increased complexity of subsequent problems and the provision of multiple problems was intended to increase learning based on the problem progression corollary (Merrill, 2002). It holds that learners' skills improve as they complete simpler tasks. Gradually, their skills build until they can master the whole problem (Merriënboer et al., 2002). Since module one's focus component skill was assessment, students were required to plan an assessment during this module and each subsequent one. Module two's focus sub task, writing effective learning objectives, was provided to students in module one, but required of students in module two and remaining modules. In this way, it was intended for students to develop mastery of isolated component skills as they navigated toward the final week when they completed the whole problem and each of its sub tasks with their design team. This, however, was still a scaffold for their final project, when they were expected to plan an entire technology-integrated lesson plan for their field placement. Additionally, they implemented the plan, provided evidence of its implementation, and reflected on their experience.

Activation. During the pre-class activities in the flipped design, structural frameworks presented and discussion of student experiences with the content was facilitated in an attempt to activate prior knowledge. The Remembering and Understanding levels of Bloom's Taxonomy defined the learning outcomes during this phase of instruction. Students were tasked with recalling (Remembering) what they already knew about the topic, discussing (Understanding) prior experiences with peers, and organizing (Understanding) new ideas according to a structural framework. These activities were based upon the second principle, "Learning is promoted when relevant previous experience is activated (Merrill, 2002, p. 46)" Three examples were the use of the Mager's framework for learning objectives (Mager, 1997), the creation of a Universal Design for Learning alphabet, and a Frayer model to focus on the properties of Web 2.0 technologies. These examples were selected to display how each corollary of Merrill's activation principle was considered.

To begin, a mnemonic is a form of a structural framework that is shown to aid learners in remembering procedures and components (Merrill, 2012). An illustration of a structural framework used in this design is Mager's Audience, Behavior, Condition, and Degree (ABCD) mnemonic for writing learning objectives (1997). The mnemonic provided structure for students during a module focused on writing effective learning objectives and planning how to support these objectives with technology. Many students in this course had prior experience with learning objectives as most were in their third year of the teacher preparation program. However, most had not yet utilized Mager's structure for writing objectives. The focus of this activity prior to class was to connect these components of writing an objective with prior experience and to have knowledge of this specific structure when arriving at class. A framework such as Mager's is one way to activate and structure knowledge, and graphic organizers can serve a similar function (Marzano, Pickering, & Pollock, 2001).

Figure 7
Student examples of slides for "K" and "P" in the UDL alphabet

Merrill also wrote that having peers share about previous experiences with the content is an effective way to activate prior knowledge (Merrill, 2012). An illustration of how this principle was applied in this design is the Universal Design for Learning (UDL) principles alphabet activity. This activity facilitated virtual peer sharing about students' prior knowledge and experiences. It challenged learners to begin thinking about the role of technology in designing instruction based on UDL principles. The task was assigned to students before class, because the students in this course customarily have a great deal of prior knowledge related to UDL based on their preparation as inclusive education majors. This activity was designed to engage them in showing what they already know, and it also modeled a way to incorporate a Web 2.0 tool into instruction.

Using Google Slides, the instructor provided a 26-slide presentation with a single letter of the alphabet displayed on each. The instructor selected the letter E to serve as an example and created a poster slide about UDL that began with the letter E. The expectation was for each student to display what they knew about UDL by creating a slide for the letter of their choice and to observe the slides of their peers (see Figure 7). Additional resources were provided on the learning management system for students who may have needed to review the UDL principles. This activity involved the students in a low risk activity that seamlessly integrated technology. It modeled UDL and technology integration through multiple means of expression (e.g. images, text, video, color, and layout on the slides), and engaged students further with the content as they browsed their peers' slides. Elaborating on this phase's activation of prior knowledge, the demonstration phase ensued to provide clear portrayals of information.

Demonstration. Although the demonstration phase of instruction occurred throughout the pre- and in-class portions of the flipped design being described, it constituted a bulk of the pre-class activities. Relevant media and multiple representations of the content during provided various portrayals of the information for the learners. When describing the role of multimedia as a necessary component of instruction, Merrill notes that (2012) irrelevant media components and distracting features can be detrimental to the demonstration phase, yet well-designed media has shown to be effective (Mayer & Moreno, 2003). When identifying existing or developing new instructional materials for the pre- and in-class activities, care was taken to evaluate their relevance and to diminish the distraction of competing modalities.

The demonstration consistency corollary states that there should be alignment between the type of demonstration and the intended learning (Merrill, 2002). In both flipped and F2F designs, there were varying types of demonstration incorporated that were intended to match the specific learning outcomes as framed by BRT (Krathwohl, 2002). For example, students were given information about the concepts and portrayals of the concept when they were being expected to relate these concepts to one another (Understanding), define a given concept (Remembering), recognize its properties (Remembering), or be able to illustrate the idea (Understanding). Additionally, they were provided with several examples and non-examples when tasked with categorizing the concept based on its components (Analyzing).

Consider the learning objectives module described previously. Each aspect of the ABCD structure was defined to the students, and examples of correctly written objectives were shown. Students were then given examples of objectives written according to the ABCD framework and examples of objectives that were inadequately written. This type of demonstration was consistent with the goal of remembering and understanding concepts prior to class. Modeling was also used in both pre- and in class activities of the flipped course to prepare students for planning their technology-integrated lessons.

Modeling has been identified as the type of demonstration to be used when a change in behavior is the intended learning outcome. These behaviors were most often framed by Bloom's Revised higher order levels of thinking and subsequently elicited during class. Students were assigned to write their own learning objectives (Applying), breakdown scenarios and standards during the planning process (Analyzing), justify decisions made during the lesson design (Evaluating), and develop activities and assessment consistent with the learning objectives (Creating). Discussed next were times when modeling was used to demonstrate a desired behavior.

After working through the module's foundational concepts online before class, it was anticipated that students in the flipped course would be more prepared to observe a model of how these concepts related to technology integration planning. The instructor made his thinking explicit as he taught a model lesson using an ABCD learning objective. When Web 2.0 was the focus digital tool, the model lesson incorporated a wiki. During the model lesson, preservice teachers were assigned the role of a third grader and built a single page on the wiki to meet the modeled learning objective. After the model lesson, the application phase of instruction took place, and preservice teachers were tasked with developing their own wiki or website as an instructional tool for an assigned instructional problem scenario. During each class, the instructor modeled a targeted component skill prior to requiring students to exhibit the skill during the application phase.

Application. In the physical class meeting of the flipped course, preservice teachers were given opportunities to apply their knowledge and gain proficiency on each component skill needed to effectively plan a technology-integrated lesson. Merrill refers to this as the “let-me” phase of instruction. It refers to the practice of a new skill of application of knowledge (Merrill, 2002). As such, this phase can incorporate practice for learning outcomes at any level of BRT. It is most important that the type of practice is consistent with the objective (Merrill, 2012). Although there were some opportunities to practice with new knowledge at the remembering and understanding levels during the pre-class activities, a majority of the application phase occurred in class and targeted the Applying and Creating levels of the taxonomy. Merrill refers to these types of practice as how-to practice (Merrill, 2002). The following paragraphs provide examples of how the application phase was structured in this flipped design.

After a model lesson, students were tasked with creating digital artifacts and lesson plans that demonstrated their TPACK. Applying this knowledge to increasingly complex tasks also provided evidence regarding students’ progression toward mastery of the whole problem: designing and implementing a technology-integrated lesson for their field placement. Coaching and feedback were incorporated into the design as they have been identified as critical to learning (Shute, 2008). Formative feedback was provided in the form of completed rubrics for each lesson designed, annotated assignments, and verbal conversations with individuals and groups. Coaching was incorporated by working with each group during the design of their lessons and was gradually removed as the semester progressed. The instructor would offer suggestions for a lesson component or think aloud about how a piece could be designed. Corrective feedback and coaching can both enhance learning, but only when the application of a task is consistent with the intended learning outcome (Merrill, 2012).

Similar to the consistency corollary for demonstration, it is necessary that the application phase is consistent with the intended skill (Merrill, 2012). An example of a how-to application activity in this flipped design was when students were required perform specific directives when designing a lesson and to create and incorporate a multimodal presentation. The goal of this activity was two-fold. First, preservice teachers would be able design a technology-integrated lesson the met the assigned content standard. Secondly, they would be able to create a presentation utilizing multiple modalities to support student learning.

The content standard of the lesson to be planned was for first graders to be able to distinguish between defining and non-defining attributes of shapes. Creating a multimodal presentation did not merely necessitate students to splash pictures and text on the screen with background narration. The critical interdependence of TPACK domains would frame this presentation as a negotiation of the preservice teacher's depth of content understanding, their understanding of best teaching practices and the multiple technological decisions that would impact the quality of the presentation and the effectiveness of the delivery. The next phase regularly occurred in conjunction with application as students were often asked to justify their planning and design decisions.

Integration. Integration occurred at various intervals throughout this flipped design. In class, students were challenged to reflect, discuss, defend, explore, and create. Students also kept reflection journals online to document their learning experiences throughout the semester and to consider how they could integrate this learning into their future teaching. Learning outcomes during this phase of instruction primarily aimed to meet the Creating and Evaluating levels of BRT as students assessed their peers' lesson designs (Evaluating), revised their own lessons (Creating), and devised ways to use what was learned in class during their field placements (Creating) (Krathwohl, 2002).

Merrill's three integration corollaries are that learners should be given opportunities to (1) show their learning publicly, (2)"reflect on, discuss, and defend their new knowledge or skill…, (3) create, invent, and explore new and personal ways to use their new knowledge or skill (2002, p. 50)." To encourage students to explore new ways to use their knowledge and skills, they were provided a new technology tool or resource to engage in each module and were challenged to consider how it could be incorporated into their teaching toolbox. They often shared these ideas with peers through class discussions or during group design projects.

Another illustrative component of integration occurred during the design projects. Students collaboratively created a technology-integrated lesson plan intended to demonstrate what they had learned about pedagogy, technology, and content during the corresponding module. Following the lesson design, groups presented their plan, the resources they had created, and their rationales for design decisions. Peer groups offered feedback and posed questions about design decisions. The presenting group responded to the feedback by further explaining the decision, providing additional support for their design, and by using the feedback to improve their lesson.

An example of how the reflection corollary was applied in this design was how students individually reflected after each module on what they had learned about designing the technology-integrated lesson planning. Reflection prompts were provided to facilitate students' thinking about critical aspects of the design process. Prompts asked about what instructional strategies were used to support learning, whether they felt the selected technology tools supported the instructional strategies, and often probed for deeper explanation by requiring rationales. They were also prompted to think about what lesson modifications would better exemplify TPACK in their upcoming lessons, field placements, and future classrooms.

Date Source Overview

Four primary data sources were generated during this study: (1) survey, (2) student reflections, (3) pre- and post-course lesson plan designs, and (4) semi-structured interviews. While the researcher had access to all students' coursework for data analysis, it was believed that the reflections and lessons plans offered the greatest amount of data relevant to the research questions. The interviews were the only source of data not part of the assigned coursework for the class. As such, interviews were conducted with convenience sample instead of all participants.

Technology-integrated lessons. Pre- and post- lesson plan designs were completed using a specified template that is available in Appendix D. Participants were familiar with the language used in the template and the idea of designing a lesson with technology as they had all completed the prerequisite course, IDE 201. In the pilot study (Hall, n.d.), participants did not express confusion when completing a lesson design at the beginning of the course. The instructor explained that some components may not be completed on the pre-lesson due to their lack of knowledge about the context. For instance, the participants knew what elementary school their placement was located and the grade level, but they did not know the number of students in the class, technology available for teaching, nor the topic their supervising teacher would assign them to teach.

For the post-design, the participants completed the template with authentic information. For the initial lesson design, they were directed to complete the template by selecting a topic of their choice and assigning their own contextual information to the lesson. The TIAR used for the analysis of this data source does not account for contextual variation. Since identifying and accounting for contextual variation was a component of TPACK highlighted in the course, these components of the lesson plan were intentionally kept in the lesson plan design to prompt students to being thinking about these ideas.

Semi-structured interviews. The semi-structured interview was conducted by the researcher with a convenience sample of participants at the end of the semester after final grades were posted. The protocol overview in the following paragraphs can be found in full in Appendix D. Patton (2002) details six types of interview questions that can be drawn from when constructing a protocol: (1) experience and behavior, (2) opinion and value, (3) feeling, (4) knowledge, (5) sensory, and (6) background/demographic. As this protocol was constructed, attention was paid to how these types of questions may impact the flow of the interview.

It was also important to vary the way participants were probed about the phenomenon. Some question types, however, were deemed either unnecessary or irrelevant to this study. For instance, sufficient background/demographic data was collected through other means such as the SPTKTT. Further, consistent with recommendations by deMarrais (2004), this protocol attempted to elicit fuller description and detailed narratives from participants through the design of well structured, open-ended questions. Finally, this protocol was meant to support a guided approach to interviewing. Guided interviews are intended to assist the researcher in thinking about potential gaps in the information being collected by reviewing how the guide prompts respondents (Patton, 2002).

The topics were specified ahead of time to construct a more systematic approach to the data collection. The initial questions, labeled opening sequence, were intended to help the participant feel at ease during the interview. They were general questions asking the participants about their experiences with technology and opinions about its role in education.

The next section of questions focused largely on the course itself. While this section was labeled *experiences with the intervention*, the questions were still asked of the F2F group. Any mention of *flipped* in these items was reworded to *this course*. Participants in both groups had experiences with the phases of instruction, activation, demonstration, application, integration, and problem-centered (Merrill, 2012). Questions for the F2F group only differed slightly in how they referred to time. For instance, question nine asks the intervention group about pre-class activities; this was changed to homework for the F2F group.

For the F2F group, the final section of the interview protocol was responsive to their knowledge of flipped classrooms. This section, titled *integrating knowledge*, probed participants about how and why they might utilize a flipped approach in the future and what skills they may need. Since the F2F group did not receive instruction designed according to the flipped model, they had varying levels of familiarity with this idea. Therefore, an initial question for the comparison group asked them what they knew about flipped classrooms. If the comparison group participant was unfamiliar with this idea, they were provided with a definition of "flipped instruction" before proceeding with the interview.

This interview guide was not meant to be rigid but was intended to provide direction to the interviewer while still permitting the conversation to be responsive to the participants. Numbered questions were given precedence, and questions following the lower-case letters were probes that were asked as deemed necessary and appropriate by the interviewer. Therefore, the interviewer selected to ask additional questions to further probe the participant about their experiences.

Reflections on learning. A third source of data will be prompted reflections written by students throughout the semester to document their learning. Reflection is an instructional principle articulated in Merrill's (2012) integration phase and a critical aspect of preservice teacher development (National Commission on Teaching & America's Future, 2016), but also served to document students' learning experiences in the course. Students wrote five reflections, one after each class meeting, responding to prompts about course activities. A final reflection was written after the final class meeting as a response to prompts about their lesson design, implementation, and experiences in the field.

Survey of TPACK understandings. Finally, the SPTKTT measured participants' perceptions of their TPACK understandings. The SPTKTT, developed by Schmidt et al. (2009), was administered during the first and last week of the course. This survey measures each of the seven domains of TPACK. One version of the survey also measures participants' perceptions of faculty TPACK and integration of technology in methods course, but these items were not used as they were not relevant to this study's research questions. Administration of the SPTKTT was conducted via a web link placed on the course's learning management system. The items were stored and structured in Qualtrics, and the survey will be administered through this system. The next section discusses the validity and reliability of the instruments used in this study.

Instrumentation

Survey of Preservice Teachers' Knowledge of Teaching and Technology. The SPTKTT measured participants' self-perceptions of their TPACK understandings (Schmidt et al., 2009). The adapted survey contained forty-seven Likert scale items specifically written to measure preservice teachers' perceptions of their TPACK. The content knowledge section was broken apart into four different subject domains that preservice teachers typically learn about in their preparation programs. A copy of the instrument is included in Appendix A.

To validate the SPTKTT, Schmidt et al. (2009) conducted a pilot study with 124 preservice teachers. Based on the results, twenty-eight of the original items were deleted. After the items were deleted, the authors conducted a second factor analysis, and a strong level of internal reliability and validity was established. For the remaining forty-seven items, Cronbach's alpha values ranged from .75 to .92 for the seven TPACK subscales. The authors continue to revise the instrument as new research informs effectiveness, and others modify the instrument to fit contextual needs (Schmidt et al., 2010).The table below summarizes the internal consistency statistics for the SPTKTT's subscales.

Table 4
SPTKTT reliability

TPACK Domain	**Internal Consistency (alpha)**
Technological Knowledge (TK)	.82
Content Knowledge (CK)	
Social Studies	.84
Mathematics	.85
Science	.82
Literacy	.75
Pedagogical Knowledge (PK)	.84
Pedagogical Content Knowledge (PCK)	.85
Technological Pedagogical Knowledge (TPK)	.86
Technological Content Knowledge (TCK)	.80
Technological Pedagogical Content Knowledge (TPACK)	.92

(Schmidt et al., 2009, p. 131-135)

Technology integration assessment rubric. A potential weakness in studies relying solely on the use of self-report data is that it may not be reflective of actual increases in participants technology integration practice (Harris et al., 2010). In fact, it could be more indicative of their confidence related to technology integration rather than their ability to apply this knowledge. Hence, researchers have called for measures of the application of this knowledge and an analysis of the relationship between the self-report data and external assessments (Abbitt, 2011).

Harris et al. (2010) recognized the many data types that can be triangulated to infer teacher's knowledge of technology integration and acknowledge the strength of observations. However, they also recognized the limitations that research and preservice teachers have regarding the observation of lessons. Hence, they state that. "A more feasible alternative is to analyze teaching artifacts that both demonstrate the results of teachers' decision-making, while also providing a pragmatic window into their pedagogical reasoning: their instructional plans (Harris et al., 2010, p. 2)."

The TIAR was developed to counter a lack of technology integration instruments available in the literature and to provide a more pedagogically achromatic assessment tool. In their literature review, Harris et al. (2010) found a single instrument intended to measure the quality of technology integration that had been tested for validity and reliability. This was used as a starting point to create a more robust TPACK-based version. Further, the authors found that many often spoke of technology integration from a purely constructive pedagogical perspective. They wanted to create an instrument that would not be biased toward this orientation but would allow for multiple pedagogical viewpoints and their relationship to the integration of technology.

Several processes were undertaken to establish the reliability and validity of this instrument. Construct validity was established for this instrument through a review by TPACK experts (Harris et al., 2010). Identified and selected by the instrument developers (Harris et al., 2010) as part of the validation process, five out of six TPACK experts agreed the instrument would measure the TPK, TCK, and TPACK from the instructional plan and provide a solid overview of participants' technology integration knowledge. The sixth expert did not believe that an instructional plan of any sort could provide enough information to adequately demonstrate technology integration knowledge. While that review could be viewed as problematic, it is important to remember that this study is not solely relying on the TIAR to draw conclusions about participants' TPACK.

Face validity was established for the TIAR by testing its utility with experience technology-integrating teachers who served as scorers and provided feedback regarding its use and perceived utility. Reliability for the instrument was established through multiple iterations of testing, feedback, and revisions at two universities in different regions of the United States. Intraclass Correlation Coefficient, interrater reliability, test-retest reliability, and the internal consistency using Cronbach's alpha were all found to be acceptable. A copy of the TIAR can be found in Appendix B.

Data Collection Timeline

Data was collected from January 19, 2017 – December 22, 2017. The Data Collection Timeline presented in Table 5 lists key events and their corresponding dates. The SPTKTT (Schmidt et al., 2009) was completed by participants during the first week of class and after the final class for both groups. Participants in both groups also individually designed a technology-integrated instructional plan between classes 1 and 2. Both groups once again individually designed a technology-integrated instructional plan between classes 5 and 6.

Table 5
Data collection timeline

Date	Description	Task
1/19/2017	Class 1	Students learned the same topics as outlined in the flipped course but via a F2F format that presented content in class followed by homework to be completed thereafter. They completed the
1/19 – 1/25	Lesson Design 1	
1/26/2017	Class 2	
2/02/2017	Class 3	

2/23/2017	Class 4	first individual lesson design between classes one and two, and they completed the final individual lesson design during their final placement.
3/09/2017	Class 5	
3/09 – 4/21	Lesson Design 2	
4/20/2017	Class 6	Jiaming Cheng, a fellow graduate student researcher, collected and stored student consent forms.
4/20/2017- 4/23/2017	Grade and Submit	Graded all remaining assignments and submitted final course grades to designated sections on MySlice. Reviewed consent forms.
4/24/2017	Contacted interview participants.	
4/24/2017 – 5/05/2017	Conducted interviews.	
5/8/2017 - 6/30/2017	Analyze collected data	Conducted statistical tests on pre- and post-course survey data. Coded and analyzed reflections for themes Conducted statistical tests on pre- and post-test lesson plans.
7/03/2017 - 7/10/2017	Discuss with committee chair and committee members.	Discussed the results with the committee chair and committee members. Went over the data from the post course surveys. Resolved any problems. Talked about the next steps in the research project.
Fall 2017	Class 1	The content during the intervention was delivered via the flipped model. Participants completed the first individual lesson designs between classes one and two and completed the final individual lesson design during their final placement.
	Lesson Design 1	
Fall 2017	Class 2	
Fall 2017	Class 3	
Fall 2017	Class 4	
Fall 2017	Class 5	
	Lesson Design 2	
Fall 2017	Class 6	Jiaming Cheng collected and stored student consent forms.
4/20/2017- 4/23/2017	Grade and Submit	Graded all remaining assignments and submitted final course grades to designated sections on MySlice. Reviewed consent forms.
12/11/2017	Contact interview participants.	
12/12/2017 – 12/22/2017	Conduct interviews.	
1/8/2018 - 2/28/2018	Analyze collected data	Conducted statistical tests on pre- and post-course survey data. Coded and analyzed reflections for themes. Conducted statistical tests on pre- and post-test lesson plans.

3/05/2018 - 3/09/2018	Discuss with committee chair and committee members.	Reviewed the results with the dissertation committee. Went over the data from the post course surveys. Resolved any problems. Talked about the next steps in the research project.
3/12/2018 - 3/30/2018	Draft of dissertation manuscript	Wrote the final draft of dissertation manuscript.
4/2/2018	Meet with dissertation chair and committee	Reviewed and edited final manuscript.
4/06/2018	Submit final manuscript.	Submitted final manuscript to the dissertation committee.

Methodological Attention to Potential Limitations

An embedded quasi-experimental nonequivalent group design has several strengths relating to internal validity. If the study employed a single groups design, one could have reasonably argued that any potential significance resulted from a testing effect. The use of a second group receiving the same pre- and post-test lesson plans addressed this threat to validity. As both groups received the same levels of testing, the potential benefits that one received from completing the first test should also be experienced by the other group.

Mortality as a threat to internal validity was not an anticipated issue in this study due to the naturally occurring nature of the context. The study was situated within the confines of a required course. All aspects of the study, except for the post course interviews, were completed by the students as part of the course requirements. Within the four years the researcher has taught the course, all students have completed it and received credit. The potential to be less obtrusive than a “true” experiment has been noted as a strength of an *in situ* quasi-experimental approach.

Two aspects of the design reduced the likelihood of maturation posing a serious threat to the results (Krathwohl, 1998). First, given the short time period of each groups’ intervention (1 semester) and the age of the participants, it is unlikely that participants will have significantly changed due to biological and psychological processes. Second, it was assumed that whatever maturation occurred within the F2F group also may have similarly impacted the flipped group.

Instrument decay “refers to changes in the measurement of observation process in ways that might account for the observed effect (Krathwohl, 1998, p. 516).” This did pose a potential threat to this study as two instruments were applied to answer several research questions (Harris et al., 2010; Schmidt et al., 2010). Since the researcher applied the Technology Integration Assessment Rubric (TIAR) to students’ technology-integrated lessons, it was susceptible to bias. To minimize this potential threat, a second researcher applied the TIAR to each lesson plan as well.

The primary researcher, who is also the course instructor, assessed the plans at the end of each semester in order to assign a course grade to students. This researcher knew what lessons were the pre- and post-tests. The second researcher, however, was blind to the potential influence of knowing whether lesson design was complete before or after the course.

Differences in usage and interpretation of the TIAR was another threat to validity. The primary researcher trained the second researcher in the use of the TIAR, and they practiced applying the TIAR to lessons during the pilot study (Hall, n.d.). To further improve reliability among the researchers, the researchers met regularly to compare their interpretations and discuss any differences in the use of the TIAR.

Finally, selection was not anticipated to influence the results of this study. Groups were formed by placement of students into their respective cohorts. Volunteers were not recruited for either group. All participants were required to complete the course satisfactorily regardless of whether they were in the F2F or flipped group. The researcher was unaware of any selective factor influencing the placement of participants in groups that may have also impacted the results. The next section further details these steps to address potential limitations in the study as it reports results of the manipulation check and procedures for checking the instructor's biases. While this section reported how potential limitations foreseen by the researcher were addressed through the research design, a section at the end of chapter six discusses additional limitations encountered during the study that were not accounted for by the selected methods.

Quantitative Data Analysis

This study compared the impact of two FPI-based courses on preservice teachers' self-perceptions of their TPACK understanding and application of TPACK when designing technology-integrated lessons. To examine this impact, the quantitative data analysis focused on comparing the two conditions (F2F and flipped) on two outcomes variables. Further, the study also explored preservice teacher learning experiences as the qualitative analysis of their reflection journals and the interview transcripts sought to better understand how they interacted with the content in each course version and how they perceived the FPI elements impacting their learning experiences.

Checking the instructor role bias: Students' perceptions of instructor quality. As I enacted the roles of designer in the course sections, instructor, and researcher, a limitation of this study may have been the bias introduced, either consciously or unconsciously, through these roles. To analyze and potentially limit the instructor role bias, the participants rated the following six items on the course evaluation related to their perception of instructor quality. These items and the analysis to follow have been applied similarly in this context to analyze the potential bias of the instructor as researcher (Johnson, 2012).

1. Instructor is knowledgeable about the topic (Knowledge).
2. Instructor is prepared (Preparation).
3. Instructor presents materials in a way that helps me learn (Presentation).

4. Instructor encourages participation (Participation).
5. Instructor is enthusiastic about teaching (Enthusiasm).
6. I would recommend the instructor to others (Recommend).

The items were answered on a Likert scale from 1=strongly agree to 5=strongly disagree. As this scale is opposite of all other scales in this study, the data were reversed prior to analysis. Therefore, the measures of central tendency for these data which were all above 4.00 indicate that participants tended to agree or strongly agree with these statements in both course sections.

The exploratory analysis of these data showed that all items were significantly correlated except for knowledge and participation. Additionally, Cronbach's alpha value for the items was at an acceptable value of .871. The significant correlations, such as *Enthusiasms'* correlation above .620 (p = .01) with every other item, may indicate potential redundancy on this instrument with high internal reliability. Given the instrument's purpose in this study was to control for overt instructor bias, it was deemed adequate for analysis.

The data, however, did not meet the assumptions of normality for a parametric test, and I employed a Mann-Whitney Test to identify statistically significant differences between the F2F and flipped groups' perceptions of instructor quality. The null hypothesis is that participants in the F2F and flipped courses will perceive no difference in instructor quality as measured by *Knowledge, Preparation, Presentation, Participation, Enthusiasm, and Recommend*. Based on critical values of the Mann Whitney Test results shown in Table 6, the null hypothesis cannot be rejected. This means there is no statistical evidence that participants in the F2F and flipped courses perceived instructional quality differently.

Table 6
Mann-Whitney U test results and descriptive statistics for perceptions of instructor quality

Item	*Group*	*n*	*Mdn*	*M*	*Min*	*Max*	*Range*	*SD*	*Mean Rank*	*U*	*Z*	*p*
Knowledge	F2F	21	5.00	4.81	4.0	5.0	1.0	.402	18.86	108.0	1.315	.326
	Flipped	13	5.00	4.54	3.0	5.0	2.0	.660	15.31			
Preparation	F2F	21	5.00	4.76	4.0	5.0	1.0	.436	17.95	127.0	.440	.753
	Flipped	13	5.00	4.69	4.0	5.0	1.0	.480	16.77			
Presentation	F2F	21	4.00	4.00	2.0	5.0	3.0	1.095	17.00	126.0	.403	.727
	Flipped	13	5.00	4.15	2.0	5.0	3.0	1.068	18.31			
Participation	F2F	21	5.00	4.52	3.0	5.0	2.0	.750	18.24	121.0	.635	.600
	Flipped	13	5.00	4.38	3.0	5.0	2.0	.768	16.31			
Enthusiasm	F2F	21	5.00	4.67	4.0	5.0	1.0	.483	18.67	112.0	1.016	.400
	Flipped	13	5.00	4.38	3.0	5.0	2.0	.768	15.62			
Recommend	F2F	21	4.00	4.24	2.0	5.0	3.0	.889	16.76	121.0	.603	.600
	Flipped	13	5.00	4.46	3.0	5.0	2.0	.660	18.69			

Comparing perceptions of instructor quality between groups revealed no statistically significant differences. The perception with the largest difference between groups was instructor's knowledge of the content, but even this difference did not approach statistical significance. Measures of central tendency for these data support a conclusion that participants in both sections had an overall positive perception of instructor quality. Only the instructor's presentation of materials received a score of two in both sections. A single participant in each group disagreed that the instructor's presentation of the material helped them to learn. Further contributing to the consistency between groups, *Presentation's* mean value was the lowest of the six items. While this may represent an area of improvement for the instructor, it was not perceived differently in the groups. As such, these data appear to support the null hypothesis that participants in the F2F and flipped courses perceived no difference in instructor quality.

Manipulation check. During the semester, a peer course instructor observed the entire class meeting four times for both course versions. She documented her perceptions of instructor quality and her observations of the implementation's consistency with the design. The observer documented ratings of instructor quality using the same scale that students completed on their course evaluations, but she only completed the items for *Knowledge, Preparation, Participation*, and *Enthusiasm.* The other two items, *Presentation* and *Recommend*, were deemed irrelevant to the purposes of the manipulation check.

Apart from two observations of the instructor's *Preparation* in the F2F section at a value of 4.0, the course observer reported perceptions of the instructor's quality at the maximum values (max = 5.0) for all other observations. Thus, the observer's perceptions of instructor quality were comparable between sections.

However, the observer also documented course elements, and differences were apparent between groups. One distinct difference noted by the observer was how much time was allocated for lecture in each group versus how much time students spent working in collaborative groups on their design problems. In the flipped course, lecture time ranged from eight to 11 minutes and in the F2F course sections, lecture time ranged from 37 to 59 minutes. As intended by the designs, time allocated to students working with peers on their design team tasks ranged from 62 to 72 minutes in the flipped course, and from zero to 30 minutes in the F2F sections. Qualitatively, the observer wrote that during the design team activities in the flipped course the instructor circulated the room, answered questions, noted students' accomplishments, and provided feedback. In the F2F sections, however, the instructor used approximately 10 minutes explaining the design team task and answering questions prior to the teams commencing their collaborative activity outside of class. These differences in time allocation were proposed in the design of each course while other elements were proposed to remain constant.

Other course elements, modeling and discussion, were noted as having similar time allocations and group structures. The observer noted these elements lasted approximately 30 minutes when implemented. In both the F2F and flipped courses, the observer also documented a mixture of groupings during instruction: whole class, pair, individual, and small group (3-4 students). These observations of comparability suggest that course elements were implemented as proposed, and the instructor quality was perceived as consistent in both treatments.

Exploratory data analysis. After exporting the raw data from the Qualtrics Research and Experience Software, the data was reviewed in Excel for inconsistencies and missing data. In the survey system, all responses were required of participants, and all participants completed the survey as part of the course. Hence, there were no missing responses on the SPTKTT, and there was a one hundred percent response rate. Survey responses were sorted by participant name. Random.org was used to generate a list of random numbers. These numbers were then assigned to participants. The same random number assigned to identify all participants' data. After these assignments were made, participants names were removed from the data. A dummy variable was also included to discriminate between F2F and flipped groups.

Next the data files were imported into IBM SPSS Statistics 24 and descriptive statistics were examined for inconsistencies and features of the data. Means and standard deviations for both groups were calculated for all pre- and post- survey scales and subscales. This was done to check for potential anomalies and to analyze for significant pre-existing differences between the groups. Correlations were also calculated for all outcome variables.

For the TIAR scores, the researchers input this data based on their application of the TIAR to the participants technology-integrated lessons. Both the pre- and post- lesson designs were a requirement of the course. All participants submitted these assignments, and both researchers' scores were accounted for in the Excel file.

In the next chapter, Table 9 displays the descriptive statistics for the SPTKTT responses, and Table 12 shows the descriptive statistics for the TIAR scores. SPTKTT and TIAR descriptive statistics will be discussed further in the sections devoted to their results, but two items will be mentioned here briefly. First, the mean pre-test scores on the SPTKTT were well above the midpoint. Some participants scored the maximum on several subscales, and only three participants scored the lowest value on an item. This elevated perception of one's TPACK on the pre-test may have limited the results, and has been discussed as a limitation of relying solely on preservice teachers' perceptions of their knowledge (Brantley-dias & Ertmer, 2013). Secondly, outliers were identified in the data on both instruments. To determine the potential impact of these outliers on the planned analyses, a sensitivity analysis was executed (Tate, 1998).

Sensitivity analysis. The identification of three outliers in the SPTKTT data and a single outlier in the TIAR data prompted a sensitivity analysis. A sensitivity analysis attempts to deduce whether an identified outlier constitutes an influential observation. Tate defines an *influential observation* "as an observation with excessive influence on any important results. The qualifier 'excessive' means an influence which qualitatively changes some study conclusions (1998, p. 50)." If these observations exert an excessive influence, the researcher may unfortunately report results based mostly on these few influential observations. A sensitivity analysis, then, helps a researcher judge the magnitude of these observations and plan how to conduct the remaining analyses.

According to Tate's method for sensitivity analysis, one must calculate the "proportion change of the point estimate of the Δβ largest in magnitude (1998, p. 51)." He suggested that a proportion of change greater than 0.3 would be considered large in many cases, but he also stated than one must determine a threshold of practical importance for each context. After calculating the proportion change of the Δβ's for each outlier in the SPTKTT data, none were identified as influential observations. When analyzing the outlier in the TIAR gain score data, Beverly's observation had an influential proportion change at .49. Based on these results and Tate's recommendations, I conducted the remaining analyses of the TIAR data with and without Beverly's TIAR data.

Reliability of Measures. Using Cronbach's alpha, the reliability of the TIAR and the subscales of the SPTKTT were evaluated. Of the twenty-two pre- and post- alphas calculated for the subscales, twenty-one were above 0.80. This indicates a strong degree of internal consistency among the items within each scale. The TPACK construct on the post-test, with a value of 0.78, was the only alpha value below .80. Although lower, researchers have noted that 0.70 is an acceptable value, and others have reported comparable alpha values when using this instrument with similar participants and contexts. (Johnson, 2012; Schmidt et al., 2009). Table 7 displays the alpha for each subscale and the inter-item correlation statistics. For item by item correlation statistics, please refer to Appendix H.

Table 7
Reliability statistics for SPTKTT and TIAR in this study

Instrument	Subscales	Cronbach's α		Inter-Item Correlation		Average Inter-Item Correlation		# of Items
		Pre	Post	Pre	Post	Pre	Post	
SPTKTT	TK	0.897	0.916	.43-.75	.50-.74	0.60	0.66	6
	CK Math	0.918	0.940	.78-.83	.83-.85	0.81	0.85	3
	CK SS	0.923	0.838	.77-.88	.53-.70	0.82	0.63	3
	CK Science	0.933	0.933	.76-.86	.80-.87	0.82	0.82	3
	CK Literacy	0.943	0.963	.81-.89	.85-.95	0.85	0.90	3
	PK	0.924	0.911	.31-.85	.39-.93	0.65	0.62	7
	PCK	0.919	0.836	.65-.82	.35-.82	0.75	0.59	4
	TCK	0.977	0.909	.87-.93	.58-.93	0.91	0.71	4
	TPK	0.956	0.939	.52-93	.34-85	0.72	0.64	9
	TPACK	0.953	0.782	.70-.93	.25-.74	0.81	0.52	4
TIAR	None	0.903	0.905	.59-.85	.61-.80	0.72	0.71	4

SPTKTT analysis. After the descriptive analysis of the SPTKTT data, assumptions of a MANCOVA were checked. As the proposed covariate, preservice teachers' pre-survey scores, was deemed inadequate, assumptions for a MANOVA were tested. As Levene's test indicated the data violated the assumption of the homogeneity of variance, a non-parametric test of variance was selected, the Mann-Whitney U test. After observing potential differences between the groups with the Mann-Whitney U test, the differences between pre- and post- course perceptions were analyzed with a Wilcoxon Signed Ranks test. Effect sizes were calculated for both the Mann-Whitney U and Wilcoxon Signed Ranks test.

TIAR analysis process. For the application of TPACK, all of the participants' pre- and post-test lesson plans' design were rated by two researchers using the TIAR (Harris et al., 2010). The TIAR, a TPACK-based rubric, was applied to preservice teachers' technology-integrated lesson plans. Preservice teachers completed a plan at the beginning and end of the course. They utilized the template in Appendix D to guide their plans for both pre- and post- designs. Due to program requirements, the second plan was required in a social studies or math lesson. Preservice teachers were completing field placements in conjunction with social studies and mathematics methods coursework. As such, their second plan was also implemented in the field.

The requirement to implement the second technology-integrated lesson in a classroom was a requirement of preservice teachers' program of study. It may have influenced differences between the lesson designs and is a factor that should be controlled for in future studies. It should be noted, however, that the TIAR does not account for whether plans are implemented. The structure of the TIAR focuses solely on the planning processes and design thinking as it relates to TPACK.

The TIAR is composed of four components that are rated on a scale of increasing proficiency from 1 to 4: Curriculum Goals & Technologies, Instructional Strategies & Technologies, Technology Selection(s), and "Fit." Technology Selection(s) will be discussed as an example of the TIAR's assessment of planning processes. This domain assessed the participant's selection of a digital tool and its' compatible with the instructional goals and strategies. On the pre- lesson designs, participants selected technologies based on their prior knowledge of digital tools for teaching. They were not required to consider the contextual constraints or affordances of a specific classroom setting at this early state in the semester. For the post- lesson design, participants' selections were limited by what was available in their classrooms. The design of this study is unable to account for the impact this may have had on specific selections. The TIAR assesses the design decisions made by the participant–not the contextual factors nor implementation of the plan. Selection of technologies for a plan, therefore, could occur for both pre- and post- designs and be assessed with the chosen instrument.

The primary author employed a second researcher, with funding from the Syracuse University School of Education Research and Creative Grant, to rate the lesson designs with the TIAR. This second researcher was a doctoral student in the School of Education and a course instructor familiar with the TIAR and technology integration development of preservice teachers. The researchers piloted the instrument with preservice teachers' technology-integrated lesson plans in this context (Hall, n.d.) and developed a working process that was then implemented in this study.

For scoring lessons designs in this study, the course instructor downloaded all lessons from the Blackboard learning management system and anonymized the documents. Random numbers, retrieved from Random.org, were assigned to both pre- and post- lesson designs. While the primary researcher was aware of what lessons were pre- and post- lessons due to his role as course instructor, the second rater was blind to this distinction.

The lesson designs, identified by numbers, were ordered from least to greatest. Researchers scored the lessons in this order by completing a digital TIAR that was created on the Qualtrics survey platform. Inter-rater reliability was evaluated after sets of ten scores were completed. Researchers met weekly to discuss scoring, and lessons with total scores between raters differing by greater than two were scored together during these meetings. Researchers reached consensus on these lessons and drafted memos to document the discussion. These memos were then used to better articulate the researchers' interpretations of the TIAR and to improve their future inter-rater reliability.

Exploratory and case analysis were conducted to identify possible anomalies in the data and to examine outlier that may have exerted excessive influence on the regression coefficient. After checking that assumptions were not violated, Preservice teachers' TIAR gain scores (posttest – pretest) were examined with an analysis of variance (ANOVA) with treatment group (F2F vs. flipped) as the independent variable. A single sample *t*-test was next computed to investigate differences between participants' TIAR gain scores and a zero change.

It has been argued that when studies include only two scores per participant, as was the case with these TIAR date, the analysis of gain scores and the ANCOVA are mathematically equivalent and should therefore reveal the same results (Smolkowski, 2013). While the reliability of gain score analyses have traditionally been debated (Dimitrov & Rumrill, 2003), Smolkowski (2013) notes that a gain score analysis better answers questions about how two groups differ in their gains. Smolkowski further argues that gain score analyses are highly appropriate for non-randomized designs. As this non-randomized study is concerned with how two groups differ in their gains, a single sample *t*-test of gains scores was deemed an appropriate follow-up analysis.

Phenomenological Analysis

For each participant, eight course assignments were analyzed, resulting in approximately 240 written artifacts. The researcher interviewed four participants, three from the F2F course (Andrew, Aadan and Angie) and one from the flipped course (Brooke). Interviews ranged from 27 to 42 minutes. All interviews were recorded, imported into MAXQDA, and transcribed verbatim. MAXQDA was the computer assisted qualitative data analysis software (CAQDAS) used to organize, manage, code, and categorize the data.

Although originally intending to interview four participants in each group, scheduling interviews at the end of the semester was more difficult than anticipated. Most participants in the cohort did not remain on campus more than a day or two after the final course meeting. Only Angie's interview was conducted as proposed, F2F the week after the final course. Andrew and Aadan's interviews were conducted in the following fall semester, and Brooke's interview was conducted virtually the week after the final class. While the small number of interviews represents of potential limitation in this study, it is one source of data among three others in this study. The experiences described by the four interviewees were valuable and offered additional depth to the reflection data. Both were analyzed using a descriptive phenomenological approach that seeks to value all participants experiences equally (Cilesiz, 2009).

The descriptive phenomenological method was selected for its alignment with the research questions that focused on exploring participants' experiences with course elements in both the F2F and flipped course versions. Further, a phenomenological approach has been applied to similar studies in educational technology to explore pre-service and in-service teachers learning experiences and TPACK development (C. Clark & Boyer, 2015, 2016; Lin, Groom, & Lin, 2013).

Phenomenological research attempts to represent the general nature of the phenomena by exploring it from the various perspectives of those who have experienced the phenomena (Matua & Van Der Wal, 2015). Thus, this study sought to represent the phenomena of experiencing a technology integration course intended for pre-service teachers that has been designed according to the FPI. From this analysis, general themes or the essence of the experience were represented as a textural-structural synthesis. The essence represented by this study does not intend to be a universal truth for experiences in technology-integrated courses or even in the same course at this university. Rather, as Moustakas wrote, "The fundamental textural-structural synthesis represents the essences at a particular time and place from the vantage point of an individual researcher following an exhaustive imaginative and reflective study of the phenomenon (1994a, pp. 101–102).” As a researcher continues to study a phenomenon, an infinite number of experiences may be discovered (Husserl, 1931), yet the goal is to best describe the general lived experiences of the participants and the essential aspects of the phenomena under investigation.

While many have claimed technology alters the outcomes of teaching and learning, technology has also been shown to alter experiences with teaching and learning. It is from this foundational difference that Bruce and Levin constructed their media taxonomy; the premise that learning with media as opposed to from media may alter how learners communicate, construct, inquire, and express themselves (1997). As teaching and learning with technology, interactions with technology, and technologically designed environments comprise phenomena unique from teaching and learning absent of digital technologies, this represents an area of needed research from a phenomenological tradition (Cilesiz, 2011).

Historically, however, research in educational technology has stemmed from post positivist and constructivist philosophies (Cilesiz & Spector, 2014). Phenomenology as a philosophy and research methodology has not typically been used but has been argued to have strong potential for future research. “Research in educational technology has started to attend to the theme of experiences with technology; however, the field would benefit from formulating a clear and coherent research agenda to explore experiences with technology, consistent with a related philosophical and methodological framework for the advancement of this agenda (Cilesiz, 2011, p. 488).” The analysis plan that follows was intended to explore these experiences and to do so in a rigorous manner consistent with the philosophical tradition and corresponding methodological framework.

Engaging in descriptive phenomenological analysis. In this section, I will first discuss the Epoche/Bracketing process. The remaining phenomenal analysis will be grouped into two sections: (1) Phenomenological Reduction and (2) Imaginative Variation and Synthesis.

Epoche/Bracketing. Epoche or bracketing is intended to help the researcher reduce bias when representing the experiences of the participants (C. Clark, 2013). It is a systematic effort to lay aside judgements and one's experiences with the phenomena. Bracketing helps the researcher to be open and receptive to what the participants are expressing in an attempt to see their experiences with a fresh perspective (Moustakas, 1994b).

For me, the epoche process was difficult, because I brought many prior experiences and prejudgments to the data and because of my relationship to the phenomena. To help maintain an openness to the participants, I wrote about my technology integration course experience as a preservice teacher before the analysis process, and I kept memos of my subjectivities while analyzing the data. What follows are bracketing excerpts.

Bracketing excerpt. My elementary education program had one required educational technology course, yet it was hardly what I had anticipated. As a digital native, my childhood interactions with technology began when I was born. My father fondly recalls watching a baseball game on television with me in his arms. By the time I was four, I had my own computer games, video games, and favorite programming on public television. My expectations for a course on educational technology were to learn how I would use these past digital experiences that had shaped so much of my childhood for educational purposes.

The three-credit online course, however, focused on the parts of a desktop computer. By the end of the course, students could label the parts, describe their functions, and explain the internal processes of a computer. Upon completion of this course, I was ill prepared for my first job in a brand-new school outfitted with document cameras, interactive whiteboards, Adobe creative suites, digital microscopes, iPads, MP3 players, netbooks, laptops, desktops, and a wireless microphone system in every class. The technological knowledge I did gain from the course was disconnected from an authentic environment and did not connect these skills to the actual practice of teaching.

Phenomenological reduction. To begin this process, I read through the data multiple times. During the first iteration, I wrote only memos and reflected on my subjectivities. In the second iteration, I began to record participants statements related to the phenomena of technology integration and interactions with course elements by noting all relevant statements in the MAXQDA. By the third iteration, participants' statements were placed in categories based on what aspect of the experience they were describing. Participants' experiences, split apart into these meaning units, were then analyzed and placed into themes based on what parts of the experience they were describing. At times during this process, MAXQDA was used to investigate the presence of meaning units in each participants' data and group together similar meaning units while at other time, data were printed and spread across the room for manual highlighting and notetaking.

Imaginative variation and synthesis. During imaginative variation, participants' clustered experiences were analyzed for underlying structures of the experiences. These themed meaning units were analyzed via different perspectives in an attempt to discover the essence of the experience. For example, were structures of participants experiences similar in both the F2F and flipped courses? Based on the quantitative data, did participants who perceived themselves as technologically proficient or non-proficient describe the experience differently? Sifting the participants' experiences through these variations was an attempt to uncover the common structures of experiencing elements of the FPI-based technology integration course, the invariant constituent of the experience. These common essential structures (Cilesiz, 2011) were then used to produce an account of participants' experiences that incorporated the essence of their experience along with in-depth descriptions from participants' interactions with the phenomena.

When considered together, the analysis of the quantitative and qualitative data addressed the final research question of how preservice experiences with the FPI explain their self-perceptions and application of TPACK. The quantitative portion examined the presence of a statistically significant impact and potential difference between groups, and the qualitative analysis provided an in-depth description of students' learning experiences in the course and documented the relationship of their learning to the FPI.

Chapter 4: Significant Impact of the FPI with No Differences between Groups

In this study, the design and implementation of flipped and face-to-face (F2F) courses designed according to the First Principles of Instruction (FPI) were explored, and their impact on preservice teacher's technology integration development were compared. The research design, an embedded mixed methods design, supplementarily utilized quantitative and qualitative data. According to Creswell and Plano Clark (2006), a key feature of an embedded design is that one type of data is framed by the other type of data wherein the secondary data are meaningful and useful for understanding the primary data. In this study, the qualitative data served a secondary and supportive role to the quantitative data. The descriptive phenomenological analysis of participants' learning experiences in both groups is intended to explain the learning outcomes measured by the quasi-experimental study.

The primary aim of this study, therefore, used the Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT; Schmidt et al., 2010) and the Technology Integration Assessment Rubric (TIAR; Harris et al., 2010) to compare the learning outcomes in two course settings, flipped and F2F. The secondary purpose was to explain how preservice teachers interacted with course elements and to richly describe the experience of participating in courses designed according to the FPI. The results and analysis presented in this chapter will focus on the quantitative analysis of the learning outcomes. Guided by the primary research question below, the analysis and ensuing discussion examine the FPI-based courses' impact on preservice teachers' self-perceptions of technological, pedagogical, content knowledge (TPACK) and its application to technology-integrated lesson designs.

1. Does a flipped course based on the First Principles of Instruction impact preservice teachers' differently than a face-to-face course?

Participant Overview

Of the 20 participants in the spring, 16 were junior-level students, three were seniors, and one was a sophomore. Seventeen of the spring participants were female, and three were male. These participants, comprising the F2F treatment group, were all inclusive elementary and special education majors.

Table 8
Participants' pseudonyms

Face-to-face				Flipped			
Pseudonym	**Gender**	**Year of School**	**Major**	**Pseudonym**	**Gender**	**Year of School**	**Major**
Andrew	M	Sophomore	IE	Brooke	F	Junior	IE
Aadan	M	Junior	IE	Brenda	F	Junior	IEC
Arthur	M	Senior	IE	Brittney	F	Junior	IEC
Angie	F	Junior	IE	Beverly	F	Junior	IE
Addison	F	Senior	IE	Brandy	F	Junior	IE
Arianna	F	Junior	IE	Brooklyn	F	Junior	IE
Aleka	F	Junior	IE	Bonnie	F	Senior	IE
Aubrey	F	Junior	IE	Betty	F	Junior	IE
Avery	F	Junior	IE	Brianna	F	Junior	IEC
Allie	F	Junior	IE	Brynne	F	Junior	IEC
Ann	F	Junior	IE	Bree	F	Junior	IE
Amber	F	Junior	IE	Bridget	F	Junior	IEC
Alicia	F	Junior	IE				
Agnes	F	Junior	IE				
April	F	Sophomore	IE				
Ali	F	Sophomore	IE				
Alyssa	F	Sophomore	IE				
Ashley	F	Junior	IE				
Adeline	F	Junior	IE				
Andrea	F	Sophomore	IE				

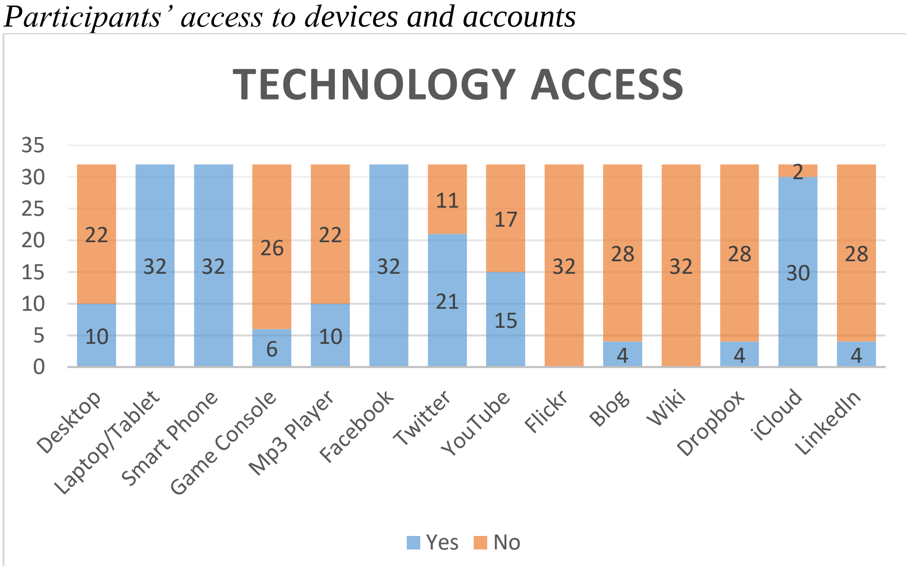
IE = Inclusive elementary and special education
IEC = Inclusive early childhood and special education

All participants in the flipped treatment group, enrolled during the fall semester, were female. Five were inclusive early childhood and special education majors, and seven were inclusive elementary and special education majors. Eleven participants in this group were junior-level, and one was a senior. Although prior research has shown that factors such as gender and year of school have not influenced the technology integration development of preservice teachers, pre-tests were administered to control for potential group differences.

For the purposes of clarity throughout the paper, all pseudonyms for participants in the F2F group begin with the letter *A.* All participants' pseudonyms in the flipped group begin with the letter *B.* The pseudonyms were generated with an online random name generator. The generator was set to construct a random list of the common names for each letter. Only gender was considered when selecting pseudonyms for the participants.

Technology access. Participants noted their access to multiple devices and accounts. In the figure below, demographics results are presented as it relates to the devices the preservice teachers owned and a selection of account they had created. Of note is that all participants owned a laptop/tablet and a smart phone and had a Facebook account. Nearly all participants had an iCloud account, and no participants had Flickr or Wiki accounts.

Figure 8
Participants' access to devices and accounts



As laptops and smart phone are both relatively mobile, participants appear to have ubiquitous access to personal technologies. The data in Figure 8 is meant to provide a glimpse of general access to technologies. It is likely that participants have additional accounts on their devices. From these demographics, participants tended to have accounts on social platforms, but it is unclear what productivity related accounts they may access.

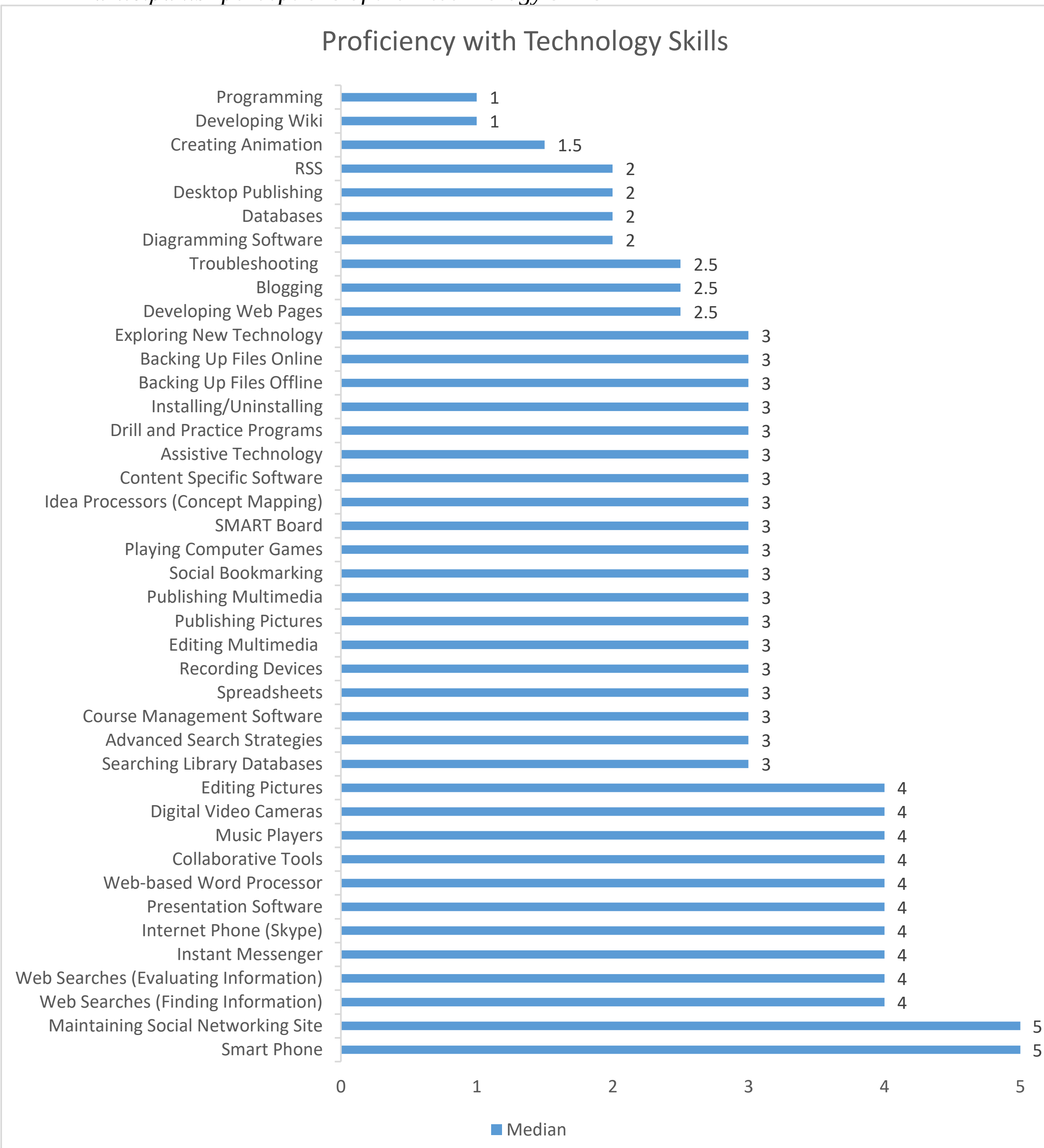
Technology use and proficiency. Besides access, participants responded to items about the frequency of use and moment when they began using a computer. 87.5% of participants began using a computer before or during third grade. The remaining 12.5% began using a computer in the fourth or fifth grade. 40.6% use a computer daily for 1-3 hours, and 60.4% use their computers daily for 3-6 hours. No respondent indicated using a computer over six hours a day or for less than one hour. From these data, it is evident that throughout most of participants' lives, they have been using computers, and digital technologies continue to play a daily role in their present activities.

Given the nearly lifelong awareness of technology and the current use, one might assume that the preservice teachers would be proficient with a range of technological skills. Prior studies have cautioned against making this assumption (Lei, 2009). The pre-assessment of participants' technology skills guided instructional decisions in the course, but the data were also collected to contextualize the qualitative data. Figure 9 displays a bar chart of the median values for the forty-one technological skills surveyed. Since there were so many technologies surveyed, the median was selected to provide a clearer visualization of the data. Please refer to Appendix I for the mean values on this measure of preservice teachers' perceptions of technological proficiency.

Items measuring participants perceptions of technological proficiency were Likert scale items with numbers representing the following levels of skill: 1=No Experience, 2=Beginner (little skill), 3=Moderate (can perform with help), 4=Substantial (can use independently), and

5=Expert (can teach others). For the technologies listed without a specific action, the skill surveyed was the use of that particular technology (e.g. Using RSS).

Figure 9
Participants' perceptions of their technology skills



These data indicate that preservice teachers feel they either have little to no skill or need moderate help with twenty-nine of the forty-one technologies surveyed. Maintaining a social networking site and using a smart phone were the only two technologies with a median value of five. These two technology skills are the only items that most preservice teachers' felt comfortable to teach. Both tools tend to support social interaction as do using an internet phone and instant messenger. These had median values of four. As a pre-assessment, these data evidenced a perceived gap in preservice teachers' technological knowledge. For this study, it provides context for the skills and technologies that participants reference in the qualitative data and their perceptions of proficiency at the onset of the study. In chapter five, preservice teachers' descriptions of prior experiences with technology are related to these quantitative perceptions of technological ability. Discussed more fully in later sections, preservice teachers depicted aspects of their K-12 technology experiences as beneficial to their current education but sensed that many of these experiences lacked purpose. These experiences may help to explain, consequently, the lack of confidence using technologies indicated by the data in Figure 9.

Perceptions of TPACK

The first research sub question intended to examine the impact of the FPI in F2F and flipped courses sections on preservice teachers' perception of their TPACK. It was hypothesized that both groups would exhibit a significantly higher perception of their TPACK by the end of the course but that the flipped group would have a significantly higher perception of their TPACK than the F2F group. This research sub question was answered with data from the SPTKTT, and the results of this analysis are discussed in this section.

a. How do the self-perceptions of TPACK understandings compare between the flipped and face-to-face course sections?

SPTKTT Overview. Preservice teachers completed the SPTKTT in the first and last weeks of the course. The survey consisted of forty-seven items split into seven subscales. These subscales corresponded to the seven domains of TPACK. The items on the survey were all Likert scale items with responses ranging from 1.0 to 5.0 with 1.0 representing strongly disagree and 5.0 representing strongly agree. All items were written in the affirmative; therefore, a strongly agree response indicated the participant's perception of having the highest level of knowledge in that area.

Since the subscales varied in their length, the maximum possible summed score for each subscale also differed. The maximum possible totals for each subscale were the following: TK (30), CK (60), PK (35), PCK (20), TCK (20), TPK (45), and TPACK (20). Table 9 displays descriptive statistics for the pre- and post- responses of both the F2F and flipped groups in this study. Twenty participants responded to the pre- and post- survey in the F2F group and 12 participants responded in the flipped group. The means, standard deviations, skew, and kurtosis were calculated from the responses for each subscale score. The median, range, minimum, and maximum values were calculated from the sums of the raw scores for each subscale.

From these descriptive statistics, it is evident that participants had a comparatively high perception of their TPACK at the beginning of both treatments. The means for every subscale indicate that participants' perceptions of their TPACK on the pre- administration were above the midpoint of 2.5 with a standard deviation of less than one. Other than TK and TCK, all variables' means on the pre- administration were above 3.5. Some preservice teachers in both groups scored the maximum possible on PK, TCK, TPK, and TPACK during the pre-administration, and only three preservice teachers scored items with a score of one. On the pre-administration, a participant in the flipped group scored the maximum possible on the TK subscale and a participant in the F2F group score the maximum on the CK subscale. Scoring the maximum value on the pre- survey eliminates possibility of measuring potential growth and may have limited the results of this study.

Table 9
Descriptive statistics for SPTKTT

Variable	Time	Group	M	SD	Raw Scores				Skew	Kurtosis
					Mdn	Range	Min	Max		
TK	Pre	F2F	3.47	0.63	21.0	15.0	13.0	28.0	-0.059	-0.232
		Flipped	3.42	0.94	21.0	23.0	7.0	30.0	-0.944	2.542
	Post	F2F	3.86	0.75	23.5	17.0	13.0	30.0	-0.337	0.225
		Flipped	4.07	0.64	24.0	13.0	17.0	30.0	-0.396	0.197
CK	Pre	F2F	3.58	0.64	43.0	28.0	32.0	60.0	0.399	-0.470
		Flipped	3.74	0.5	45.5	20.0	36.0	56.0	-0.005	-0.339
	Post	F2F	3.91	0.58	48.0	29.0	31.0	60.0	-0.361	0.606
		Flipped	4.01	0.41	48.0	18.0	42.0	60.0	1.384	2.612
PK	Pre	F2F	4.01	0.53	28.0	12.0	23.0	35.0	0.606	-0.234
		Flipped	3.96	0.63	27.5	14.0	21.0	35.0	0.079	-0.363
	Post	F2F	4.59	0.47	33.5	10.0	25.0	35.0	-0.977	-0.438
		Flipped	4.46	0.48	32.0	9.0	26.0	35.0	-0.138	-1.594
PCK	Pre	F2F	3.66	0.73	14.0	10.0	10.0	20.0	0.609	-0.268
		Flipped	3.73	0.74	16.0	11.0	9.0	20.0	-0.404	0.328
	Post	F2F	4.23	0.62	20.0	10.0	15.0	20	-0.316	-0.567
		Flipped	4.17	0.43	20.0	6.3	18.8	20	1.388	0.735
TCK	Pre	F2F	3.44	0.93	14.0	16.0	4.0	20.0	-0.708	1.473
		Flipped	3.38	0.93	12.0	12.0	8.0	20.0	0.738	-0.170
	Post	F2F	4.04	0.67	16.0	8.0	12.0	20.0	-0.048	-0.782
		Flipped	4.10	0.45	16.0	5.0	15.0	20.0	1.553	1.380
TPK	Pre	F2F	3.91	0.55	36.0	18.0	27.0	45.0	0.225	0.204
		Flipped	3.77	0.76	35.0	21.0	24.0	45.0	0.295	-0.650
	Post	F2F	4.26	0.54	38.0	18.0	27.0	45.0	-0.359	-0.036
		Flipped	4.46	0.48	40.0	10.0	35.0	45.0	0.028	-2.185
TPACK	Pre	F2F	3.53	0.78	14.5	12.0	8.0	20.0	0.095	-0.040
		Flipped	3.58	0.77	15.5	12.0	8.0	20.0	-0.331	0.789
	Post	F2F	4.15	0.48	16.0	8.0	12.0	20.0	0.134	1.258
		Flipped	4.31	0.52	16.0	5.0	15.0	20.0	0.601	-1.640

Of interest from these descriptive statistics is that the integrated domains of TPK and TPACK are higher than TK in isolation. While TK is one of the lower constructs on both the pre and post measures, it's values are close to TCK, TPK, and TPACK. In fact, TCK is slightly lower than TK on the pre- survey and may be explained by the lower TK and CK scores. Meanwhile, PK is the highest individual domain on the pre and post measures and may be the reason why the integrated factors that include PK (PCK, TPK, TPACK) are all higher than the domain that excludes PK (TCK) on both the pre- and post- measures. If viewing the TPACK domains from an additive perspective, it may be that participants higher perceptions of one domain offset their lower perceptions of another when the domains are combined.

Another way to view these data, however, is that the integrated domains are actually unique forms of knowledge (Koehler & Mishra, 2009). While Kimmons (2015) argues against the TPACK figure's representation of integrated knowledge domains as independent constructs, this is what Mishra and Koehler proposed in their articulation of the framework (2009). If this is the case, one would not expect the isolated domains of TK, CK, and PK, to equate with their integrated counterparts.

Lastly, potential measurement inconsistencies that are discussed further in chapter six may offer a perspective on the lower TK values. The lower TK values may relate to a shift in participants' frame of reference related to the interventions focus on TK or the potential redundancy of items based on the very high inter item correlations. One TK-subscale item asked participants whether they perceived themselves as knowing a lot of technologies and another asked whether they kept up with new technologies. There was qualitative evidence indicating preservice teachers' growth in awareness of technologies and knowledge of procedures of using these tools. Yet, there were participants who regressed in their perceptions on these items. These inconsistencies may signify the presence of biased results for TK.

Self-perceptions of TPACK measurement challenges can be further seen when identifying the highest scoring participants on the pre-test and their total gains. Three participants, one from the F2F group and two from the flipped group, scored above 200 on the pre-survey (Agnes=209, Brooke=202, and Bree=200). The maximum score was 230. These participants then comprised three of the five lowest gains between the pre- and post-scores (Agnes=9, Brooke= -9 , and Bree = -9). With an overall mean gain score of 32.73 and standard deviation of 21.59, the gain scores of preservice teachers displaying the highest perceptions of TPACK on the pre-survey were not within one standard deviation of the mean.

SPTKTT Analysis of Variance. Several tests were run to test assumptions for using a multivariate analysis of covariance (MANCOVA) on the pre- and post- SPTKTT subscale scores. An assumption for a MANCOVA is that the dependent variables, the post-survey subscales, should be correlated; dependent variables should also be correlated with the covariate. The planned covariate in this model was the pre-survey, but most of the pre-survey subscales were not significantly correlated with the post-survey subscales. The lack of significant correlation implied that the pre-survey subscales were not suitable covariates. To further test this, the pre-survey scores between groups were analyzed with a *t*-test. Based on this test, it was evident that the two group's pre-test scores were not significantly different. Therefore, the pre-test scores would not serve as an appropriate covariate and did not need to be controlled. As the results of these initial tests ruled out a MANCOVA, the analysis shifted to a multivariate analysis of variance (MANOVA).

Next, I conducted a MANOVA to determine if there were statistically significant differences between the F2F and flipped course participants on a linear combination of gain scores of TK, CK, PK, TPK, TCK, PCK, and TPACK. While Box's Test of the equality of covariance returned null, Levene's Test displayed that the gain scores for PK, PCK, TPK, and TPACK violated the assumption of the homogeneity of variance.

Based on the results of Levene's Test, the next analysis run was a non-parametric test - the Mann-Whitney U Test. The results in Table 10 indicate there were no statistically significant differences between the F2F and flipped groups on their gain scores of self-perceptions of the seven TPACK domains.

Table 10
Mann-Whitney U test results and descriptive statistics for SPTKTT gain scores

Gain Score	*Group*	*n*	*Mdn*	*M*	*Min*	*Max*	*Range*	*SD*	*Mean Rank*	*U*	*Z*	*p*
TK	F2F	20	2.50	2.35	-7.0	13.0	20.0	5.10	15.35	97.0	.900	.368
	Flipped	12	3.00	3.92	-1.0	10.0	11.0	3.75	18.42			
PK	F2F	20	4.00	4.00	-3.0	11.0	14.0	4.12	16.65	117.0	.118	.906
	Flipped	12	4.00	3.50	-7.0	14.0	21.0	6.40	16.25			
CK	F2F	20	3.50	4.05	-7.0	24.0	31.0	7.00	16.73	115.5	.176	.860
	Flipped	12	3.50	3.17	-8.0	14.0	22.0	5.91	16.13			
TCK	F2F	20	2.40	2.00	0.0	12.0	12.0	2.93	15.13	92.5	1.092	.275
	Flipped	12	4.00	2.92	-5.0	8.0	13.0	3.90	18.79			
PCK	F2F	20	6.13	6.48	3.0	13.0	10.0	2.54	17.90	92.0	1.098	.272
	Flipped	12	4.00	5.92	0.0	16.0	16.0	4.30	14.17			
TPK	F2F	20	3.00	3.15	-7.00	12.0	19.0	5.07	15.15	93.0	1.055	.291
	Flipped	12	8.50	6.25	-9.0	18.0	27.0	8.88	18.75			
TPACK	F2F	20	2.00	2.50	0.0	8.0	8.0	2.42	16.28	115.5	.179	.858
	Flipped	12	4.00	2.92	-3.0	8.0	11.0	3.68	16.88			

Although the Mann-Whitney U results showed non-significant differences between the two groups, the measures of central tendency for the gain scores provided evidence of a positive change between pre- and post- survey administrations. The next analysis, a Wilcoxon Signed Ranks Tests, examined whether preservice teachers' self-perceptions of TPACK at the beginning and end of each course were statistically significantly different. Table 11 displays the Wilcoxon Signed Ranks results for each group and TPACK construct.

Table 11
SPTKTT Wilcoxon signed ranks results

Construct	*F2F*			*Flipped*		
	Z	*p*	*r*	*Z*	*p*	*r*
TK	1.877	$.061^{\dagger}$	.42	2.680	$.007^{**}$	.77
PK	3.212	$.001^{***}$	.72	1.724	$.085^{\dagger}$	.50
CK	2.420	$.016^{*}$	.54	1.532	.126	.44
TCK	3.210	$.001^{***}$	.72	2.016	$.044^{*}$	.58
PCK	3.192	$.001^{***}$	.71	1.442	.149	.42
TPK	2.408	$.016^{*}$	.54	2.092	$.036^{*}$	.60
TPACK	3.194	$.001^{***}$	.71	2.333	$.020^{*}$	.67

$^{***}p$-value = .001 $^{**}p$-value = .01 $^{*}p$-value = .05 $^{\dagger}p$-value = .1

The effect sizes, calculated by dividing *Z* by the square root of N to produce an *r* value, provide insight regarding the significance of the study or potential for replication. Given the small sample size in this study, it was determined that the effect size could provide important information regarding the size of the differences and help determine the efficacy of repeating the study with a larger group. While estimates for value of *r* and its relative effect size vary, Yatani (Yatani, 2014) suggests the following relationship: small effect size (r = 0.1), medium effect size (r = 0.3), and large effect size (r = 0.5). Given these estimates, the effect size for the F2F group's TK and the flipped group's CK and PCK would be considered medium. The effect sizes for all other differences between preservice teachers' pre- and post- perceptions of TPACK constructs would be considered large in magnitude.

These effect sizes constitute potential for replicating the study with a larger sample. When this study was proposed, it was anticipated that enrollments in each course would be larger. Given the small sample sizes, especially the *n* of 12 in the flipped group, it can be difficult to detect statistical significance. Effect size is independent of sample size, and therefore, is a useful metric for considering the practical significance of the results. Comparison of the pre- and post- perceptions of TPACK in the F2F group resulted in statistically significant results for each domain. While the flipped group's results were not statistically significant on CK and PCK, the effect sizes in this study are larger than comparable studies (Abbitt, 2011; Nordin, Morrow, & Davis, 2011; Tournaki & Lyublinskaya, 2014) and would constitute a rationale for replicating the study with a larger sample. The effect sizes, given the context and previous research, may be meaningful and may provide support for the positive impact of the flipped course on preservice teachers' perceptions of TPACK (Hall, n.d.).

Application of TPACK to Technology-Integrated Lesson Designs

For the second research sub question, data from the TIAR scores were analyzed to determine possible changes in preservice teachers' application of TPACK to technology-integrated lessons designs and whether these changes were significantly different between preservice teachers in the F2F and flipped treatments.

b. How do preservice teachers' application of TPACK compare between the flipped and face-to-face course sections?

Table 12
Descriptive statistics for TIAR

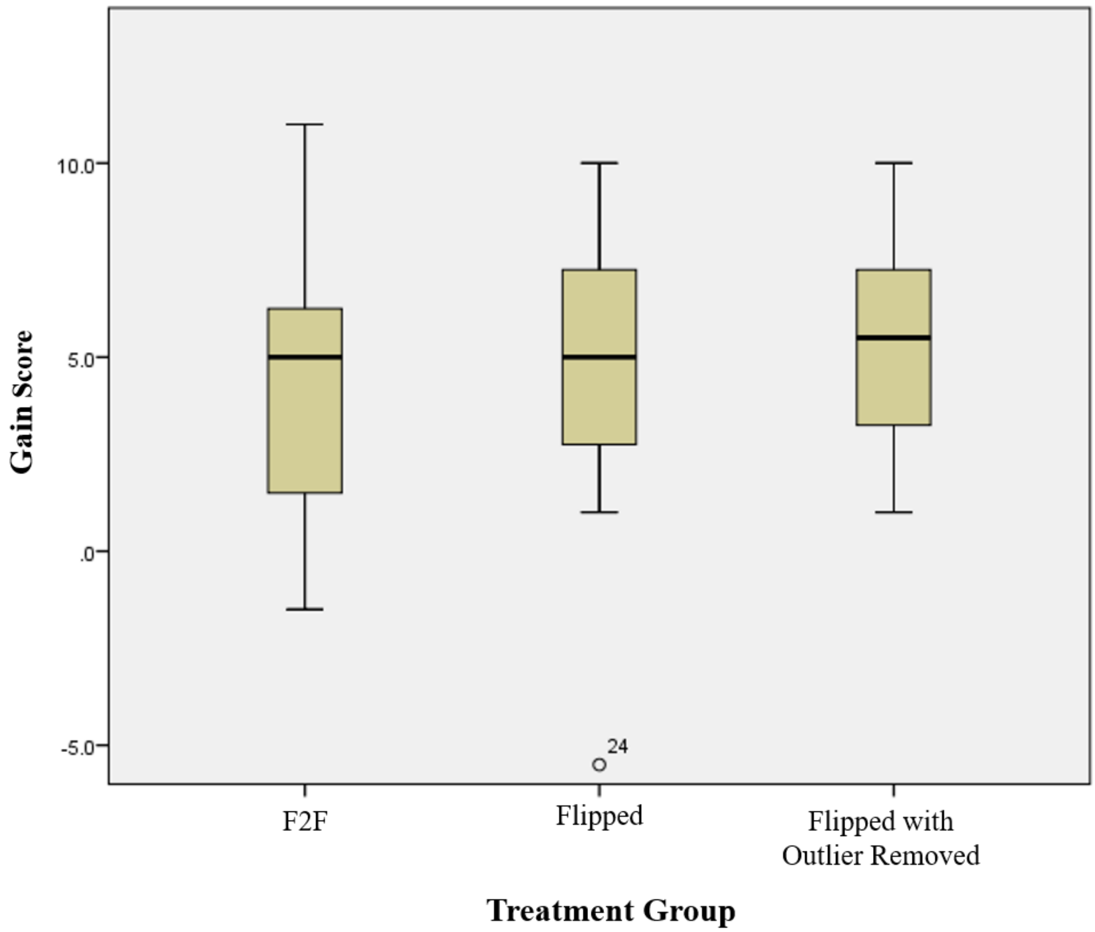
Group	*Score*	*n*	*M*	*Mdn*	*Variance*	*SD*	*Min*	*Max*	*Range*	*Skew*	*Kurtosis*
F2F	Pre	20	7.78		7.70	2.77	4.0	13.0	9.0	0.42	-0.70
	Post	20	11.88		6.08	2.46	8.0	16.0	8.0	0.09	-0.99
	Gain	20	4.10	5.00	12.20	3.49	-1.5	11.0	12.5	0.19	-0.73
Flipped	Pre	12	8.13		10.233	3.20	4.0	14.5	10.5	0.31	-0.25
	Post	12	12.63		8.097	2.85	6.5	16.0	9.5	-1.01	0.46
	Gain	12	4.50	5.00	16.77	4.10	-5.5	10.0	15.5	-1.25	2.35

Table 13
Descriptive statistics for TIAR with outlier removed

Group	*Score*	*n*	*M*	*Mdn*	*Variance*	*SD*	*Min*	*Max*	*Range*	*Skew*	*Kurtosis*
F2F	Pre	20	7.78		7.70	2.77	4.0	13.0	9.0	0.42	-0.70
	Post	20	11.88		6.08	2.46	8.0	16.0	8.0	0.09	-0.99
	Gain	20	4.10	5.00	12.20	3.49	-1.5	11.0	12.5	0.19	-0.73
Flipped	Pre	11	7.545		6.82	2.61	4.0	11.0	7.0	-0.31	-1.74
	Post	11	12.96		7.47	2.73	6.5	16.0	9.5	-1.43	2.27
	Gain	11	5.41	5.50	7.54	2.75	1.0	10.0	9.0	-.004	-.883

Total scores were calculated by combining the scores from each subscale. There were four subscales, each with a score ranging from 1-4. TIAR total scores, therefore, ranged from 4-16. Table 12 displays descriptive statistics for the raters' combined TIAR scores for all participants. This combined score was obtained by calculating the mean of the two raters' scores. Gain scores were calculated from the difference between the pre- and post- scores. This difference was then analyzed to produce the descriptive statistics in the last row for each group. Table 13 displays the descriptive statistics for the TIAR scores with Beverly's outlier data removed. In the analysis to follow, the combined mean score from these descriptive statistics is used.

Figure 10
TIAR score boxplots by group



Prior to conducting *t*-tests with these data, the assumption of homoscedasticity was checked. From case analysis discussed earlier, an outlier was identified that had an excessive influence on the data. This excessive influence is due to both the extreme value of the data point and to the small sample size. Figure 10 presents the boxplots showing the spreads of the TIAR gain scores for both groups as well as the boxplot when the outlier in the flipped group is removed. The spreads of the data in these boxplots appear to be homoscedastic and satisfy this assumption.

Based on the relatively small sample size, the Shapiro-Wilk test of normality was analyzed. The results of the Shapiro Wilk's test were not significant for either group's scores.

Even when the outlier was included, the Shapiro Wilk's test did not indicate a violation in the assumption of normality.

TIAR Analysis of Variance. Next, preservice teachers' TIAR gain scores (posttest – pretest) were examined with an analysis of variance (ANOVA) with treatment group (F2F vs. flipped) as the independent variable. Although not at a level of statistical significance, the increase in the application of TPACK to technology-integrated lesson designs was greater for preservice teachers in the flipped group (*M* = 4.50, *SE* = 1.075) than for those in the F2F group (*M* = 4.10, *SE* = .83), *F* (1, 30) = .086, $p < .771$, $\eta^2_{partial} = .003$. Still a non-significant difference when the outlier is removed, the increase in the application of TPACK for preservice teaching in the flipped group (*M* = 5.41, *SE* = .981) was greater than for those in the F2F group (*M* = 4.10, *SE* = .728), *F* (1, 29) = 1.148, $p < .293$, $\eta^2_{partial} = .038$. The partial eta squared indicates that at most the treatment group accounts for nearly 4% of the variance in the gain scores.

While the ANOVA results showed no practical or significant differences between groups, an examination of the confidence intervals offers information about the potential statistical significance of each treatment group's mean gain score. In an ANOVA of gain scores, a confidence interval that excludes zero indicates a significant change. This is due to the gain score being the difference between the pre- and post-scores. If there were no change, the gain score value would be zero. A confidence interval including zero would result from a mean gain score that is not significantly different from zero.

The 95% confidence intervals for this analysis did not include zero for any group. The intervals for each group ranged as follows: F2F group ranged from 2.61 to 5.59, flipped group with outlier removed ranged from 3.40 to 7.42, and the flipped group with all data points ranged from 2.30 to 6.70. These data show that both treatment groups exhibited a significant increase in their application of TPACK to technology integration lessons as the mean gain score is statistically different from zero. While the previous analysis indicated no differences between the treatment groups' gains, there were significant differences within groups. To further examine these differences, a single sample *t-test* was conducted.

A single sample *t*-test was next computed to investigate differences between participants' TIAR gain scores and a zero change. Significant increases in the gain scores were evident from the ANOVA's confidence intervals. The assumptions of the *t*-test were tested and met when testing the assumptions for the previously computed ANOVA. As the ANOVA had already revealed a significant increase in the gain score, a one-tailed t-test was computed. The results of the *t*-test confirmed there was a statistically significant increase in preservice teachers' application of TPACK to technology-integrated lesson designs for both treatment groups. Further, the large effect sizes signified a degree of practical significance as well. As an example, the mean gain score for preservice teachers completing the flipped course as designed by the FPI would be at the 84th percentile of the distribution of scores for an untreated group (Becker, 2000). Table 14 exhibits the descriptive statistics, level of significance, and effect size for this *t*-test.

Table 14
Single sample t-test of TIAR gain scores

Group	*n*	*M*	*df*	*SD*	*t*	*Mean Diff*	*p*	*Cohen's d*
F2F	20	4.10	19	3.49	5.25	4.10	.000	1.17
Flipped	12	4.50	11	4.10	3.81	4.50	.002	1.10
Flipped[a]	11	5.41	10	2.75	6.53	5.41	.000	1.97

[a]Outlier removed from this group.

Discussion of TPACK Self-Perceptions and Application

Effective design is effective design. In both treatment groups, preservice teachers' self-perceptions and application of TPACK statistically significantly increased. The strength of their growth in application of TPACK to technology-integrated lesson designs (F2F $p = .000$, $d = 1.17$; Flipped[a] $p = .000$, $d = 1.97$) provides compelling support for a well-designed course. The lack of statistically significant differences between the F2F and flipped groups on any measure suggest the FPI were no more or less effective when applied to designing flipped and F2F courses.

These results align with Merrill's premise that the FPI are applicable across disciplines, contexts, and learning environments. While technologies, environments, and educational terminology may vary, he posits that there remain fundamental instructional principles and strategies. "While their implementation may be radically different, those learning strategies that best promoted learning in the past are those learning strategies that will best promote learning in the future (Merrill, 2012)." This study substantiates his claim regarding the effectiveness of the FPI and their potential for designing F2F and blended approaches.

Variations between groups. While most self-perceptions of TPACK domains displayed statistically significant growth for both groups, the F2F group's TK self-perceptions and the flipped group's CK, PK, and PCK self-perceptions did not evidence significant change. The variations between groups' self-perceptions of TK will be further explored in the following chapter's analysis of their learning experiences. To clarify, the differences between groups for all self-perception measures were non-significant, but this discussion is based on the results of the Wilcoxon Singed Ranks Test which measured the significance of gain scores on individual TPACK domains separately for each group. While the medium to large effect sizes for these constructs' increase would justify a simple statement concerning the impact that sample size has on *p*-values and how a larger sample size would likely result in significant values, the following paragraphs will discuss other potential factors.

As noted earlier, this study was conducted in a one-credit technology integration course situated within a teacher preparation program. The participants were simultaneously completing additional coursework. The pilot study, which used a single group quasi-experimental design, resulted in similar variations of CK growth when studying only the flipped group (Hall & Lei, 2017). It was noted that participants' perceived growth in Math and Social Studies CK was statistically significant while their perceived growth in Science and Literacy CK was not. The proposed rationale was that participants were completing math and social studies methods coursework while enrolled in the course being studied thus resulting in a stronger impact on these CK domains.

In line with this rationale, there were broader programmatic experiences that may have influenced participants' perceptions of knowledge. As they completed methods coursework simultaneously, it would be expected that these experiences would also influence their TPACK knowledge, especially the CK, PK, and PCK domains. The non-significant growth in these domains for the flipped group as well as the noticeably lower effect sizes (F2F- PK $r = .72$, CK $r = .54$, and PCK $r = .71$; Flipped - PK $r = .50$, CK $r = .44$, and PCK $r = .42$) could be a result of varying programmatic experiences that were not accounted for within the interventions.

Experiences in teacher preparation courses have shown the importance role faculty outside of the technology integration course play when developing preservice teachers technology integration capacity (Brenner & Brill, 2016). Researchers have further conveyed the need to consider sequencing of multiple technology integration courses and how this sequencing relates to their concurrent programmatic learning experiences (Pierson & Thompson, 2005). Broader programmatic experiences, however, are not likely explanations for the non-significant growth in F2F self-perceptions of TK.

The isolated non-significant growth of the TK domain evidenced by the F2F group may support the calls for better defined TPACK constructs and more sensitive instruments (Chai et al., 2013). While discussion is ongoing about whether the intersecting domains are distinct knowledge domains or a sum of the overlapping domains, the results in this case seem to align with Kimmons' (2015) concern regarding the tautological assumptions based on the TPACK image regardless of their transcendent or summative properties. A clear distinction between TCK and TK plus CK has not been made in the literature he claims. Therefore, it becomes difficult to adequately measures the constructs or interpret results such as occurred in this study. How are F2F participants' self-perceptions of the hybrid TPACK domains that include TK significant while their self-perceptions of TK non-significant?

One potential explanation is that lack of internal consistency when measuring TPACK. When Archambault and Barnett (2010) measured TPACK perceptions CK, PK, and PCK loaded as one factor while TK formed a single factor, and the remaining four (TPK, TCK, and TPACK) loaded as the final factor. Additionally, instrument validation studies have also resulted in varying factor loadings when conducting a factor analysis (Chai, Koh, & Tsai, 2011).

Another potential explanation is what Kimmons (2015) referred to as the fuzziness of instruments evaluating TPACK. Many items on the SPTKTT (Schmidt et al., 2009) include the word "appropriately." For example, "I can teach lessons that appropriately combine social studies, technologies and teaching approaches (Schmidt et al., 2010, p. 6)." Kimmons describes this terminology as "subject to behavioral and dispositional interpretation with little or no explanation of what constitutes ‘appropriateness’ (2015, p. 60).” Stronger definitions of TPACK domains may be needed to help distinguish between isolated and hybrid factors as well as a closer examination of how to better measure technology integration knowledge (Chai et al., 2013).

Lastly, the differences in the design of the F2F and flipped approaches may have contributed to the variation in self-perceptions of TK. Throughout the qualitative data, participants frequently described experiences with technology, interactions with technology, or learning about technology. One of the themes discussed in the next chapter is participants' experiences *Learning about different forms of technology.* Results from this theme will be integrated with the SPTKTT data for possible further clarification of the F2F group's non-significant change in TK self-perceptions. In chapter six, dedicated entirely to integrating the quantitative and qualitative findings, preservice teachers' experiences with the FPI will be considered as potential explanations for the growth in their TPACK application.

When TPACK self-perceptions and application differ. In both groups, participants' growth in their application of TPACK to lesson designs was statistically significant with large effect sizes while their self-perceptions of TPACK varied in significance and effect size. Previous studies have resulted in similar inconsistencies among TPACK measures (Johnson, 2012). Possible reasons for these differences have been posed in the literature: different aspects of TPACK being measured (Abbitt, 2011), inconsistency of self-report measures in this context (Harris et al., 2010), and limitations of the TPACK framework (Archambault & Barnett, 2010).

Researchers have noted that the SPTKTT and the TIAR are measuring different aspects of TPACK. Abbitt (2011) posited that surveys measure TPACK knowledge and rubrics measure outcomes expected of this knowledge in practice. Discussing the different foci of the measurement, Harris et al. (2010) believed the SPTKTT to measure preservice teachers' confidence rather than their knowledge in practice. Examining items on the SPTKTT affirm these positions as one of the items ask preservice teachers about their readiness to lead and help others at their schools coordinate technology, content, and teaching (Schmidt et al., 2010). On the surface, this item does appear to measure TPACK confidence. Regardless, it can be argued that the knowledge measured by this item and the knowledge applied to the design of technology-integrated lessons were different. Therefore, variations in the results or degree of significance may have been epiphenomenons of different aspects of TPACK being measured.

Harris et al. (2010) identified difficulties in gathering consistent self-reports with preservice teachers due to their inexperience, yet self-reports remain one of the most utilized forms of data generation when studying preservice teachers' TPACK development (Koehler, Shin, & Mishra, 2011). Researchers of teachers and preservice teachers' self-report behaviors related to technological use and competency have reported their participants' tendency toward self-presentation or social desirability bias (Kopcha & Sullivan, 2007; Maderick, Zhang, Hartley, & Marchand, 2016). This desire to present oneself in a more positive manner can skew data and results. The mean values of pre-test scores present potential evidence of self-presentation bias in this study. The mean TIAR scores, a performance-based score assigned by two reviewers, were below the midpoint of 10.0 for both groups (F2F M = 7.78; Flipped M = 8.13). The lowest mean self-report scores on the SPTKTT, conversely, were above the midpoint of 3.0 (F2F M = 3.44; Flipped M = 3.38).

These findings may lend support to current recommendations for cautionary use of self-report measures as stand-alone measures (Maderick et al., 2016). Preservice teachers' self-reports of technological competence, however, may serve as useful educational tools for selfassessment and reflection and should not be entirely disregarded. Preservice teachers' self-report data may also function adequately in a supplementary role. For instance, the TIAR data in this study may present a more precise picture of preservice teachers' TPACK development, but there were nevertheless informative results within the measures of preservice teachers' self-perceptions of TPACK. These self-reports will be additionally beneficial when analyzed alongside preservice teachers' course experiences.

Summary of Quantitative Findings

These quantitative results show there were no statistically significant differences in course learning outcomes between the F2F and flipped courses as measured by preservice teachers' changes in perceptions of TPACK and their application of TPACK to technology-integrated lesson designs. There was, however, statistically significant growth from the beginning to the end of both courses. Further, both interventions displayed medium to large effect sizes on all outcome measures. The effect sizes and high degrees of significance evident in the TIAR results provide strong support for an impact of these interventions on applying knowledge, in this case applying TPACK. The results may possibly demonstrate the efficacy of the FPI in F2F and flipped approaches and support Merrill's premise that these instructional design principles are foundational to efficient, effective, and engaging instruction (Merrill, 2012). A more in-depth discussion of these results, their intersection with theory and current literature, and their relationship with participants course learning experiences will follow in chapter six.

Next, I will present the qualitative results from a descriptive phenomenological analysis of preservice course learning experiences in both the F2F and flipped technology integration courses designed according to the FPI. While the quantitative analysis sought to answer the primary research questions regarding the impact of the FPI on the TPACK based learning outcomes, the qualitative analysis will describe participants interactions with course elements and attempt to clarify what the quantitative results have disclosed.

Chapter 5: Experiencing FPI-based Course Designs and Furthering Conceptions of TPACK Development

In this chapter, I will present results from the descriptive phenomenological analysis of preservice teachers' experiences with the First Principles of Instruction (FPI). Building on the results from the previous chapter's research questions, this chapter will offer qualitative insight into the quantitative outcomes. Course reflections and semi-structured interviews generated data that conveyed preservice teachers' perceptions of course elements and documented their course learning experiences. The course reflections, as part of the course design, were also intended to further promote preservice teachers' technological, pedagogical, content knowledge (TPACK) development. The data and subsequent analysis were directed toward answering the study's second question:

2. How do preservice teachers experience face-to-face and flipped technology integration courses designed according to the First Principles of Instruction?

To answer the research question in this chapter, the essence of the FPI-based technology integration course will be presented in three themes. The presentation of each theme will begin with a description of the associated course design elements and an overview of the guiding FPI. Next, I will present the theme and sub-themes, representative excerpts and quotes, variations in the experience between the flipped and F2F approaches, and an analysis of the essence of the experience being portrayed. To close this section, I will interpret the results, contextualize them with relevant literature, and summarize the results for a succinct and clear answer to the research question.

From Activation to Integration: Reflections on Technology Integration Experiences

Two phases of the flipped and F2F course designs emphasized learner's contemplation of experience: discussion of the experiences with peers and rich description of those experiences.

The activation phase prompted learners to consider their prior experiences, and the integration phase guided learners to reflect on and share what they had learned. Preservice teachers' experiences with the activation and integration phases of instruction will be presented in this sections' theme.

During the first week of the course, preservice teachers wrote about their prior educational experiences with technology. A couple preservice teachers wrote about an experience in the prerequisite course, IDE 201, but most wrote of a K-12 experience with technology. The FPI posits that recalling relevant prior experiences help learners to lay a foundation for new knowledge (Merrill, 2002). Based on the theory of constructionism (Papert & Harel, 1991), connecting to these prior experiences with the design-centered activities can also be valuable for learning. Every participant engaged in the activation phases by describing their past technology-related educational experiences, recalling any experience teaching with technology, and suggesting ways they would like to integrate technology in their future classrooms. These data from the activation phase were used for constructing the theme below, but they also provided information for connecting the instruction to learners' values and technology integration expectancies.

As preservice teachers constructed their tangible artifacts and knowledge in this course, technology-integrated lessons with digital resources and TPACK, they were guided to share these with peers and reflect on these learning and design experiences. Constructionism posits that reflection and sharing are critical to arriving at more formalized thinking (Maxwell, 2006). The FPI's reflection corollary, part of the integration phase, states that learners "need the opportunity to reflect on, defend, and share what they have learned if it is to become part of their available repertoire (Merrill, 2002, p. 51)." Preservice teachers, as part of the integration phase of instruction in the F2F and flipped courses, reflected on the technology-integrated lessons designed with their peers and the lesson they designed individually. These reflections offered a glimpse into preservice teachers' design thinking and their perspectives on technology integration at various phases of the semester.

"Not like I could do it better but like that would be interesting if you did." As part of learning activities in the course, preservice teachers reflected on their prior experiences with technology as K-12 students and observed their mentor teachers' technology use with their students. These course activities were based on the activation principle and corollaries that emphasize the importance of prompting learners to recall prior experiences and structuring opportunities for them to explore relevant new experiences. The second part of the above quote, "but like that would be interesting if you did," represents preservice teachers' prior experiences and observations and their frequent desire for more effective technology integration.

From these observations and reflections, I identified subthemes that represented the essence of participants' reflections on observing technology-integrated in K-12 classrooms. Brooke's quote below is representative of the subthemes to be discussed in the following paragraphs as it discusses perceptions of early technology experiences, observations of current technology integration practices, and a vision for something more.

> In my early experiences with technology as a student, I would say I was exposed to computers and program software in late elementary school and middle school. A subject that each class spent part of the school day in was the computer lab learning technical computer skills, and more specifically how to type and use Microsoft office in middle school. This was the wave of teaching students how to use technology, and since I have completed high school and started college, I believe that the focus in education has shifted to using technology as a way to enhance learning-- like a tool for success. In my first block placement I saw how much technology has been integrated into elementary school classrooms, as most schools try to work towards a one-to-one ratio for students and laptop/tablets within the class itself. I saw the use of technology primarily in math instruction because one of the class stations required students to use an iPad application that helped students practice their new math skills. In this instance, I don't think the

> technology was implemented in an efficient and enriching way because students often times wanted to use the apps that were for coloring pictures instead of furthering their content knowledge. This is a case where the technology is standing in place of a worksheet, not being used to supplement a child's learning (Brooke).

Based on the survey data, all participants began using technology during or prior to elementary school. Brooke, in this quote, notes this early exposure to technology as a mostly segregated subject area that taught technical skills. Participants also described their experiences with technology in these early years as contributing to their current perceptions of technology and confidence working with it.

Next, Brooke highlights a shift in the way education views technology. She states that it is now seen as a "way to enhance learning—like a tool for success." Stated after recalling her elementary experiences with computer classes emphasizing technical skills, she introduces the contrasting new paradigm in education and notes her observations during her placement. She has observed the evidences of investment in this vision in her placement and believes that other schools are working toward increased technological capacity. Other preservice teachers in this study also described characteristics of their school and mentor teacher's investment in technology integration.

An additional characteristic of preservice teachers' reflections on technology integration practices was the development of their ability to evaluate technology integration, noted as a higher order thinking skill on Bloom's Revised Taxonomy (BRT). As part of the integration phase of the FPI, preservice teachers discussed technology integration decisions, collaboratively constructed rationales for these decisions, and evaluated their peers' and mentor teacher's technology-integrated lessons. In the final section of the above quote, Brooke shares an observation of her mentor teacher's technology integration, evaluates its effectiveness, and offers a rationale for the evaluative statement.

Brooke exhibits this evaluative thinking when she questions the purpose of an app. In her reflection, she states the belief that a paper worksheet could have supplanted the app. She notes this was the primary method of technology integration observed in her class, yet students were not performing the assigned task. Further, she perceived the selected technology as an ineffective tool for engaging students as they often preferred apps unrelated to the content.

Preservice teachers practiced this analysis and evaluation of technology integration during the application and integration phases of the course as they were regularly asked to provide rationales for how they chose to integrate technology. Developing this critical perspective was not entirely focused on ineffective instances of technology integration as Angie explains in her interview, but rather "it was more like like seeing technology used and realizing like why they did it that way or or like um how it could have been used more effectively in the classroom." Evaluating technology integration became the way Angie observed others teaching with technology, and it informed how the preservice teachers thought technology could and should be integrated.

Lastly, the implementation of a technology-integrated lesson plan was part of the integration phase of the course design. Within the initial part of the theme's quote, "Not like I could do it better," is an acknowledgement portraying the essence of preservice teachers' integration experiences and reflections. While preservice teachers perceived this experience as successful, they admitted to grander visions for technology integration practices and a lack of confidence in their ability to implement this vision. As Angie stated when observing a teacher, "Not like I could do it better, but like that would be interesting if you did." She expresses uncertainty in her ability to institute change but would like to see change nonetheless. Within this subtheme, I will synthesize the structures underlying preservice teachers' settling for what they perceived was less effective technology integration amidst their anticipations for surpassing what they had observed. Data for this subtheme were extracted from preservice teachers' technology-integrated lessons and reflections on the implementation of this lesson.

"Not only did I learn a lot about technology…but it also was interesting for me…." One of the first course experiences during the activation phases of instruction was for preservice teachers to reflect on their prior experiences with technologies as students and to construct a vision for what would be their future teaching with technologies. From this activation of prior knowledge and experiences, I have synthesized participants' narratives. This subtheme will potentially supply important contextual information as a backdrop for participants' perceptions of technology in education at the beginning of the course and their confidence using technology in teaching.

Skill building in the lab. Most early experiences shared through the preservice teachers' reflections described learning how to type in a computer lab or taking a computer course. Perceptions of the computer classes varied according to the emphases of the class. As noted earlier, participants were dissatisfied with the experience when the focus was typing skills, especially when it was their sole exposure to technology at school. Amber wrote, "In middle school, I had one computer class where we learned how to type. That was it. I feel that was a very ineffective use of our time and computer resources because most of us already knew how to type." April contrasts this sentiment slightly by stating that her typing class taught her something new-a skill that has helped her type essays and search for information more efficiently. Although perceiving the acquired skill as beneficial, April expressed disapproval for her instructor's methods. Brenda also disapproved of the methods for teaching computer skills at her elementary school and recalled the experience as frustrating and conforming.

The teaching methods and purpose seem to have contributed to the sentiment of frustration more than the class itself. For example, Bree's experiences appear to align closely with what Brooke declared to be a shift in education toward using technology as a tool for learning.

> My past experience with technology in the classroom has been pretty engaging. As a student, my school always had classes with our librarian where she would teach us a new technology tool on the computer, smart board, etc. I also used powerpoint, word, excel and many other tools very often in my school experience which I found useful and beneficial towards my overall education. It not only covered important topics that I needed for my curriculum but it also helped me with an overall education on technology and what it has to offer (Bree).

Bree's experience in this computer class was perceived as engaging and useful. She wrote that it covered important topics, one's she needed to succeed in other areas, and contributed to her overall educational success. While this experience was unique, the underlying structure aligns with the previous experiences learning how to type in the computer lab. The participants who perceived the skills being taught as relevant perceived the separate computer course outcomes more positively, regardless of instructional method.

This is not to imply that participants, whose primary experiences with technology as K-12 students was in a computer lab, deemed this to be sufficient. Andrew, noting that technology was not a part of his daily K-12 experience, further wrote that he remembered "technology being almost frowned upon by teachers and administrators in the actual classroom." They did, however, have a computer lab to visit weekly for games and typing practice. Allie added that her experiences with technology were more limited that they should have been, relegated to a computer lab or "watching videos controlled by my teacher's projector." Bonnie described her elementary and middle school experiences as having "limited exposure to technology." Although her school had labs and cards, they "rarely used these computers."

The essence of the computer lab experience as shared by these participants is the potential for the integration of technology to feel segregated from the broader educational goals. While skills taught in this setting can be relevant to students' lives and can be recognized as important for success across disciplines, participants' accounts demonstrated that relevance was not implicit to all activities in the computer lab. Other participants, however, experienced technology integration directly in their K-12 classroom. These narratives will be examined next and compared with the previous experiences that underscored the value of relevance.

One-to-one initiatives - not a one size fits all. Similar to the computer lab experiences, perceptions of one-to-one technology initiatives hinged more on how they were implemented and their perceived relevance rather than a particular technology adopted. Take for example the contrast between Aadan's and Brandy's experiences with one-to-one computing initiatives during their high school years.

> Um I think technology can be a fantastic tool depending on how it's used. Because I remember from my student experience in high school we were given chromebooks my senior year. And I am very thankful that they did not come any sooner because I was checked out with the chromebooks. Not enough teachers engaged us uh with the chromebooks so I would often just sit on my laptop and whether I'm watching game film from my previous basketball game or checking fantasy football or reading articles, I was not engag--like that was just a distraction for me (Aadan, interview).

> Every student in my high school was given a laptop to use throughout the school day for taking notes or doing online activities that teachers had assigned to us. We completed lab simulations on the internet, completed web quests, created projects, and were given the opportunity to research information pertaining to certain topics. This allowed me to build knowledge on my own. In addition, giving every student a computer took into account that students learn in different styles and some like to take notes on a computer or follow along with a teacher's PowerPoint in front of them (Brandy).

Although Aadan felt that not enough teachers engaged the class with the tools, he still perceived that technology could be a fantastic tool- "depending on how it's used." Brandy's experiences offered ideas of how teachers can use the one-to-one initiative in a more engaging and effective way as she lists several activities assigned to her: simulations, webquests, and projects. Beyond these uses, Brandy mentions the pedagogical approach teachers employed at her school. They allowed her to use the technology to build knowledge and varied modalities for engaging content. Andrea further contributes to the underlying structure of the experience by describing an individualized reading program employed through her school's one-to-one initiative. She felt this use of individual laptops helped her learn to read, focus, and make progress through data driven instruction.

Constructing a sense of technological ability. These prior experiences with technology contributed to how participants felt about their abilities with technology. For example, preservice teachers indicated on the pre- course survey that they either had little to no skill or needed moderate help with twenty-nine of the forty-one technologies surveyed. Many noted in their reflections that the ubiquity of technology in their childhood helped them feel more comfortable using technology daily and others wrote that learning how to use technology in elementary, middle, and high school has helped them succeed in higher education and have ideas for using technology in teaching.

Yet, some participants such as Bridget cited poor technology experiences in K-12 education as contributing to their lack of confidence using technology for teaching. Avery, explicitly ties her negative perceptions of technology integration to a lack of relevance in the below excerpt:

> I feel as though my past experiences with technology in the classroom have not been great. The times I can remember using technology as a student in things like homework, projects, or presentations seemed forced. I would've rather done things my own way, but usually when technology was involved we were required to do things so specifically and include so many components (follow so many steps). Furthermore, the types of technology I used were very confusing to me at times and I feel that they were not helpful to my learning. I would've been better off without the technology and just doing things the old school way. For example, in high school I was required to create a website where

> my peers would comment on things I posted and I would do the same for their websites. I cannot even remember what the content of the websites was, but I do remember focusing more on the actual making of the website than the content of the website itself. I feel that whenever I use technology I lose sight of what I am actually learning (Avery).

While the previous quote inserted from Brandy praised her teachers for allowing her to construct her own knowledge with technology, Avery perceived it to be disengaged from the content. For Avery, the technology seemed forced, or irrelevant. It was irrelevant to the content and seemed to unnecessarily complicate the task. In these experiences with technology integration, Avery lost sight of the learning and had to focus more on procedures.

Technology, described by participants as important and relevant to children's education today, was experienced in different contexts, with varying devices, and for diverse purposes. As the subtheme quote suggests, participants generally wanted to learn more than the technology, but they wanted it to connect in a way that was interesting. Consistent through these cases was a more positive perception of those experiences perceived as relevant to the instruction and to the participants' personal goals. Carrying these prior experiences with them, preservice teachers in this study began observing their mentor teachers' integration of technology and reflecting on how this could inform their future practice.

"So now a days it's more about finding and using the RIGHT technology, not just finding any technology." As participants began applying technological, pedagogical, content, knowledge in class, they were prompted to reflect on their initial experiences designing technology-integrated lessons. The quote used to describe this subtheme represents the idea of "purposeful use" underlying preservice teachers' initial reflections on their experiences. The ways they considered "purposeful use" were different. They began to realize the abundance of technologies available, as examined elsewhere in this study, and now they reflected on what it meant to begin "finding and using the RIGHT technology (Angie)."

"Nail down forms of technology that fit." As preservice teachers wrote about selecting technologies for instruction, they discussed this process in terms of a proper fit. This term, taken from the Technology Integration Assessment Rubric (TIAR), may refer to the overall alignment of the technology selection with all other elements in the lesson. Preservice teachers emphasized that technology use should not overshadow objectives (Brooke), should be aligned with ISTE standards (Bree), can be effective for assessment (Ann), should be age appropriate (Brianna), and should "add much to aid student learning (Andrew)." There were several factors they began considering, a different approach than what had been noted earlier.

During the first week of the course Bridget wrote that her prior experiences with technology left her lacking confidence in her ability to use technology yet felt that "the more technology a teacher can incorporate into the lesson the better. This will make [it] feel like a normal part of everyday life." Contrast this statement with one written during the final weeks of the course as she reflected on how her group's technology-integrated lesson design could be improved.

> I think that it would be important to make sure that our objectives are closely aligned with the technology that we incorporated. I want the technology included to extend and build on the lesson, not be completely irrelevant or come across as busy work. I hope that as we finalize our lesson, we can nail down forms of technology that fit our objectives (Bridget).

In this statement, there was a strongly expressed desire to select technology fit for the objectives. Note, however, that Bridget wrote she was hoping to nail down forms, not a singular form of technology. She was still open to incorporating it extensively as her earlier quote indicated but now her plan for integration differed in purpose. She did not want to integrate technology for it to be normative but rather for it to extend and build upon a lesson and the learning objectives.

In the prior quote used for the subtheme, Angie conveyed a similar idea from a different perspective. She wrote, “I think now it is really impossible to plan a lesson without technology. Either there is a powerpoint, a website, research online, or something else imbedded in almost every lesson. Or we are using technology to find lesson plans and printable materials. So now a days it’s more about finding and using the RIGHT technology, not just finding any technology.” For Angie, it seemed impossible to plan a lesson without technology as she observed it embedded in almost every lesson, even when used to generate ideas and resources for a lesson. Thus, she concluded, it may be more about deducing the RIGHT technology and not settling for any technology.

“Having students work hands-on with it.” As preservice teachers reflected on their technology selections for lessons created in class, they often chose to evaluate the strength of their selection and use based on how students were engaged. They wrote of engagement differently, even when referring to the same technological tool. They described students’ engagement with the content, peers, task, and the resource itself. Table 15 displays examples for each of these types of engagement from participants’ reflections. There was a sense of excitement with how technological tools could support student engagement and a desire to increase technology-mediated interaction.

Table 15
Participants’ reflections on engagement with digital tools

Participant	Engagement with…	Reflection Excerpt
Brooke	Peers	One of the requirements of our lesson is for students to upload their final group work to a page on the class website, and to then comment on all the other groups' posters and give pieces of constructive feedback. This is a way for students to engage with each other while also learning about what is appropriate for the comments section and what is not.

Participant	Engagement with…	Reflection Excerpt
Aleka	Task	Without it [technology], there would not be any structure for the students to search, create, and then be assessed throughout the lesson, because all of those components happen on technological platforms. Specifically, students find the information they need to acquiring by using the search engine, then organize and format that information through the wiki page, and then are assessed on the content through a quiz on google forms. Therefore, technology really is the backbone of this lesson, providing it structure and a step-by-step way for the teacher to instruct students on what to do.
Aadan	Prior Knowledge	Relating to prior knowledge can be difficult with new subjects sometimes but putting a tool and a resource that students know how to operate is a great way to engage them and allow them to show what they know or can create. Without the technology, the students would have not been able to access the information as easily or engage as actively so, throughout the entire instruction of our lesson, the technology is a unit of support for the students.
Angie	Content	It [Google site the students created] allows us to bring in images from multiple sources and allows students to explore at their own speed. Also, [by] using Lino, students can go back and forth between the class wiki and the Lino to get ideas and fully explore the concept. Also, having a class wiki allows students to comment and ask questions, as well as revisit the ideas and concepts later if needed.

No participant stated that the technologies selected for their in-class lesson designs were ineffective for engaging students, but some did identify ways they could improve future engagement. Brianna mentioned the need to allot additional time for students to share ideas throughout the technology-integrated lesson and highlighted the importance of collaborative skills. In the quote referenced for this subtheme, Aubrey reflected on her group's use of a YouTube video in a lesson and wrote of her desire to incorporate more technology with the content by "having students work hands-on with it." In line with the larger theme, preservice teachers throughout the semester were interested in technology's potential, were recognizing ways to engage students with it, and were open to improving their instructional uses of selected technologies. Preserve teachers' reflections on their final lesson implementation offer additional insight into their conceptions of future improvement.

"If I were to do this lesson again." As preservice teachers contemplated their implementation of technology-integrated lessons, eighteen participants noted a specific improvement if they were to do the lesson again. In both courses, a commonly expressed modification was for a more interactive or hands-on technology integration component and ways to engage students with each other and the content. After noting the potential of technologies selected and used in class for hands-on student engagement and expressing their interest in adding these components to future lessons, preservice teachers felt their implementation could have still been better in this area if they were to do the lesson again.

Many preservice teachers displayed a video or presentation during a whole group setting as part of their technology-integrated lesson. After the lesson, twelve preservice teachers wrote how they could have adapted this part of their lesson to increase student-led interaction with peers and the content. April wrote, "I could have used VoiceThread, ED puzzle, etc. to help me with the content and it would have been easy for the students to take over the technology and use it themselves." Following a lesson on community structures, Ali wrote, "I would have invited students to freely explore GoogleMaps in a station setting. I would have downloaded GoogleMaps on the IPads and asked students to zoom into their homes, school, and other meaningful places in their lives." While April and Ali explained ways they would have liked to incorporate independent student interactions with technology for learning in future lesson, other preservice teachers' offered insight into what they experienced as barriers to their attempts prior to or during the implementation of independent student interactions with technology.

Angie excitedly explained the lesson she wanted to implement for teaching cardinal directions and maps during her interview:

> [My original plan] was to have them use the computers and have a bunch of maps pulled up and have them like explore the maps on the computer. But uh my teacher wasn't really comfortable with that technology… I figured trying to explain to them [students] how to work together in a group and technology would be like a great skill for them to learn but in the time I had, it probably would've taken half my lesson (Angie).

She then recalled what factors led her to showing a Brainpop video in class. In Angie's experience, both her mentor teacher's comfort and students' skill were factors considered during her application of TPACK. Context, the dotted line encircling the TPACK framework, is a critical factor to TPACK (Koehler et al., 2014). Angie modified her integration of technology based on the analysis of her context. These modifications and the thinking process detailed by Angie are not considered by the TIAR or Survey of Preservice Teachers' Knowledge of Teaching and Technology, yet they represent valuable knowledge of how to effectively integrate technology.

Allie notes that the Web Quest she designed had "strong potential for student self-directing learning" but that her "strong planning did not transfer in practice." On the day of her implementation, only one to two computers were usable, and the school's wireless internet was not working. Brynne also wrote of needing functional computers to implement a more effective individualized lesson. Addison, equipped with a supportive mentor teacher, a handful of iPads, and a backup plan, attempted a student-directed stations strategy with technology. "I had a backup plan if all of the iPads weren't working, but not a plan if only one or two weren't working. I felt as if the students who had to deal with the broken iPad didn't get as effective lesson than the rest of the students because they were rushed through their station."

Altering instructional decisions based on contextual factors and experiencing the challenges of failed backup plans were unique to reflections on the final lesson implementations. As preservice teachers designed and implemented their technology-integrated plans during the application phase, they began to understand the complexity of the technology integration process and were often able to negotiate resource constraints, mentor teacher expectations, and students' technology skills as they adjusted in the context. Table 16 shares two participants' descriptions of their context for integrating technology, excerpts from their lesson plan, and their reflection on what was learned through this process.

Table 16

Participants' reflections on placement factors and their final lesson designs

	Context Description	Lesson Plan Excerpt	Reflection on Process
Aadan	I would say that my experience might be somewhat limited compared to a more affluent school district. And the experience was in a first grade classroom in which the teachers primarily used a projector screen. It wasn't even a SMARTboard and uh they would put videos on it or pictures on it and have the students....look at the picture while they read a module perhaps uh when we were doing social studies modules or uh we would do math activities as a class where there would be an activity where a student could pick and drag or something with that sort or the teacher would do it while the students told them what to do.	The Prezi is used in the beginning of the lesson (after the hook) to provide background knowledge for the material and guide students toward being able to engage with the content we are going to be discussing over the following two days. I will present the information on the Prezi and ask supporting questions to monitor student engagement, understanding and to promote critical thinking. The VoiceThread is used on the third day of the lesson in a small group station and is used to provide background information on William Bradford and his role within the Plymouth Colony. This discussion is pushed into what it takes to be a leader and how William Bradford fit that role. The students will watch the VoiceThread and interact both during and after.	Through this process, I learned that it's important to think about how the students will interact with the technology. In a classroom with very few resources, this was very challenging for me. I feel that, given another chance, I could find more ways for the students to directly interact and perhaps lead the lesson with the technology provided. This would take careful consideration of how open-ended this would truly be but I feel as though this balance could be found with careful consideration.

Avery

There are 24 Google Chromebooks in the classroom and the students use them everyday for almost every subject. From the beginning of the year, they have had routines in place with the technology so that now they are able to log in quickly on their own. They can navigate the Chromebooks, and do almost anything on them. For example, they are familiar with Kahoots, Nearpods, Google Classroom, Google Slides, Google Read and Write, and more. Furthermore, students are called up to use the Elmo and Promethean in the classroom so they have a lot experience with that.

So for both days of the lesson students needed to know how to log onto the Google Chromebooks, get onto Google Classroom, and click on a link provided on their Social Studies page. Then, depending on the day they needed to use different skills for the activity they did. For the first day, students did a Nearpod. So they needed to know how to use a mouse, how to use Google Read and Write if needed, and how to navigate the Nearpod. For the second day, students did a WebQuest so they needed to know how to use a mouse and how to navigate through a website to find valuable information.

Planning these types of lessons is helpful depending on what type of classroom you are in and what type of resources you have. For example, in my placement now each student has a laptop and they use them for almost every subject. Therefore, learning to plan these lessons is very helpful because I have technology in my classroom to use and my students are familiar with it. Furthermore, my host teacher is comfortable with me using the technology in his classroom. However, if I was placed in a school with barely any resources I would not find planning these lessons to be helpful because there would not be any opportunities for me to put what I am doing into action.

One of the first things to note from these experiences is the difference in what technological resources were available and how the available technologies were integrated. Aadan expresses frustration with a lack of resources and the use of technology for displaying information and tasks such as dragging. In contrast, Avery details a class with a one-to-one device to student ratio where students are taught procedures for using technology from the first of the year. Thus, Avery lists several technologies the students know how to use for furthering their learning.

Next, the technology-integrated plan is observed to account for the context. Aadan creates presentations on two different web-based platforms, Prezi and VoiceThread. Students mostly receive background information through the technologies and discuss the information with the teacher and their peers. Avery plans for her students to navigate a Nearpod and research information about an assigned topic via a WebQuest. She lists the technological skills students will need for successfully interacting with the content in this lesson.

Although their experiences with resources and the technology-integrated plans that reflect the context were different, Aadan and Avery's reflections on the process had a striking similarity. Both noted the role that classroom resources played or would play in learning to integrate technology. Avery wrote that the process of designing technology-integrated lessons would not have benefitted her if she were placed in a class with limited resources. She wanted to practice what she was planning and highlighted the important role of her host teacher's comfort with technology, student's technological proficiency, and high level digital resources. Aadan wrote that the process was a challenge, but he learned how to consider the ways students would interact with technology. Given another chance, he would like to have students take a more active role in the lesson and with the technology. Perhaps if his future classroom is more comparable to that of Avery's placement, he will find this a more tolerable threshold to surmount (Ertmer et al., 2012).

Discussion of activation to integration. During the activation phase, many preservice teacher's prior experiences with technology could be characterized by Hokenson and Hooper's metaphor of a ghettoized technology integration experience (Hokenson & Hooper, 2010). Borrowed from civil rights vernacular, the term computer ghettos refer to labs segregated from mainstream educational activities. They are perceived as separate educational spaces but often held as special or unique. As the experiences in this study would affirm, a computer ghetto is not conducive to technology integration in the curriculum. According to Hokenson and Hooper though, "Exceptional results may occur in limited areas, but that progress will not extend across the curriculum until the computer leaves the single-use room and is dispersed physically and pedagogically (2010, p. 140)." Generally, participants' prior experiences in a computer lab setting were intended to improve typing skills. While some did perceive this as beneficial for future learning, this experience was mostly viewed as limiting.

Prior experiences with the one-to-one initiatives may have evidenced the physical dispersion of technology, but they did not guarantee pedagogical dispersion. For example, contrast Aadan and Brandy's experiences with one-to-one facilitated instruction. Aadan characterized the physical presence of the device as a detrimental distraction while Brandy believed the use of computers to promote constructivist learning environments and differentiated instruction. As the most recent National Educational Technology Plan (NETP) stresses, access to devices and ubiquitous connectivity to high speed internet services do not guarantee a quality educational experience (Office of Educational Technology, 2016). The new digital disparity is between technologically consuming classroom environments that Aadan experienced and environments that Brandy described as helping her construct knowledge through her active engagement with technology.

In order to address this digital disparity, the NETP urges that preservice teacher must develop the ability to select, evaluate, and use effective and engaging technologies for promoting learning (Office of Educational Technology, 2016). Preservice teachers' experiences reflecting on learning in this study exemplified growth in these areas and a desire for further improvement. They noted the ubiquity of technology and recognized the importance of selecting and using the best technologies. In identifying the best technologies, the preservice teachers also reflected on factors that should be considered during this process.

Preservice teachers' reflections on their technology-integrated lessons revealed their experiences with first-order barriers and resilient beliefs about hands-on approaches to technology integration. First-order barriers refer to things external to the teacher such as resources and policies (Ertmer et al., 2012). Beliefs, knowledge, and skills, things internal to the teacher, have been deemed second-order barriers. Ertmer et al. (2012) noted that second order barriers are stronger predictors of technology integration practice. Preservice teachers' experiences during the integration phase of instruction are next discussed through the first and second-order perspective.

During the application phase of instruction, preservice teachers designed technology-integrated lessons in class as a group and noted their desire for hands-on technology use. This represented a pedagogical belief in a student-centered approach to instruction. When it was time to implement a technology-integrated lesson, however, preservice teachers noted first-order barriers that prohibited them from enacting a student-centered approach to technology integration or barriers that made it difficult for those who tried.

These barriers were unexpected by some preservice teachers, as Angie states she was planning to conduct a student-led exploration of online maps until her mentor teacher expressed discomfort with this idea. The first-order barriers encountered were elementary students' limited technological proficiency and experience, school's limited access to devices and lack of internet connectivity, mentor teachers' pedagogical beliefs and attitudes, and school and classroom norms and culture. Ertmer wrote that while pedagogical beliefs can be strong enough to overcome many first-order barriers, teachers have a barrier threshold. "If you can't surmount the barrier threshold, practices are limited, despite beliefs (Ertmer et al., 2012, p. 433)." Some preservice teachers did surmount the barrier threshold and attempted technology integration practices consistent with their pedagogical beliefs.

Allie, for example, described her attempt as not going as well as it could have due to computer and internet complications. Amidst recalling the struggle, she remained optimistic:

> This had strong potential for student self-directing learning, however because of the technical difficulties, this did not go as well as it could have. I learned that as well as you think you planned, more is always needed. There were still many measures that I could have taken to ensure that this station went well – perhaps eliminating one station so I could be there to help with the computers. This will not stop me from using technology in future lessons, but rather drive me to have better implementation (Allie).

Allie's belief in student self-directed learning and the way her plan for technology integration could support this belief appears strong enough to overcome an experience that did not got as well as anticipated. The first-order barriers experienced during the lesson will not stop her from future technology-integrated designs. After reflecting on this experience, she is driven toward better designs and better implementation.

Allie's excerpt exemplifies the integration principle's reflection corollary. "Learners need the opportunity to reflect on, defend, and share what they have learned if it is to become part of their available repertoire (Merrill, 2002, p. 51).” Although her integration did not go as planned, she intended to revise and implement again in the future. She believed her technology integration decisions to have strong potential for supporting student-centered learning, and the technical difficulties do not appear to have swayed this belief. From the results, additional preservice teachers’ contemplations of lesson revision and desires to improve are evident. There was a realization that technology integration development, the design of effective technology-integrated plans, and implementing these plans well are all processes.

Reflecting on these practices is one way to improve technology integration decisions. While reflection will not improve computer and internet complications, it can help to improve how they are addressed (Mishra & Koehler, 2009). These complications are inevitable and as preservice teachers reflect on how they addressed the complications, share these decisions with peers, and discuss alternatives, they may build a repertoire of strategies to use in the future.

In this theme preservice teachers sensed their early experiences with technology in elementary through high school as often lacking purpose. They experienced many ways of integrating technology while in class and noted the importance of selecting and using technologies in ways that support student learning. Amidst the successes during the implementation of their technology-integrated lessons, preservice teachers also experienced “strong planning that did not transfer in practice (Allie)” and the process of considering contextual factors during their planning. Considering these factors, preservice teachers situated their TPACK in their placement context and adjusted their lesson design lessons accordingly.

The next section will explore preservice teacher’s experiences learning about the forms of technology they would begin using in their lesson designs and implementation. Some of these technologies have already been identified in this section as selections made in the final lesson implementation. Other technologies were identified in this section as ones that preservice teachers perceived as better selection but felt inhibited by first-order barriers. Either way, the next theme will focus on preservice teachers' experiencing the process of learning different forms of technology.

Activation, Demonstration, Application, and Integration - Experienced as Exploring, Modeling, Practicing, and Design Thinking

In both the F2F and flipped sections, each phase of the FPI was applied to helping preservice teachers learn to use technologies. These phases were situated within a real world, complex problem of designing technology-integrated plans and resources. Before discussing the results of how preservice teachers experienced learning about these different forms of technology through these instructional phases, I will briefly outline the design components intended to facilitate these learning experiences.

In the activation phase of the flipped section, preservice teachers gained new experience with technologies as they explored these tools online before coming to the physical class space. In the F2F section, preservice teachers explored these same technologies during an allotted time at the beginning of the class meeting. Describing the flipped section, Bridget wrote, "I found the activities that I completed online before coming to class were very helpful. Due to the fact that I had read about Google Sites prior to coming to class, I was able to understand and incorporate the use of Google Sites into the lesson plan." F2F participants, however, wrote of being introduced to the technologies in class. For example, when asked about when he explored new technologies introduced by the course, Andrew said, "Probably in class. Yeah I mean we were really busy outside of class. I feel like we had a lot of time to do it more in class." So, both course designs included activation through gaining experience with new knowledge. The flipped participants, by design, encountered these experiences primarily online before class and F2F participants experienced activation during class.

Soon after the exposure to new technologies, both groups of preservice teachers would observe a demonstration of procedures for using the technologies and a modeling of how to teach with a specific technology. Below Angie describes observing the demonstration of procedures for an interactive tool called Bio Cube, and Ann discusses her observation of a model lesson through writing how she copied its elements in her own design:

> You showed us the finished project, of like an actual box, I thought that was super duper cool! Cause it wasn't just like, "Oh this is what it is," you like showed us how you would go about it and how you would set it up, a teacher account versus a student account. You know like it was the whole process of how to use it and then what it would look like when it was done not just this exists. It was the actual step-by-step process (Angie).

> We are also planning to use the same activity we did today on wiki to have our students fill out the class website; students will be assigned to one holiday, they will research how that holiday is celebrated in urban, suburban, and rural communities and add this new-found information to the class website page dedicated to that specific holiday (Ann).

The demonstration phase, therefore was focused on two distinct types of knowledge. Through a step-by-step demonstration of the processes for using the technology, it was intended to develop what BRT refers to as the application of procedural knowledge (L. W. Anderson et al., 2001). Through the explicit modeling of how to teach with a specific technology, preservice teachers were observing how to integrate this technological, procedural knowledge with pedagogical and content knowledge (Mishra & Koehler, 2006) as a prelude to their application.

During the application phase, preservice teachers extended their practice with new technologies. As part of the model lesson, preservice teachers worked with the technologies as if they were elementary students. They practiced using the tool and were prompted to consider how elementary aged students would interact with the lesson and its digital components. According to

Brooke, it helped her to both practice using the technology and to consider how the technology could be integrated in the future.

> Well when you're being asked to you know think in the perspective of the student it's--it forces you to think of like all the different perspectives and all the different ways that a student might approach something or think about using the technology that-that um we're practicing using so I thought that it just gave you a-an extra perspective when you're planning cause you have that experience to say, "Oh I had to think this way but a student might approach it this way." So it just kind of gave you an extra level of understanding when you go into a--planning a lesson or completing a task and a reflection (Brooke).

In this way, the application and integration of phases of instruction merged within the problem-centered environment. After they practiced with the technology, preservice teachers reflected on what they had learned and considered its potential future use. These future uses, identified by Brooke as planning a lesson or completing a task and reflection, were components of the integration phase of the FPI in this course design. In the sections to follow, preservice teachers' experiences illustrate the essence of "learning about different forms of technology" through these FPI-based course elements.

"Learning about different forms of technology." In this section, I will be discussing the essence of how participants experienced learning about different forms of technology. Data instances in this category are those where participants mentioned a change in knowledge or skill as it related to technology. In many cases, participants would begin with, "I learned," "I was learning," or "This course made" a concept simpler or easier. Data captured in this theme detail how participants experienced learning about different forms of technology, and in the following sections, I will devote further attention to the complexities of this theme.

In this theme, experiences learning about different forms of technology were commonly discussed as a process that began with exposure to or an introduction to a technological tool, followed by practice using the tool and culminating with contemplation of how it could be used in a lesson or with actual use of the tool in a lesson. These steps in the process describe how preservice teachers experienced elements of the FPI. The activation phase of the FPI introduced preservice teachers to new digital tools and structured experiences for them to build new knowledge about and with these tools. During the demonstration phase, preservice teachers observed modeling of procedures for using the tool. Accompanying this modeling, preservice teachers practiced using the tool, often with a partner or within a group. During the application phase, preservice teachers began considering how the new form of technology could be used in a future lesson as they designed a lesson integrating the new tool.

This quote from Andrew captures the essence of the process, "We worked on so many things this semester that I'd never even heard of before. One of these new technologies was EDpuzzle, which I ultimately ended up using in my own lesson." He noted the introduction to the technologies, highlighted the work that occurred to learn them, and closed with stating that he ultimately used them in an authentic context. These themes will be further explored in the next sections along with related sub-themes as a textural-structural synthesis of learning to integrate technology in a course designed according to the FPI.

New experience corollary: "New technologies that I had no idea existed." Participants in the course recalled becoming aware of "so many different programs and websites." Per the FPI's new experience corollary of the activation principle, the course design structured relevant new experiences to expose preservice teachers to new digital tools and to build a foundation for application and integration. The new technologies mentioned by participants ranged from resources for planning to features of devices to specific applications such as Google Apps for Education, VoiceThread, and EdPuzzle.

When using the term “new” as it relates to technology in this section, I will use it as defined by Andrew when he wrote, “Before yesterday, I had never heard of vlogging. There’s also so many new apps I learned about last week when talking about wikis. I definitely think that learning about these new (to me at least) technologies….” New in this context is not defined by time but rather by novelty to the one making the claim. New is not a characteristic of the technology but a characteristic of the participant’s relationship to the specific technology. To many participants, therefore, these technologies were new as they had never encountered them before the course. As noted by Andrew, even students who consider themselves tech savvy were introduced to tools for the first time.

> Prior to the semester starting, I would’ve considered myself to be fairly tech savvy. However, each class period I was learning about different forms of technology that I had never even heard of before, like voki, voicethreading, edpuzzles, and vodcasts (Andrew).

Some participants wrote about the ubiquity of technology and perceived themselves to be “savvy” or comfortable with digital tools, yet the essence of their experiences was an exposure to a world of opportunities they had not previously considered. Along with Andrew’s sense of technological savviness in the statement above, there is a note of surprise at being introduced to these new forms of technology, forms he had “never even heard of before.” This introduction to new technologies is also described as something that frequently occurred as he wrote of learning of these new forms in “each class period.”

Aadan also expressed confidence about working with technologies. Amidst this level of comfort, he acknowledged the introduction to new programs and an expanded scope for future integration. He notes that learning of the existence of the new technologies did not make them less complicated per say, due to his comfort with technology, but rather it opened possibilities for future application and independent exploration.

> My experiences in this course has made technology seem somewhat less complicated. I was not aware of the different programs that we have used in class such as VodCast and WikiPages. I think this class has actually opened up my range of technologies more than made them less complicated, however. I feel as though I am pretty good at figuring out technology that is in front of me. Being exposed to these programs does show a world of opportunity that I may not have otherwise been exposed to, though (Aadan).

Citing this exposure to new technologies, several participants described experiencing an increased sense of confidence integrating technology and excitement to try using the tools in their instruction. Alyssa shares how being introduced to various types of technology helped the entire idea of integration seem achievable. “I now know of many resources and options that I can use in the classroom, which makes the idea of technology integration less complicated, and makes it a reachable goal in my teaching (Alyssa).” A sense of excitement is shared by Bree who wrote that she has already been planning to use some of the tools, Google sites and forms, that were introduced in class, “These are great resources to use because I can use them on any device, they're free programs and are user friendly.” Ashley shares her affinity for Google sites and Google forms and describes them as “simple types of technology…simple efficient ways to make a lesson.” Arthur also shared that learning about VoiceThread made the “integration of technology in the classroom less complicated because it is an easy device for students” to use. There was a shared experience across many participants that as they became aware of new technologies for teaching and learning that were perceived as simple to use, the idea of technology integration became less complicated as well.

While regarded as beneficial, the exposure to new technologies was not universally perceived as a comfortable experience.

> This course has opened a lot of doors to technologies which [I] didn’t even know existed, which is slightly overwhelming…I’m ok at technology, I can work a phone and computer and run some programs, but I’ve never been a whiz. Th[is] course has showed me that I don’t need to be a whiz at technology in order to have it in my classroom. It has showed

> me how easy it is to make a class website or a video to go along with a powerpoint or slideshow…I think overall this course is a bit overwhelming and complicated at first, but has definitely made more sense and become less so as it's gone on (Angie).

> I think I definitely learn[ed] more ways that I can use technology in the classroom…which is very beneficial for me. However, in the sense that technology use becoming more complicated for me is that it [is] difficult picking and choosing what technology to use (and potentially how to get the best use out of it) for a specific lesson/topic (Aubrey).

For Angie, the experience of so many new avenues for technology integration was a bit overwhelming. These unveiled opportunities, combined with a lower sense of confidence related to using technology, contributed to feelings of complication that lessened as the course progressed.

Experiencing the new opportunities for integrating technology as a complicated enterprise was not relegated to preservice teachers who perceived themselves as lacking technological knowledge. Aubrey describes in the above quote an increasing sense of complexity arising from the difficulty in selection and effective use. Being introduced to new technologies and methods of integration was beneficial, yet Aubrey recognized that the vast variety of digital options necessitated careful selection, understanding of how to best leverage the selection, and consideration of the content as a factor in this selection process. Other participants discussed experiences with these processes as they wrote about practicing with the technologies and "try[ing] out these different means of educational technology (Brianna)." The next theme will further examine the essence of participants' experiences in this application phase of learning to integrate technology.

Demonstration and Application: "Taken out the step of learning how." In both face to face and flipped versions of the course, preservice teachers practiced using the technologies that had been introduced during the application phase of instruction. They practiced individually, in pairs, and in groups referred to as design teams. Prior to their practice, they participated in a model lesson where they would interact in a lesson as an elementary student. The lesson, a component of the demonstration principle, would model the behavior of teaching with the technology and the procedures for using the technology. After this model lesson, preservice teachers designed a lesson with the same technology just observed and applied their knowledge of teaching with the technology and using the technology to the lesson components.

During the second meeting of the semester, the preservice teachers were tasked with creating a Google Site and incorporating a way for students to interact with the site. Alyssa recounts the experience creating a wiki and describe her initial draft:

> On this Wiki designed by me, there was a main page that described the task at hand: learning about various holidays that many people celebrate around the country. There are tabs of six different holidays: Dia de Los Muertos, Holi, Lunar New Year, Kwanzaa, Ramadan, and Rosh Has[h]anah. When these tabs are clicked on, the student is given a short synopsis on who celebrates these holidays, when they take place, why they are celebrated, and how the celebration happens. There is a picture on each page to help with the student's understanding as well. This website was not difficult for me to make, and required no knowledge of coding. The general outline was already there, and all I had to do to complete it was write and add pictures. The construction of this website took no more than 45 minutes, and can help students understand all of these holidays in a way that is interesting and aesthetically pleasing to them. I would definitely use this website again to create content for students to enjoy and learn from (Alyssa).

Preservice teachers' experiences practicing the technologies, as evidenced in Alyssa's account, were characterized by practicing skills required by the technology, perceptions of the digital tool's difficulty, and evaluation of the technology's potential uses. Alyssa's application of skills for using Google sites is seen in the phrases, "designed by me, there was a main page…tabs of six…tabs are clicked [for a short synopsis] …picture on each page." These were skills or artifacts of skills evidenced by Alyssa when designing the website. While practicing these skills, Alyssa perceived working with Google sites as simple. All Alyssa "had to do to complete it was write and add pictures." She notes that it required no knowledge of coding nor did it consume a significant amount of time. Finally, Alyssa evaluates the tool for potential use in the future. She concludes that she will definitely use the tool in the future based her perception of its usefulness and ease of use.

This quote was selected for its comprehensive nature as it exemplifies three invariant constituents of learning how to use the technology in the application phase if this course within a singular episode and from a singular perspective. It was not a singular experience, however, as 22 of 32 participants described these invariant components in their experiences of the application phase.

Practicing the skills. Preservice teachers wrote about gaining experience with various technologies through practice. While those in the flipped version of the course discussed exploring Web 2.0 tools online before class, both groups recalled using technologies in class. In the aforementioned theme that focused on the introduction to new technologies, Aadan noted that becoming aware of the technologies was sufficient as he could independently figure out the procedures for use. Avery, in the following statement, describes how using the technologies as part of the course was an important aspect of learning to integrate technology:

> [The course] has taken out the step of learning how to use certain programs. For example, I already know how to use Google Forms and VoiceThread from taking this course so I won't need to spend time learning them when I want to use them in my teaching. If there are other technologies I am not familiar with that I want to use in my classroom I still think they will be complicated to use because I will have to learn the "ins" and "outs" of them on my own (Avery).

Learning to use the technologies independently was viewed by Avery as a barrier to future integration. She refers to needing to learn the "ins" and "outs." While this could be a sundry of factors and skills, participants noted several potential "ins" and "outs" they achieved while practicing with the technologies: Incorporating diverse question types in a video (Andrew), giving students edit access on a website (Agnes), creating an online quiz and retrieving results (Agnes), integrating Google Slides within Google Sites (April), and developing online rubrics (Brittney). Likewise, Ann's practice with specific technologies in class was part of her teams' decision making process when designing a lesson.

> We will not be using lino because the students will be posting on the class website so we simply do not need this resource as well. We will not be using blogger, wix, or jing because the activity we did talked more about classroom experiences with these websites and we didn't get to explore them ourselves (Ann).

Lino was a common Web 2.0 selection made by other design teams, yet Ann identifies it as redundant in their lesson. The second part of the quote refers to a specific class activity. In this class activity, preservice teachers each read one of four technology integration cases. Each case shared experiences of a teacher using a different technology with students (Blogger, Wix, Jing, and Google Sites). After reading their assigned piece, preservice teachers formed a group with one person in the group who has read about each case. They then discussed questions that were provided to them on a class discussion board hosted on Lino and post responses to the Lino board.

Due to time constraints, only Google Sites was modeled for the preservice teachers during the class demonstration phase and assigned to them for practice during the application phase. Referring to this activity, Ann states they will not be using the other three technologies. They did not have an opportunity to explore them, to practice using them, to learn the "ins" and "outs." They were introduced and became aware of these technologies, but the course experience did not take "out the step of learning how." Ann's group was not alone in their decision to avoid these other tools that had only been introduced via the reading. Although given the choice of practicing from this group of tools in class, no other design team used these three tools in a lesson.

Preservice teachers' practice with these technologies were anchored to the design of lessons and support resources via the problem-centered principle. Experiencing the problem-centered principle through their application of technological knowledge and skills in authentic design tasks were perceived as relevant to their professional goals. Brianna notes the benefit of trying the technology and applying it – experience planning lessons and increased confidence.

> It is also helpful to try out these different means of educational technology and apply them into a lesson so we have more experience with actually writing a lesson plan that utilizes these technologies. Practicing them in class also helps us become more confident in using it in a classroom (Brianna).

As preservice teachers' reflections communicated the process of practicing with the technologies, they regularly contemplated the difficulty level of the technology for themselves and students. Additionally, they considered the potential implications for classroom use as they practiced the technological skills.

Application in class as a way to overcome technological anxiety. Practicing technological skills for some required confronting technology integration fears and pre-conceived perceptions of difficulty. Bridget feared "that using technology would be too hard to learn how to do" or that if she did plan a technology-integrated lesson, the technology would fail. Self-identified as "not a big technology person," Adeline felt that making technology accessible and relevant would be difficult. Even once interacting with technologies in class, the experience was uncomfortable for some, as Arianna wrote, "I must admit, sometimes the websites and software(s) seem confusing and overwhelming at times." Evaluating the difficulty, whether easy or perplexing, was the essence of preservice teachers' journeys through practicing technological skills and knowledge in the course.

Certain technological tools, such as VoiceThread and Google Sites, were perceived as more difficult. Yet it was noted that the step-by-step nature of "being able to see and understand the components of each technology component (Arianna)" would typically reduce the feelings of confusion. Other technological tools, such as Lino, were consistently perceived as simple as indicated below by Beverly.

> A technology that I have learned to use is a Lino board. This is a board in which teacher can post questions on a bulletin online and then students can post an answer to each question. …By learning about Lino we were able to create a discussion board for rural, suburban, and city. There was one discussion board for each group (one for suburban, one for city, and one rural). Then we created a google site that had questions for each student to answer individually about communities that were rural, suburban and city…This is a great and easy way for teachers to see if their students understand the topic they have been studying (Beverly).

Components of tools may have contributed to perceptions of difficulty. Yet for preservice teachers such as Bridget, it was a general anxiety related to the use of technology that was not isolated to practicing the use of a specific tool. Confronting this anxiety through practice in class was part of Bridget and Adeline's experience.

> "I have learned that technology integration doesn't have to be a scary thing…Through this class, I have explored many simple ways such as Edpuzzle, Google forms, and digital storytelling that I could easily integrate into a lesson (Bridget).
>
> I am not a big technology person....However, working with technologies such as Wiki, Google forms and VoiceThread has shown me that it isn't as complicated as it seems. Even something as "advanced" as creating a podcast with accompanying pictures can be made fairly simple through something such as VoiceThread (Adeline).

Through working with these technologies, Adeline and Bridget experienced shifts in their perceptions of difficulty. They both close these ideas by stating the technologies were simple or fairly simple or not a complicated as it seems. Confronting a pre-conceived notion of difficulty or a fear can be an additional challenge when learning to integrate technology. As highlighted in the previous theme, preservice teachers noted they were more likely to use the technologies they had practiced in class. This notion, separate from beliefs about difficulty or degrees of anxiety, may warrant the design of course experiences that allocate space for practicing the “ins” and “outs” of educational technologies. A possible connection to a shift in perceptions of difficulty may offer an additional rationale for designing these environments.

Evaluating a tool’s potential for future integration. In addition to practicing the technologies and considering their levels of difficulty, preservice teachers evaluated their potential for future use. Evaluation, identified as a high level of the cognitive domain by BRT and an important component of the integration principle of the FPI, was intentionally structured in assignments by prompting preservice teachers to reflect on the digital tool’s potential. They considered their experiences with the tool during the online or in-class activities and discussed how they could modify or extend future integration with the technology. The interview excerpt below conveys what Brooke perceived to be the purpose of the activities and time in class – a space and a time for evaluating technology integration ideas and tools.

> Um...well I think it was to like introduce new ideas but then give us a chance to try them out ourselves. Um...Even in--if--cause--well a lot of us I'm sure weren't able to do all of these things in our own classrooms just because of limited resources or access to technology so it was nice to have a place to uh at least try it out. Um...even if you couldn't in the classroom. And it was sort of just--we were able to decide what things we would use or what things we do--wouldn't see ourselves using (Brooke).

The essence of class time, according to Brooke, was to introduce new ideas and provide a space for testing them. Put differently by Ali after designing a website, “I could imagine elementary aged students using this source to publish information given appropriate instruction.” It was a place for imagining, considering, and testing the limits. These limits were both anticipated from past experiences with technology in classrooms and experienced by preservice teachers as they entered their field placements. Brooke mentioned limits imposed by resources or the limits of what she could see herself doing. Aadan experienced these limits and explained them as he began his interview with, " Uh so technology...I was in an [urban school] to preface uh so I would say that my experience might be somewhat limited compared to a more affluent school district."

Aadan smiled, laughed, and waved his arms during the retelling of his experiences and chuckled loudly during his recollection of how his mentor teacher attempted to use technology in this field placement as compared to how it was used in the course. Yet his reflections conveyed potential frustration by the dichotomy of experiences. Around midterm, he wrote, "At times, I feel as though some of these activities may be unrealistic for the classroom in terms of the technology available. I guess this course is taught as if it is available but my previous two placements did not have sufficient technology to apply any of these lessons so it made the assignments seem very idealistic as opposed to realistic." The ideal – this is what was practiced in class. It allowed for imagining possibilities and practicing with fewer boundaries or for considering boundaries that seemed relevant.

Excited to have been exposed to the many Google Apps for Education and sensing confidence from two hours of practice, April considered the tool's potential in a class setting.

> For instance, I didn't know that Google had so many different applications such as Google Slides, and through the two hours that I was in class I found out how to work the website through instruction and activities. As a teacher, if I was to have my students do the same thing within the class, create a Google Slides webpage I would have to take a few days on the lesson which might not have been something that I would have thought about before (April).

Time would be something to consider. April offers an ideal provision of taking a few extra days on the lesson to integrate technology. In time, April and others would begin to consider the realistic bounds of time as they considered what technology would be integrated in their field experience.

When considering the technology integration classroom as a place for testing and imagining digital tools' potential, idea generation characterized this creative space. Ali wrote of Web 2.0's potential for students' to publish their work, and Brittney wrote of the potential for the technologies she had learn about to be used as assessment tools. Considering the possible benefit of the technologies being practiced, Brooklyn added that, "it will be very helpful for us to have a wide variety of tools we feel comfortable leaning on and creating lessons from. Not only will we know about these tools, but we will also have an idea of how to utilize them so that they can help our students meet both curriculum standards as well as technology standards." These general ideas, often lacking a context and a specific purpose, were foundations for preservice teachers' initial design considerations.

Aubrey succinctly summarizes the essence of what participants drew from the process of being introduced to new technologies, practicing with the technologies, and considering their use in authentic settings. After listing several technologies introduced to her and citing the many ways she learned to incorporate technology from the course, she wrote, "I now consider all of these things when I am thinking about technology in the class and ways that I can incorporate them for my future lessons." Considering these tools, according to Aubrey, had been integrated into her design process. Avery adds that "by being more rounded in a technological education, we have more options to explore for our lessons and know which ones may work best with our students."

While not every participant devoted equivalent attention to the invariant constituents of the essence of learning about different forms of technology, most wrote about two or three components of this process. Only one participant mentioned none of these three components. Preservice teachers took what had been introduced and practiced and considered how it could fit into their lesson designs. Aside from considering the different forms of technology they had learned for future teaching, preservice teachers also considered their beliefs about technology's place in teaching and what they believed constituted effective technology integration.

In the next section, I will present preservice teachers' experiences with the problem-centered principle and its problem progression corollary. These design principles were essential to the structure of the course and the integration of the design principles outlined previously. Additionally, TK will be discussed as a component of the broader TPACK framework, and preservice teachers' experiences designing will be used to inform the results of the courses' impact on their application of TPACK to technology-integrated lesson designs.

Situating, Segmenting, and Sequencing via the Problem-Centered Principle

Creating design problems to model varied examples for students was an essential component of the problem-centered principle in this course. The overarching problem for preservice teachers was the design, development, and implementation of a technology-integrated lesson. According to Merrill, the three corollaries of the problem-centered principle are show task, task level, and problem progression (Merrill, 2002). These corollaries guided the segmenting of the technology-integrated lesson design into component skills, sequencing the skills in an effective way, and planning the phases of instruction to develop mastery.

Based on the problem progression corollary from the FPI (Merrill, 2002), technology integration design components were separated into their own modules. The individual components, referred to as component skills, were provided as worked examples until taught. This meant that the earlier in the semester a skill was taught as part of the progression, the more learners practiced applying this skill. One may consider having students first learn the most difficult skills and thereby practice these skills the most, but this has students learning the most difficult component skills at the beginning of the semester when they may be least prepared. For selecting the sequence of the first component skill, I based the decision on degree of importance and opportunity for variation.

Further, in strategically selecting the sequence of skills to be learned, the instructor can highlight significant relationships among the skills. To highlight these relationships and orient the learners, the show task corollary states that the instructor should demonstrate the whole problem to learners and situate future skills within the problem (Merrill, 2002). Relationships between skills or tasks can be further highlighted by displaying the whole problem regularly throughout the course.

Lastly, the task level corollary informed the application of the problem-centered principle as it stresses the need for learners to engage the problem in a real world setting and not merely learn actions or skills that could support solving the problem (Merrill, 2012). Instruction should guide learners as they learn actions and complete tasks, but it should ultimately lead toward engaging a real problem. As preservice teachers in these courses were taught specific technological operations and skills such as crafting effective learning objectives, the instruction was meant to match these task levels and always intended to situate the skills within an authentic design problem. Preservice teachers' experiences with the problem-centered principle are discussed in the following sections. As they devoted much attention to the problem progression corollary, which they termed scaffolding, the subthemes in this section relate mostly to how they experienced this element of the problem-centered principle.

"I knew when I was doing something and why I was doing it and how it connected to the day before." Within the problem-centered approach espoused by the FPI, learners are given many opportunities to apply and integrate their learning within the context of an overarching problem. In this study, learners applied their TPACK to the design of five technology-integrated lessons with their peers, and they integrated their TPACK in an authentic setting when they individually designed and implemented a technology-integrated lesson during their field experience. The quantitative results of this study have already indicated a statistically significant growth in preservice teachers' application of TPACK to the design of lessons, and this section of the qualitative results will be devoted to participants' in-class design experiences.

Angie shared the quote referenced for this theme's heading in her description of the general course process. An extended excerpt of the quote is provided below. After describing the course in an earlier portion of the interview as "predictable," I asked Angie to expand on what she meant by this statement. Her response indicated an awareness of an overall course structure that helped her know what to expect, comprehend its' relevance, and connect it to prior course experiences.

> Um so being predictable means I know what to expect…You know so in that sense, it was, it was comforting in a way cause I knew what to expect. I knew it was happening. But its also because I knew why I was doing something. *Oh this is the part where we practice for our students. Okay that's why I'm doing this.* So it was also like that I knew the fact that I knew when I was doing something and why I was doing it, how it connected to the day before, because, *Oh during this time the day before we did this, okay this will kind of build on this, and this is also for our students*. So it was also like I could build it upon the other classes easily cause it was really easy to connect between classes. Even though sometimes we saw each other a month and a half apart cause of the placement and everything like that (Angie).

As Angie highlights in her last line, the course structure of six meetings over the span of fourteen weeks resulted in lengthy gaps between meetings. Amidst this intermittent schedule, Angie states it was easy for her to make connections between classes due to the way the content built upon prior content. One of the subthemes resulting from this analysis was that preservice teachers recalled the ways in which they made connections between classes. Their reflections revealed experiencing of a repetitive process of designing lessons in class, and similar to Angie, other participants conveyed a sense of comfort with this structure.

Noted in italics, Angie tended to change her vocal intonation when describing her thinking during a class activity. In recalling her thought process, she mentions knowing why she was doing an activity-she knew she was practicing for students. Practicing in class, according to Angie, was clearly connected to her life, because it was for her students. She reiterates this idea again after talking about the building of content between classes when she states that this was "also for our students." While the previous theme focused entirely on how preservice teachers learned about different forms of technology, this subtheme will focus on how they connected these technologies to their teaching. Preservice teachers discussed making these connections while practicing in class and working with peers.

"This scaffolded approach, beginning with the most support and ending with the least support, helped us learn how to plan lessons with integrated technology." Following the guidance of the FPI problem progression corollary, the course design presented preservice teachers with the problem of designing a technology-integrated lesson on the first day of class. This first design task only required preservice teachers to design a single component, and each subsequent lesson required the original component and an additional element until they were designing an entire technology-integrated plan. While Merrill's FPI refer to this process as the problem progression corollary of the problem-centered principle, the preservice teachers used the term scaffolding. As such, the term scaffolding will be used throughout this section instead of problem progression to use the participants' language for describing their experiences.

Angie noted this scaffolding process when she said, "Yeah so I thought it was cool how you started us off-like you gave us like you know four and five things we needed for a lesson and then we kept having to make more and more and more." Then she noted when her F2F section engaged this process as she continued, "Because that was in our design team tasks but also in class we started off with definitely simpler technologies." She experienced the process of beginning with a nearly complete lesson to design outside of class and having elements gradually removed. Contrast her experience with that of Bonnie, in the flipped section, who wrote that "To me, technology integration is not a complicated concept, especially seeing how we practice writing lesson plans every class." Bonnie experienced the same repetitive process, yet she remarked that the practice of writing lesson plans occurred in class.

The next quotes are also from participants in the flipped sections, with the first one indicating that the experience of designing technology-integrated lessons occurred in class. In retelling their experiences with what Bonnie labeled the scaffolded approach, the participants often chose to contrast the most recent design experience with their first design experience. In these selections, they explained what was provided to them in the first lesson and how they could still succeed amidst the waning support.

> In every class, each team has [to] develop a lesson plan that integrates technology. The first day of class, the only thing we had to create was the rubric/assessment and the rest of the lesson was given. Each class, we have to do more and more of the lesson by ourselves and less is given. By the most recent class, class 4, we now have to do every part of the lesson ourselves without any of it done already (Brittney).

> At first we were given a social studies standard that we were required to design our lesson around, however, in the most recent lesson we started planning, we had to choose our own standard. We were able to design our own lessons from scratch because of the fact that each week we were given a little bit more independence and freedom. We had practiced the task so many times by creating a lesson each week that we were soon able to replicate the same design without guidance on the fourth week. This is similar to what teachers should do with students. They provide guidance to their students in the beginning to help them understand their objectives and how to go about their learning. However, as the teacher sees that students are becoming more familiar with a topic they provide less and less guidance. They are now able to create their own product, which is the highest level of Bloom's Taxonomy. This is what a teacher is aiming for his/or students to reach (Beverly).

> The way that IDE 301 is organized allows for scaffolded guidance. For example, for the first lesson, we were provided both the learning objectives and the lesson standards. This acted as the introduction to the technological concepts, and we were given the most support. Looking at this last lesson, our design teams wrote our own learning objectives and chose our own lesson standards. This scaffolded approach, beginning with the most support and ending with the least support, helped us learn how to plan lessons with integrated technology (Bonnie).

Concerning her first design team experience, Brittney simply wrote that her group initially designed only the assessment portion of the lesson plan. In following classes, they designed more until the most recent week when they designed an entire technology-integrated plan. Bonnie adds that the learning objectives and standards were provided the first day, and Beverly remembers the standards from the first class being a social studies standard. Both Beverly and Bonnie perceived the process as beneficial to their learning to integrate technology. Bonnie felt that having the most support at the beginning of the course served as an introduction to technological concepts. Beverly contributes her teams' ability to replicate the design process and plan a technology-integrated lesson "from scratch" to both the increasing "independence and freedom" and the many iterations of practice.

"Practiced the task so many times…" In the second half of Beverly's excerpt above, she selects language to convey her experience with this problem progression corollary that is

somewhat ambiguous in terms of how she felt about the repetition yet clear regarding the frequency. She wrote, "We had practiced the task so many times…" Earlier in the quote, she noted aspects of the task that varied, but the task itself she recalls experiencing so many times. Beverly was the only participant in the flipped section to characterize the experience in this manner, "practiced the task so many times." She follows this sentence with her observation of how this should be mimicked in her own practice as a teacher. According to Beverly, teachers should provide repeated opportunities for practice with diminishing guidance to help students understand the lesson's objective and the processes of learning. She concludes with expressing the goal of this instructional approach - for students to be able to independently create, a high level of cognitive complexity.

Two participants in the F2F section also detailed the essence of the task's repetitive nature and offered their perspectives of potential limitations with this implementation. In the first sentence of the following excerpt, Arianna first indicates her experience with the repetitive practices were productive. She then reflects on what others may feel of these repetitive practices, redundant and tedious, but notes that it still elicits practice and consideration of technology integration ideas. Through the body of this excerpt, Arianna describe the variants of the tasks and explains how this prompted her thinking, and she closes the reflective statement with a description of the scaffolded task structure and how she experienced this as beneficial to her development.

> In my involvement in these processes from a broad perspective, I would definitely say the repeated practices we complete in this class are productive to us as future educators. As it may be redundant and tedious for some, it still is eliciting great and continuous practice of effective ways to consider and implement technology into the classroom. Also, all of the situations and scenarios require different content areas and issues that are possible in a classroom. Furthermore, they all also incorporate a different sort of technology that can be used for various instruction. Thus, each technology-integrated lesson created builds

> upon our repertoire of new technologies we can use, as well as the different classroom environments we may have, regarding technology or just demographics overall. I also think these technology tasks are helpful for our development, because the way they are structured really allows us to build on our prior knowledge. Each task is scaffolded, so that we are constantly working on what we practiced on to complete more of the tasks on our own. Such a structure really allows such new learning processes to be structured step-by-step, which makes it less overwhelming. Therefore, my peers and I feel able to digest the content and concepts in front of us to further our technology instruction. So even though such a repeated task, I think it is very beneficial, because we are being exposed to so many new ideas and skills as we develop as future educators (Arianna).

While some may have experienced the tasks as redundant and tedious, Arianna also lists how the design tasks varied throughout the semester. All the design task situations varied, Arianna wrote of her experience; they included different content areas, issues, selection and use of technology, classroom environments, technological availability, and demographics. Through these variations, Arianna recalls completing more of the design tasks throughout the semester via a step-by-step process and felt this structure helped to further "digest the content and concepts" as she developed her knowledge and skills integrating technology.

Angie also described this task variation in the following excerpt and provides a unique case of apparent contrasting perceptions of the repetitive nature of the design tasks. The first quote below is from a reflection written mid-way through the semester, and the second quote was extracted from the post course interview.

As context for the quotes, the course design provided a content area and standards for the first three design tasks, and students selected these components for the final three, one of which is their individual technology-integrated lesson. The first two design tasks were contextualized within the same social studies standard but different ISTE standards. At the time Angie submitted this reflective statement, her group had selected their topic for one of four design tasks.

Table 17
Angie's reflections on the design process at two points in the semester

Angie Mid-semester Reflection	Angie Post-course Interview
I think this process, overall, is helpful to teacher development. However, I think we've overdone it in this class. I think that adding one thing at a time helps, but we do different topics and ideas, are given different instructions, and what we repeat is way too similar. We need to maybe add one more thing to an existing lesson plan each time, rather than making entirely new ones each time. If we were allowed to pick out our own topics, I would be much more invested in the assignment.	Yeah, so I thought it was cool how you started us off-like you gave us like you know four and five things we needed for a lesson and then we kept having to make more and more and more…Um so starting off simple and like having it a little more laid out for us was nice cause I got to kind of like you know dip my foot in the water a little bit in a sense. Like it wasn't quite as, "Okay go plan a lesson." It was like, "Okay, I've planned a lesson mostly for you. You just have to do the last piece of it." So in that sense, it was kind of more like the scaffolding that we talk about in like other classes…

Partway through the semester, Angie's experience with the repetitive nature of the design tasks was "overdone." Adding one thing was helpful, she wrote, but she perceived the overall design task experience to be "way too similar." Instead of repeating subtask components, she proposed simply revising previous technology-integrated lesson's subtask components when a new skill was learned. She also expressed a desire for choice and independence to ameliorate a lack of personal investment in the assignment.

While Angie's statement in the post-course interview does not mention her group's experiences selecting their own topics, she does convey an increased sense of autonomy in her experience of having to do more and more and more. She also restates her appreciation for the scaffolded approach allowing her to "dip her foot in the water." Looking back on the entire process, Angie "thought it was cool," but amid the process, she thought it to be overdone. Was the increased autonomy she desired to be attributed for this shift or does completing the entire design process individually offer a newfound appreciation for the, "Okay, I've planned a lesson mostly for you?" These data may have fostered more questions than answers regarding the mechanism for the Angie's shift in perception. However, they have offered important insights into participants' learning experiences with the scaffolded, repetitive nature of the design tasks. The participants did propose how these experiences may have furthered their development.

Break down and build up. From their experiences with this scaffolded approach to technology integration development, preservice teachers wrote of two primary benefits this approach had on their learning. First, they related that each design iteration's introduction of one new component helped them break down the important components of design. Secondly, the way each design iteration increased in complexity built preservice teachers' confidence with designing technology-integrated lessons.

In the table below, representative quotes have been selected and labeled as *focus* and *confidence*. These terms were selected from Brittney's quote which included perceptions of how the *break down* and *build up* benefitted preservice teacher development. Quotes were coded as *focus* when participants discussed how the isolation of a new task helped them to focus on learning or mastering it, and quotes were coded as *confidence* when participants described how the scaffolded structure helped them feel less stressed, more comfortable, or confident.

Table 18
Participants' perceptions of the benefit of the scaffolded approach

Participant	Perceived Benefit	Reflection Excerpt
Brittney	Focus and Confidence	Due to the fact that each class we had to do a new part of the lesson was really helpful because it allowed us to focus on a certain aspect of the lesson. This repetitive task helps us as teachers practice making lesson plans and gives us the confidence to complete one on our own and correctly. Due to the fact that we slowly added more and more complexity in the lessons, I feel less

Participant	Perceived Benefit	Reflection Excerpt
		stress and more comfortable using the various forms of technology into my lessons.
Brenda	Confidence	Each week I feel I am becoming more and more comfortable with creating lessons with my design team, while incorporating the new types of technology we are learning each week and the ISTE standards. I feel that when the time comes around and I have to plan a lesson for my second grade students this semester, I will have so many new technology options that I can incorporate into my lesson.
Brooke	Focus	The process begins at the basis of lesson planning, which helps teachers break down where the integration of technology starts, because it is not something that is restricted to activities in the lesson. Technology is important to consider when planning objectives and assessment. I found it impactful to first begin with these two aspects of lesson planning and work on them individually before moving to planning an entire lesson. By using this process I believe that it has benefited our groups understanding of what the most important components that go into a lesson are.
Bridget	Confidence	I think that starting with most of the information filled in made me feel more successful in my abilities to plan a lesson that met both Common Core State Standards and ISTE standards. Adding an element of complexity provides a different challenge when writing each different standard. Each time I complete a lesson, I feel that I have had to really push myself to make a great lesson, but also that the lessons are never way outside of my comfort zone.

Each participant’s experiences focused on something slightly different in the process that helped them focus or sense confidence. For Brittney, the isolated “new part” helped her to focus, and the slowly increased complexity reduced her stress. Practicing each week with her team helped Brenda feel more comfortable designing lessons with technology and breaking down lesson components helped Brooke identify what she believed to be the most important components of lesson design and a place for beginning to integrate technology. Finally, Bridget shared that each new element added a challenge and the need to push herself. The challenge, though, was never beyond her reach.

Discussion of preservice teachers' experiences of the problem progression corollary. Preservice teachers experienced the problem-centered principle as a process that gave them many opportunities to practice. Repeating component tasks was sometimes redundant, but they appreciated engaging with variations of the problem and the increasing independence. Progressively adding one component helped preservice teachers to focus on learning new tasks and remain confident while challenged. The process was perceived as beneficial for technology integration development, and the TPACK-application outcomes affirm the impact of this process.

Theoretical perspectives on the design experiences. These experiences, viewed through the perspective of expectancy value theory (EVT) and constructionism, help explain participants' statistically significant growth in application of TPACK to their technology-integrated lesson designs. For example, Bridget's statement of confidence that, "I feel that I have had to really push myself to make a great lesson, but also that the lessons are never way outside of my comfort zone," demonstrates an expectancy for success. The scaffolded approach experienced through the problem progression may have fostered this expectancy. Bridget's description seems to be an account of her experiencing what has been termed the zone of proximal development (Vygotsky, 1978). Locating instruction within this zone helps learners sense they can achieve the outcome while encouraging them, in Bridget's words, to push themselves.

As for intrinsic and utility value, there were ostensible differences expressed of experiences with the problem progression process. Intrinsic value, seen as an individual's enjoyment or interest inherent to the task (Myrold & Ullrich-French, 2017), was potentially exacerbated by problem progression. Some participants felt it to be too repetitive. As recommendations, Angie said it would have been fun to change teams and encouraged future designs to increase the variation between problems. Other FPI corollaries address both recommendations (Merrill, 2012), and researchers of FPI-designed courses advise instructors to incorporate students' feedback, identify their needs, and attempt to view the instruction from their perspective (Keller, 1987; Long, Cummins, & Waugh, 2016).

Participants' high regard for the utility of practicing the process may have facilitated their efforts in this constructionist environment. Papert (1988) underscores the criticality of the meaningful tasks as the basics for the construction process. He posits that they should be authentic and relatable. As Angie's experience suggests, the utility was valued for how the design tasks could benefit participants' teaching practices and for how the practice connected to future success in f the course. "*Oh this is the part where we practice for our students. Okay that's why I'm doing this…*I could build it upon the other classes easily cause it was really easy to connect between classes. Even though sometimes we saw each other a month and a half apart cause of the placement and everything like that (Angie)." The construction of knowledge and tangible artifacts via a problem-centered progression was perceived as valuable for future and current goals.

Summary of Qualitative Findings

As each preservice teacher entered the course with individual prior experiences learning with technology, each preservice teacher also uniquely experienced aspects of the course. From these unique experiences, this analysis sought to unveil the essence of learning experiences in these technology integration courses design with the FPI.

The first theme detailed the underlying structures of participants' reflection on prior learning experiences with technology and their conceptualization of how to integrate technology based on their reflections of class activities. They noted differences in the current and past expectations to integrate technology in teaching and the needs to have students work hands-on with fit technologies. Yet amidst their perceptions of their prior experiences with technology as lacking and ideas for what effective technology integration should be, most preservice teachers in their final course reflection sensed a need to still improve their own technology integration practices.

Secondly, preservice teachers described learning about different forms of technology in the course as a process. This process detailed by participants began with an introduction or exposure to new technologies. Next, they were given opportunities to practice the new technologies, and the process ended with their contemplation of how they could integrate the technologies in a lesson.

Lastly, preservice teachers' characterized learning how to integrate technology in this course as scaffolded. They contrasted initial design experiences with later weeks, emphasizing the difference between what was expected from them and their sense of increasing independence. The essence of the iterative design tasks was a repetitive nature that some perceived as redundant but useful. Amidst this essence of repetition, preservice teachers also characterized the tasks as having variation. Preservice teachers perceived the scaffolding, repetition, and variation as beneficial to their technology integration development; it helped them focus on learning specific tasks and feel confident during the process.

Chapter 6: Integrated Findings and Implications for Future Work

The final research question necessitates a re-examination of the quantitative outcomes detailed in chapter four via what was learned from the analysis of participants' course learning experiences presented in chapter five. These findings will be applied toward answering how preservice teachers' experiences with the FPI explain their self-perceptions and application of TPACK. Thus, this final chapter will integrate the quantitative and qualitative results to produce a more comprehensive discussion and interpretation of the First Principles of Instruction's (FPI) impact on technology integration development in flipped and face-to-face (F2F) approaches. Following this discussion of the study as a coherent whole, I will present implications for future course design, technology integration preparation, and opportunities for subsequent research. This chapter will close with an overview of the study's limitations followed by the conclusion.

Clarifying Participant's Perceptions of TK Growth with Their Learning Experiences

Aspects of preservice teachers' experiences with the FPI as they learned about new technologies may enlighten the observed differences in group's perceptions of technological knowledge (TK) growth. In terms of shifts in TK, preservice teachers in the flipped section exhibited statistically significant growth, while F2F participants' growth was non-significant. Participants' course experiences may lend explanation to these different outcomes.

The non-significant growth in TK for F2F participants' may be attributed to several factors. First, many studies measuring preservice teachers' perceptions of TK with Schmidt et al.'s (2009) instrument use much larger samples (Chai, Koh, Tsai, & Lee Wee Tan, 2011; Chai, Koh, & Tsai, 2010). TK's effect size of .30 would suggest that an increased sample size would lead to potentially significant results. Further, similar studies have detailed decreases in TK or insignificant results (Johnson, 2012; Tournaki & Lyublinskaya, 2014). Johnson (2012) described a potential cause; a bias that results from a shift in participants point of reference resulting from the intervention.

The language used by Andrew to describe his savviness as a status of the past appear to indicate support the claim that participants point of reference may have shifted due to the intervention. Andrew's reflection affirmed this shift as he wrote,

> I have learned so much about integrating technology into teaching this semester. Prior to the semester starting, I would've considered myself to be fairly tech savvy. However, each class period I was learning about different forms of technology that I had never even heard of before, like voki, voicethreading, edpuzzles, and vodcasts. Not only have been learning about them, but I even got the chance to incorporate new technology into my teaching. During my extended social studies lesson, one of the centers required the students to complete an edpuzzle, which they really seemed to enjoy. It's been great being able to apply what we've learned directly into our teaching.

Andrew used to consider himself tech savvy before completing a course on technology integration. It begets the questions of whether learning about new forms of technology increase perceptions of TK given the new knowledge or does the awareness of technologies decrease one's sense of TK as one considers afresh how much is still unknown? In this reflection, Andrew discussed learning about specific technologies and integrating a specific technology into his teaching practice. Yet when surveyed about his TK, he perceived no growth in how frequently he engages technology, his ability to solve technical problems, and how up-to-date he is on available technologies.

FPI's demonstration principle was integrated in this course via showing preservice teachers' many new technologies and modeling how to use these technologies in instruction, and this principle may have impacted all F2F participants' frame of reference. Preservice teachers indicated a beginner level of proficiency for developing wikis and webpages. These technologies were shown to students and the development of these tools related to instruction was modeled.

While showing preservice teachers the possibilities for these tools could increase their knowledge, as noted by Andrew, the increased awareness could potentially reveal how little is known about these tools and shift preservice teachers point of reference for what comprises moderate to expert knowledge of these tools.

When asked on the SPTKTT whether preservice teachers felt they kept up to date on new and important technologies, responses differed slightly from the pre- to post- administrations by a mean increase of .24. On each of the six items responded to by the 20 F2F participants, there were participants who perceived a lack of change or a regression in their knowledge. “I know about a lot of different technologies” is the item that may be most closely related to a potential shift in preservice teachers’ frame of reference. Given their experiences with the new technologies via reflections and interviews, one may expect a universal positive change. Of the 20 participants in the F2F section, four perceived no changes, and five felt their knowledge of different technologies regressed. It may be that the active demonstration of new technologies to the preservice teachers influenced their perception of what it means to stay current with relevant technologies. As opposed to preservice teachers sensing an improvement in their knowledge of new technologies, the regular demonstrations may have revealed how little they were keeping up with important new technologies relevant to their teaching practice.

Students in the F2F course have commented on course evaluations that they would like more time to explore and play with new technologies. This may represent a potential difference in the flipped version’s outcomes as they were allotted more time for exploring technologies online before class. The FPI’s provide experience corollary, a component of the activation principle, promotes learning by structuring opportunities for learners to acquire relevant experience and background knowledge when engaging new knowledge and skills (Merrill, 2002). In a flipped version of this course, learners were given several opportunities before class to engage in exploration and to play with new technologies prior to the in-class demonstration of how to integrate these tools into instruction.

Except for Brooke and Bree, preservice teachers in the flipped group all perceived an increase in their TK resulting in overall statistical significance. The lack of growth perceived by Brooke and Bree, however, may further support the bias previously discussed. Of a maximum mean value of 5.0, Bree's perception of her TK on the pre-survey was 5.0 and Brooke's was 4.17. The remaining 10 participants perceived their TK as 4.0 or less and none indicated a regressed perception of TK.

The positive growth of TK and the experiences of the participants in the flipped section may potentially support the premise that the exposure to new technologies prior to the physical class contributed to the increased perception of TK. Abeysekera and Dawson (2015) posit that engaging content prior to class may increase autonomy, reduce cognitive load, and promote a sense of competence. Bridget's perception of TK at the beginning of the course was the lowest at 1.17. Her experience with the pre-class modules as a means of exposure to the content appear to support Abeysekera and Dawson's premise and may be further interpreted by EVT.

Bridget wrote, "I am always so grateful that we use the modules outside of class as a way to familiarize ourselves with content prior to class." At another time she added, "I found the activities that I completed online before coming to class were very helpful. Due to the fact that I had read about Google Sites prior to coming to class, I was able to understand and incorporate the use of Google Sites into the lesson plan." EVT asserts that a learners' expectancy for successful completion of a task will contribute to their ultimate exertion of effort (Hancock, 2001). Eleven of the 12 preservice teachers in the flipped section mentioned using what was learned in the pre-class activities during class. This self-paced, structured yet independent exploration of Google Sites is what Bridget attributed to eventual use. She expected to succeed with this technology based on her online experiences and amid her low self-perceptions of TK. Although her peers' initial perceptions of TK were higher, they also connected their pre-class activities to applications in class, and as a group, their perceptions of TK significantly increased.

The Problem-Centered Principle: Past Attempts and the Impact of Current Experiences

In this study, preservice teachers exhibited statistically significant growth in the application of TPACK to technology integrated lesson designs. Many shared that experiences with elements of the problem-centered principle positively influenced their learning, helped them apply knowledge in the course and provided an authentic context for their learning. Brenda clearly connects her problem-centered course experiences with her learning how to integrate technology in the following quote,

> Each week I feel I am becoming more and more comfortable with creating lessons with my design team, while incorporating the new types of technology we are learning each week and the ISTE standards. I feel that when the time comes around and I have to plan a lesson for my second grade students this semester, I will have so many new technology options that I can incorporate into my lesson (Brenda).

In this quote Brenda identifies the repeated opportunities for practice, her increased comfort with design and knowledge of technologies, and her confidence that these knowledge and skills will be useful. From the perspective of Expectancy-Value Theory (EVT), Brenda's experiences appear to have corresponded to an increased expectancy for success and utility value.

In terms of TPACK-application, the statement aligns closely with elements of the Technology Integration Assessment Rubric (TIAR). Experiences with the problem-centered principle included opportunities to incorporate new types of technology, consider the selected technology's place within the curriculum, and design a lesson that fits these components together seamlessly.

In contrast to prior studies of the FPI applied to flipped courses, this course design included time for engaging the problem during the physical class meeting. Further the problem presented to preservice teachers was a complex and authentic problem broken down into component tasks that were scaffolded through the problem progression corollary. Finally, the entire problem was presented to learners at the beginning of the course and served as an anchor for instruction throughout the semester.

Several recent studies have applied the FPI to flipped courses. Some, as this study has done, compared the learning of F2F and flipped course designs. On the surface, Lo, Lie, and Hew's (2018) results appear to contradict this study. In three of four disciplines studied, they reported that the flipped treatment group outperformed the F2F group. Critical to these results, though, was that instruction in the three F2F groups was primarily lecture-based. In the one flipped to F2F comparison that exhibited no differences in outcomes, the instructor stated that he embedded hands-on activities within the F2F course. Instead of countering the results of this study, these results rather seem to have a similar conclusion. The learning outcomes may be a result of the design of the learning environment. When designs included high leverage instructional practices such as hands-on learning espoused by the problem-centered principle, F2F and flipped approaches may prove equally effective.

As researchers have studied the FPI-based course's impact, their designs exhibit a misunderstanding the problem-centered principles and its corollaries (Hoffman, 2014; Lo & Hew, 2017). Thus, their conclusions are problematic or lead to restating the need for the problem-center principle. For example, in Lo and Hew's study of designing mathematics classrooms with the FPI, their real-world problems resemble tasks. The instruction appeared to match the task level and did not seem to incorporate the problem progression corollary. As such, learners in their study requested more examples and experiences with problems prior to attempting the real-world problem. While their conclusion was to provide learners more time for application, it may be that a scaffolded approach advocated by the problem progression corollary is needed.

A similar application and potential misinterpretation of the FPI further highlights the difference between the experiences of learners in this study and other designs in the literature (Hoffman, 2014). Realizing the complexity of designing and implementing a research study, Hoffman sought to redesign her graduate qualitative methods course. Concerning students' requirement to design and conduct a qualitative research study, she wrote, "putting this as an initial problem-centered activity that would require all semester to complete was clearly too big, made more complex and drawn out (2014, p. 56)." Her solution was to change the problem entirely and have student learn the task level skill of analysis. While this may have been an effective decision in terms of course scope, it seems a pragmatic interpretation of Merrill's problem progression corollary.

Preservice teachers' experiences with the problem progression, task level, and problem progression corollaries and the robust TPACK-application outcomes further support the need to apply them as intended by the FPI. This is not to say that incorporating the FPI as described by Merrill is a simple process. Studies of the FPI application vary drastically in their application of the problem-centered principle, and a recent study of a flipped course based on the FPI even observed the absence of problem-centered activities during the physical class meeting (Lo et al., 2018). The essence of participants' experiences in this study, however, indicate the importance of the problem-centered principle, its embedded corollaries, and proper implementation.

For my reflections on refining the problem-centered component of these courses, please refer to Appendix J. In this reflection, I share what was learned from a pilot study and how this informed the current design iteration. This may provide additional context for these results and the design process.

Experiences with the FPI as Explanations for Growth in TPACK Application

To determine the course's impact on preservice teachers' TPACK in practice, their pre- and post- technology integrated lessons were analyzed with a TPACK-based TIAR (Harris et al., 2010). All lessons were scored by two raters, and a combined score was generated by calculating the mean of both raters. This mean score was used for the comparisons of pre- and post- TIAR scores. The full analysis of these data was detailed in chapter four, but the comparison of the subscales has been added here as a basis for the ensuring discussion. As the TIAR subscales' data did not meet the assumptions of normality for parametric tests, a Wilcoxon Signed Ranks test was applied. Table 19 displays the pre- and post- medians, effect size, and degree of significance. In chapter four, the analysis showed that that TIAR total gain scores were also statistically significant for both groups, yet they were not significantly different between groups. Similarly, all four domains of TPACK application as measured by the TIAR were significant for both groups.

Table 19
TIAR results for each subscale

Criteria	*Group*	*n*	*Mdn (Pre)*	*Mdn (Post)*	*Z*	*Sig. (2-tailed)*	*Effect Size r*
Curriculum Goals and Technologies	F2F	20	2.00	3.00	2.86	.004	0.64
	Flipped	12	2.50	3.50	1.79	.074	0.52
	Flipped[a]	11	2.50	3.50	2.41	.016	0.73
Instructional Strategies and Technologies	F2F	20	2.00	3.25	3.47	.001	0.78
	Flipped	12	2.00	4.00	2.97	.003	0.86
	Flipped[a]	11	2.00	4.00	2.97	.003	0.90
Technology Selection(s)	F2F	20	2.00	3.00	3.03	.002	0.68
	Flipped	12	2.00	3.00	2.03	.043	0.59
	Flipped[a]	11	2.00	3.00	2.68	.007	0.81
"Fit"	F2F	20	2.00	3.00	3.43	.001	0.77
	Flipped	12	2.00	3.00	2.56	.010	0.74
	Flipped[a]	11	2.00	3.00	2.95	.003	0.89

[a]Outlier removed from this group. See sensitivity analysis in chapter three for explanation.

Preservice teachers exhibited consistent growth across all criteria with medians increasing one point. The median for the instructional strategies and technologies criterion, however, increased 1.25 points for the F2F group and 2.00 points for the flipped group. The effect sizes for this criterion were also the largest. Preservice teachers' experiences with the FPI-elements in the courses may offer explanations for the growth in these criteria and lay the groundwork for considering future design implications. The integrated findings discussed next will focus on relating participants' experiences with two criteria from the TIAR, (1) *Curriculum Goals and Technologies* and (2) *Technology Selection(s)*.

Curriculum goals and technologies. Emphasizing the alignment between technology selection and curricular goals, this area of TPACK application was noted as an area of concern during activation phase of instruction and early application phases. Recall the from Aadan's interview excerpt in chapter five when he reflected on his experiences with a one-to-one chromebook initiative, “Um I think technology can be a fantastic tool depending on how it's used.” He often did not sense there was an alignment with curricular goals when he was student and found the tools distracting. Avery also noted times when technology seemed to be used for the sake of technology and not in service of content and learning when she wrote, “I would’ve rather done things my own way, but usually when technology was involved we were required to do things so specifically and include so many components (follow so many steps). Furthermore, the types of technology I used were very confusing to me at times and I feel that they were not helpful to my learning. I would’ve been better off without the technology and just doing things the old school way.” While some preservice teachers recalled learning important skills with technology, its’ integration in their K-12 education was frequently seen as superfluous to curricular goals.

In spite of these critical perspectives, preservice teachers at the beginning of the course still remained open to the possibilities as Bridget wrote “the more technology a teacher can incorporate into the lesson the better. This will make [it] feel like a normal part of everyday life.” Bridget’s rationale for incorporating technology and her peers’ observations of technology integration attempts in their K-12 classrooms offer possible factors for the limited alignment between curriculum goals and technologies on the pre-course lesson designs. In preservice teachers’ prior technological experiences, content was often relegated, ignored, or misaligned with the digital tools affordances. As Bridget argues to more technology in the classroom, she does not support her position by relating it to learning and instruction. Her premise assumes that teachers should be concerned with technology becoming normative and that instruction will be better as a result. This perception of technology’s role does not account for content nor consider the role of pedagogy as technology becomes the end goal. Throughout chapter five, additional evidence of these themes and the textural-structural synthesis of several participants' experiences is provided, but for examining this sub-theme in-depth, Bridget's' case will primarily be used as an example of the shift over time and its potential relationship to the FPI.

Preservice teachers' iterative lesson designs during the application phase of instruction may explain the positive shift in their attention to the alignment of technology with content goals. As Arianna's quote, referenced more fully in chapter five, would support this link, "I would definitely say the repeated practices we complete in this class are productive to us as future educators. As it may be redundant and tedious for some, it still is eliciting great and continuous practice of effective ways to consider and implement technology into the classroom." She and Angie both highlighted the benefits of this continuous practice. The subtheme of *break down and build up* notes participants' experiences with the problem progression corollary as benefitting their ability to isolate and focus on key design elements.

One of these key design elements, or what Merrill (2012) would refer to as a subtask, was referenced in Bridget's reflection on her group's technology integrated lesson design near the end of the semester.

> I think that it would be important to make sure that our objectives are closely aligned with the technology that we incorporated. I want the technology included to extend and build on the lesson, not be completely irrelevant or come across as busy work. I hope that as we finalize our lesson, we can nail down forms of technology that fit our objectives (Bridget).

The continuous practice elicited by the problem progression corollary during the application phase of instruction provided a space to reconsider technology's relationship to curricular goals within a lesson design. Bridget shifts from "the more technology…the better" to writing of the importance of alignment and fit between learning objectives and technology. Whereas considerations of learning and content were absent from her earliest reflections, she now wants the technology to "extend" and "build" and to be relevant.

Further connecting the increase on the curricular goals and technologies criterion with preservice teachers' experiences with opportunities for practice and problem progression is another of Bridget's reflections referenced in chapter five. She wrote, "I think that starting with most of the information filled in made me feel more successful in my abilities to plan a lesson that met both Common Core State Standards and ISTE standards." In this statement she identifies technology and content standards, recognizes the need for lesson to address them, and relates the problem progression corollary to her sense of success and confidence. Brooke's experiences also support this connection as she wrote, "By using this process I believe that it has benefited our groups understanding of what the most important components that go into a lesson are." While she believed that technology is an important element to consider from the beginning, she wrote that is should be considered in conjunction learning objectives and assessments. This iterative design process, regarded as beneficial by the preservice teachers and guided by problem-centered principle and its corollaries, may have been influential in preservice teachers' increasing their alignment of curricular goals and technologies.

Technology selection(s). The *Technology Selection(s)* criterion focused on the compatibility of selected technologies in the preservice teachers' lesson design given their instructional strategies and curriculum goals. The previously discussed criterion evaluated alignment, but *Technology Selection(s)* evaluated the appropriateness of the selected technologies. While median of participants' selections of the pre- lesson designs corresponded with marginally appropriate technology selections, the median for their post lesson technology selections was at the appropriate but not yet exemplary level. While not the highest possible level of technology selection measured by the TIAR, this growth was statistically significant. Preservice teachers' experiences with the activation, demonstration, and application principles may partially explain this observed increase.

In a subtheme more fully conveyed in chapter five, learning about different forms of technology, experiences learning various digital technologies were discussed as the following process: introduction to a technological tool (Activation and Demonstration), practice using the tool (Application), and evaluating its potential for a future lesson implementation (Integration). Preservice teachers' descriptions of this process manifest how they experienced elements of the FPI. The activation phase introduced preservice teachers to new digital tools and structured experiences for them to build new knowledge about and with these tools. Recall Andrew's acknowledgement that prior to the course, he would've consider himself "tech savvy". He then listed the many technologies he had already learned in the semester. Similarly, Aadan observed that course experiences exposed him to a range of technologies. Audrey and Alyssa tied these introductory experiences to preservice teachers' capacity for appropriate technology selections when they wrote that technology integration seemed more achievable after learning about new digital tools. An expanded repertoire of tools, Audrey also wrote, made technology selections more complicated. "It [is] difficult picking and choosing what technology to use (and potentially how to get the best use out of it) for a specific lesson/topic (Audrey)." Yet, exposure to new tools was just the beginning of the process of learning about new forms of technology.

Based on the FPI's demonstration and application principles, preservice teachers observed modeling of procedures for using new tools. Along with this modeling, preservice teachers practiced using the tool with a partner or their design group. Discussed previously, the following quote demonstrates the transition along this process. "For instance, I didn't know that

Google had so many different applications such as Google Slides, and through the two hours that I was in class I found out how to work the website through instruction and activities (April)." While April concedes a lack of knowledge of Google's applications, she then acknowledges the benefit of working through instruction and activities in class to develop procedural knowledge. Constructing knowledge of the digital tool's affordances through the construction of a meaningful artifact, "a Google Slides webpage", is consistent with constructionist tenets and perceived by participants as critical for future technology integration decisions.

Recall also Angie's quote referenced in chapter five, "I think now it is really impossible to plan a lesson without technology…it's more about finding and using the RIGHT technology, not just finding any technology." The TIAR makes the same assumptions as Angie; technology will be selected for the lesson. This stems from the instruments' purpose and the nature of the course rather than their TPACK foundation. Regardless, Angie concludes that technology selections will occur, and teachers must not settle for any technology. Through these processes and as indicated by the TIAR data, preservice teachers selected more appropriate technologies for their instructional scenarios at the end of the course, and as was detailed in chapter five, participants' experiences helped them learn the "ins" and "outs" of several new tools as a means for improving their selections.

Constructing and Exhibiting TPACK

As seen in chapter four, participants in both groups perceived a significant increase in their TPACK (F2F p=.001; Flipped p=.020). Additionally, they exhibited significant growth in their application of TPACK to technology integrated lesson designs (F2F p=.000; Flipped[a] p=.000). The aim of both course approaches was to facilitate the construction of knowledge through addressing authentic problems and constructing meaningful artifacts as potential instructional solutions (Merrill, 2002; Papert & Harel, 1991). Prior researchers and teacher educators labeled this process *learning by design* and posited that it “requires teachers to navigate the necessarily complex interplay between tools, artifacts, individuals, and contexts (Koehler & Mishra, 2005, p. 99).” This complex interplay was negotiated by preservice teachers in this study as they engaged in the authentic practice of design during the application phase of the FPI and shared these design artifacts publicly with their peers and the elementary students and teachers in their placements during the integration phase of the FPI.

Maxwell contends that two key features of constructionism are an individual’s construction of knowledge in practice and the embodiment of that knowledge in a public artifact (Maxwell, 2006). Drawing from participants’ experiences learning by design in this course, there were several FPI-based elements that may have facilitated TPACK construction and guided the creation of digital artifacts and technology integrated lesson designs.

As exemplified by participants’ experiences reflecting on their initial design iterations, preservice teachers began considering the nuances of purposeful technology use for instruction versus the mere presence of technology in a lesson. After relating her perception of technology’s ubiquity, Angie stated that it is important in today’s classroom to consider what the right technology is than to find a technology. Others also discussed what they began to view as ineffective uses of technology or moments when technology should have been integrated. These more critical perspectives on technology, indicative of developing TPACK, were observed in participants’ reflections on their constructions of knowledge through active engagement with a problem, designing technology-integrated solutions, and collaboration with peers. The ill-structured nature of selecting fit technologies and purposefully planning how to leverage them for improving learning outcomes provided a complex and authentic space for preservice teachers construction of knowledge and artifacts (Jonassen, 1999).

To support preservice teachers in this complex space, they were shown new technologies during the activation and demonstration phases as detailed in chapter five. Afterwards, during the application and integration phases, they were encouraged to explore and select alternative technologies based on their analysis of the scenario and evaluation of the identified digital tools' alignment with lesson goals, affordances of the tool, and constraints within the scenario. During these experiences, they discussed with their peers how to align components of their designs and "nail down forms of technology (Bridget)." Through this they constructed understandings of technologies' affordances and constraints, the role of context, how to respond to technological breakdowns, and how they might improve future iterations of their designs. Proposed improvements often included ways of making their designs more student-centered with additional opportunities for hands-on interaction.

After conducting their final lessons, 18 of the 32 participants noted a specific improvement in how they would integrate technology the next time. These reflections on their learning experiences also demonstrated preservice teachers' learning about design, its iterative nature, and the complex interactions between design elements. Table 18 presents participants descriptions of how the scaffolded nature of the FPI's problem progression corollary helped them break down these complexities and build their confidence by focusing on new skills. Amidst learning experiences that increased their expectancy for success, preservice teachers still noted barriers that influenced how they managed the interactions of technology, pedagogy, and content in their technology integrated lessons (Ertmer et al., 2012).

Through addressing barriers such as digital resources, mentor teachers' pedagogical beliefs and attitudes, time, classroom norms, and student' technological skills, preservice teachers design decisions further exhibited increasing TPACK. Their experiences with these barriers may have even more clearly demonstrated to them the need for TPACK. As they shared their constructed artifacts, preservice teachers noted the need for backup plans, instructional strategies such as scaffolding and peer support to help students succeed, and an appreciation for the course as an ideal place for practicing, overcoming technological anxiety, and evaluating digital tools' potential. This experience practicing skills and evaluating tools, some noted as especially critical, otherwise they may not ever have become aware of the tool or invested the time to learn the skills individually while navigating the novel terrain indicative of a classroom teacher's first year.

The FPI's application and integration phases, as discussed in the prior chapter, provided ample opportunities for construction of knowledge and embodiment of knowledge in a public entity. While the flipped approach offered more time for these phases during the physical class meeting, students in the F2F group still engaged in these instructional phases both during and after class as homework. The F2F group's lesson design submissions and created digital artifacts throughout the course are evidence of this time and exhibit their learning process alongside their reflections. The sustained engagement by the F2F group in the post-class activities and the flipped group in the pre-class activities may be additional evidence for the FPI's potential to engage students in constructing meaningful knowledge regardless of the learning environment. The following implications will build on this discussion of the FPI's potential for course design and also consider opportunities for future research.

Implications for Course Design and Approaches to Technology Integration Preparation

This study's findings suggest that the FPI are an effective model for designing F2F and flipped courses for preservice teachers that focus on technology integration development. These findings are explained in more depth in chapter five's discussion. Further, the findings, as detailed in chapter four, suggest that the FPI may be equally effective when designing F2F and blended environments. Although this was but one study within a specific context, researchers may find it profitable for replication or reference as they continue to examine technology integration development, teacher preparation, the flipped approach, and the FPI. This section will provide suggestions for future design of technology integration courses and approaches to technology integration preparation.

Design opportunities for pre-service teachers to actively explore an array of new technologies in different contexts. The pre-service teachers in this course, based on their initial lesson plan designs and reflections, had a limited perspective of what tools were available for teaching and learning. As Lei (2009) suggested, this may be due to their primary exposure to technology as personal and social tools. They may not yet have developed an awareness of technology potential for enabling learners to communicate, construct, inquire, and express (Bruce & Levin, 1997). This course design facilitated the exploration of new technologies through activation phase of instruction and modeling these technologies in class. Teacher educators should continue to identify ways to expand pre-service teachers' repertoire of digital tools and prompt them to critically think about the multi-faceted ways these tools can impact learning.

Model "Fit" to help pre-service teachers connect new technologies to their teaching practice. "Fit" as Harris et al. (2010) refer to a strong alignment of technology, pedagogy, and content, was a struggle for pre-service teachers at the beginning of the course based on their lesson design scores. Building on research showing that adeptness with technology is not enough for “fit” integration (Mishra & Koehler, 2006), this course design modeled technology integration in multiple capacities. Preservice teachers need to observe effective models of how pedagogy, content, and technology intertwine in a lesson (Lei, 2009) as a ways to help them systemically think about technology integration. Vaughan (2014) details the central role modeling played in teaching and writes that each instructional practice modelled was identified, discussed with students, and documented for future use. Making these instructional decisions explicit and discussing the contextual factors and rationales are keys to effective modeling (Lu & Lei, 2012).

Support and provide opportunities for pre-service teachers to practice in the field. Modeling in a controlled classroom of undergraduate students should not replace authentic practice in the field (Lu & Lei, 2012) as practicing new skills in a realistic setting contribute to learner’s satisfaction from the learning process and contributes to further refinement (Keller, 1987). One way to support an opportunity for authentic practice may be to collaborate with other faculty and fuse a technology integration component with other field experience requirements. If pre-service teachers are required to implement a technology-integrated lesson, teacher educators can support by identifying what technologies are available at host districts and modeling how to teach with these technologies (Bakir, 2015). An effective way of accomplishing this task is for pre-service teachers to conduct an audit of available technologies in their placement classrooms. Finally, give pre-service teachers several occasions for developing lessons in a low stakes environment, perhaps via the problem progression corollary (Merrill, 2002). Via these multiple efforts, coaching, and feedback, they may be more confident when implementing the plan in their field experience.

Implications for Future Research

Building on no significant differences. There have been studies of the FPI applied to flipped courses that report the flipped treatment group as outperforming their F2F counterpart, yet the F2F group was not comparable (Lo et al., 2018). This incompatibility between comparisons within research on flipped classrooms has led some to claim the flipped approach as somehow superior to F2F instruction. While this was single study, in one discipline, and a specific context, it did attempt examine differences between two rigorously designed courses that both applied the same principles of instruction. The lack of significant differences is not something to be disregarded as results with no bearing. They represent the potential of the FPI to inform instructional design in multiple contexts and are a call to more rigorously design comparisons of a flipped approach.

As the model for flipped instruction examined by this study was intended for design beyond the teacher preparation context, it would be beneficial for research to study the efficacy of designing with it and the impact it may have on learning outcomes. Does the premise of its applicability to diverse contexts hold true? There has been ineffective implementation (Cargile & Karkness, 2015), inadequately conceptualized designs (O'Flaherty & Phillips, 2015), and struggles with designing flipped courses (Bech Lukassen, Pedersen, Nielsen, Wahl, & Sorensen, 2014) reported throughout the literature. Following this model in designing a flipped course could be a valuable approach for skilled designers and novices alike. It affords a flexible approach to design, provides supportive prescriptions, and offers a much-needed conceptual framework for bridging pre- and in-class activities (O'Flaherty & Phillips, 2015).

Research may focus on the impact of modifying aspects of model implementation when designing for specific contexts. For example, what might be the influence of varying amounts of time given to each principle of instruction in the pre- and in-class portions of the course? While the model prescribes a greater focus on activation and demonstration of concepts prior to class in conjunction with Understanding and Remembering level learning outcomes, what additional factors may influence this and other design decisions? Finally, it would be valuable for design research to utilize the model and report results as it could improve future educational outcomes and offer additional perspectives for further model and theory development.

As a field, let us not latch on to trending approaches as if they are the next magical wrench (Tennyson, 1994). Instead, studies should replicate the design in other disciplines, three-credit courses, larger sections, and diverse spaces. If the goal is to compare approaches, study designs should better document the validity of this comparison.

A closer look at how TPACK is measured. The Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT) has been widely used for the last decade to measure preservice teachers' self-perceptions of technological, pedagogical, content knowledge (TPACK). Recently, its item construction has been questioned, and researchers have noted that it may not adequately discriminate TPACK domains (Johnson, 2012; Kimmons, 2015). Several of these concerns were addressed in this study as well and resulted in a closer examination of the SPTKTT items and constructions. During this closer analysis of the SPTKTT data, potential patterns in the item by item correlations were observed. In appendix H, it can be noted that the correlations between items is less on the post-test than the pre-test. While some correlation is to be expected, a correlation that is too high indicates potential redundancy. TPACK, for example, has an average pre-test inter-item correlation of .81 compared to a post-test inter-item correlation of .52. Nothing definitive can be said from this analysis, but it has prompted a recommendation for future research on whether preservice teachers' understandings of TPACK shift because of an intervention. Are preservice teachers able to better comprehend the nuances of the SPTKTT items because of an intervention? Research focusing on how TPACK is measured and preservice teachers' response patterns may help to improve instruments in the future.

Limitations

Unmeasured confounding variables presented potential limitations in this study: (1) course activities outside of class, (2) programmatic experiences, and (3) placement context. An assumption of the course design was an approximately even amount of time needed to complete the assignments outside of class in both treatment groups. The design intended for learners to spend 45 – 60 minutes working on the pre-class activities (flipped) or their design team tasks (F2F). Time spent on these course activities was not monitored. In prior iterations of the flipped course, preservice teachers self-reported working on the pre-class activities for 30 – 60 minutes, and in this study Angie noted spending a similar amount of time on the group's design team tasks. This was not monitored and could be a limitation of the non-significant differences between course outcomes as some have argued that blended courses require students to allocate more time to their coursework (Means et al., 2013). If this is true, it undermines the claim that the two course approaches based on the FPI were equivalently designed as the flipped group would have received a potentially stronger treatment based on the increase time required of students.

Another limitation of the coursework outside of class was the expectation that F2F students would complete their design team tasks as a team. A tenet of constructionism and a corollary of the FPI's application principle is to collaborate with peers, thus constituting an important design element. Both groups collaborated with peers during the model lessons in class. The flipped group collaborated during the design team or problem progression tasks in class as well. As these tasks were assigned to the F2F group to complete together for homework, they were more open to negotiating this collaborative arrangement. The degree to which they collaborated similar to the flipped group represents another unaccounted factor. Future studies could assign individual tasks for homework or collect data that would inform how groups worked together outside of class.

Discussed earlier, the broader program in which this study was situated likely impacted preservice teachers' TPACK as well. Since the courses in which participants were concurrently enrolled focused primarily on differentiation, social studies methods, and mathematics methods, it was believed these would not have an extensive impact on participants' TK related domains or application of TPACK. Through collaboration an instructor after the study had begun, I became aware of an added component in the social studies methods course that had a technological emphasis. As *in situ* studies unavoidably introduce such confounding variables, some unanticipated, this study sought to further inform the quantitative outcomes with an embedded qualitative secondary question.

Experiences in the field, particularly the mentor teacher's TPACK, may also have contributed to the results. Nelson (2017) found that preservice teachers were impacted by the frequency and quality of their mentor teacher integration of technology. Technological competency was not considered as mentor teachers were selected, therefore, this variable was not measured. Knowing that this could potentially impact preservice teachers' implementation of the lessons factored into the decision to isolate planning as an outcome. First order barriers such as access and mentor teachers' attitudes toward technology were evident in preservice teachers' reflections and could not be controlled. I purposefully selected the Technology Integration Assessment Rubric (TIAR) to measure planning for integration as it was constructed with an intent to remain neutral of a constructivist orientation and student-centered uses of technology. Its main focus is on the alignment of components within a technology-integrated plan for purposeful integration and not the theoretical perspective that is applied to the integration. Applying the TIAR was intended to reduce the impact a mentor teacher might have on the score, as it was believed preservice teachers could score a maximum possible score even with first-order barriers present in the placement context.

Chapter 7: Conclusion

The flipped classroom approach has garnered much attention lately that is likely due to its increased application in higher education and anticipated impact. Confirming its extensive growth, results from 2013 survey of higher education faculty revealed that 56% of respondents planned to use a flipped approach within a year (Bart, 2013). Amidst this optimistic adoption, researchers have noted that “flipped” can be implemented quite differently, resulting in vast variations of learning experiences and effect on educational outcomes (Bull et al., 2012; Lo et al., 2018; Waldrop & Bowdon, 2015b). The variations in design and implementation may influence how this approach has been perceived by faculty and students and its learning outcomes.

While the growth of flipped classrooms in higher education has been rapid and widespread, it has encountered starkly contrasting perceptions. Flipped has been perceived as an opportunity for renewal of an outdated teacher-centered model, an approach rendered less effective by under-utilized conceptual frameworks, and an established means of instruction that has been referred to a good teaching for several decades (Baggaley, 2015; O’Flaherty & Phillips, 2015). Several researchers have responded to the under-utilization of conceptual frameworks by developing instructional design models for flipped classrooms (Y. Chen et al., 2014; Hall & Lei, 2018; Liu, 2016). These models intend to guide faculty and designers toward a more effective blend of face-to-face group learning and online information delivery (J. Lee, Lim, & Kim, 2017).

Merrill boldly claimed that the First Principles of Instruction (FPI) would promote the effective, engaging, and efficient instruction in emerging environments such as flipped, blended and online settings (Merrill, 2012). While blended approaches may differ from how the FPI were implemented originally (Merrill, 2002), Merrill claimed that the fundamental processes of learning and instruction have remained constant (Merrill, 2012). Therefore, the FPI should serve as a solid instructional model for flipped approaches that are often based on instructor's intuition and inadequate conceptual framing (Means et al., 2013; O'Flaherty & Phillips, 2015).

Overview of the Study

To examine whether the FPI are equally effective in emerging learning environments as and F2F instruction, technology integration course sections in this study were designed by applying this instructional design model to both face to face and flipped versions. An embedded mixed methods design was used to investigate TPACK-based learning outcomes and learner's experiences with the FPI-based elements. This mixed method design utilized quantitative and qualitative data with one data set serving a secondary and supportive role to the other. The primary purpose of this study used the Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT) and the Technology Integration Assessment Rubric (TIAR) to test the FPI's impact on preservice teachers' technological, pedagogical, content knowledge (TPACK) in two course settings, flipped and F2F (Hofer & Grandgenett, 2012; Merrill, 2002; Schmidt et al., 2009). The FPI predict that the problem-centered, activation, demonstration, application, and integration principles will positively influence learning for preservice teachers in both F2F and flipped courses.

The secondary purpose was to gather qualitative interviews and reflections on learning to detail how preservice teachers experienced course elements and learning in the two different course settings. The qualitative data collection intended to inform the primary research question by explaining how participants interacted with the principles of instruction in both course versions and by expanding upon the quantitative measures of TPACK outcomes.

Comparing the learning outcomes between the face-to-face and flipped group. The significance of this study was the examination of the FPI applied to both F2F and flipped courses, and the use of a flipped course to develop preservice teachers' technology integration knowledge and application. The FPI, abundant with indirect support, had not undergone rigorous empirical investigation, but this study demonstrated their potential for designing both F2F and flipped courses that develop preservice teachers TPACK.

In both treatment groups, preservice teachers' self-perceptions and application of TPACK statistically significantly increased. The strength of their growth in application of TPACK to technology-integrated lesson designs (F2F $p = .000$, $d = 1.17$; Flipped[a] $p = .000$, $d = 1.97$) provides compelling support for a well-designed course. The lack of statistically significant differences between the F2F and flipped groups on any measure suggest that the FPI were no more or less effective when applied to designing flipped and F2F courses.

These results align with Merrill's premise that the FPI are applicable across disciplines, contexts, and learning environments. While technologies, environments, and educational terminology may vary, he posits that there remain fundamental instructional principles and strategies. "While their implementation may be radically different, those learning strategies that best promoted learning in the past are those learning strategies that will best promote learning in the future (Merrill, 2012)." This study substantiates his claim regarding the effectiveness of the FPI and their potential for designing F2F and blended approaches.

Based on the flipped group's results, the statistically significant growth of preservice teachers' TPACK self-perceptions and application also inform an important literature gap. In prior studies of flipped courses, few have employed measures of robust educational outcomes but rather have used measures of student satisfaction (O'Flaherty & Phillips, 2015). Comparing a flipped and F2F course designed according to the same instructional principles also uniquely contributes to what is known of the efficacy of flipped courses as prior studies have compared flipped and F2F courses that were based on different instructional principles. As the FPI's application to designing both groups significantly impacted the technology integration development of preservice teachers, it may offer a beneficial model for future preservice teacher development.

Preservice teachers' experiences as a lens into their interactions with course elements. To better comprehend preservice teachers' interactions with the FPI, this study gathered their experiences through course reflections and semi-structured interviews. The use of these experiences to explain the learning outcomes offered additional insight not always generated by studies only comparing pre- and post-test measures. These experiences may also prove informative when designing future learning environments that focus on technology integration development.

An example of how these experiences may lead to design consideration can be seen in how the course design provided a space for testing and evaluating digital tools' potential for instruction. Evaluation, an essential part of the FPI's integration principle, was incorporated in assignments by prompting preservice teachers to explore, design, and reflect on a digital tool affordances and constraints. They contemplated experiences with the tool and discussed with peers how they might modify or extend future integration.

Preservice teachers even perceived this process to be the purpose of class time and noted it as essential for their development due to constraints in their placements. Having this place to test their ideas, learn the tools, and decide what technology to integrate may have fostered both a more critical perspective and an openness to imagining the possibilities. Yet, they described this space as idealistic, flush with resources that were not available at some placements. This idealistic setting was helpful and supportive, reducing obstacles and helping students overcome their threshold barriers, yet the preservice teachers still had to face the realistic challenges of a classroom with real students, an authentic context, and genuine constraints. While this study's implications suggest methods for supporting preservice teachers' technology integration development in a course setting, they offer equally important suggestions for further inquiry on how to support their technology integration development in the clinical experience as well.

Explaining shifts in self-perceptions and application of TPACK. Preservice teachers' experiences with the FPI offered explanations for the observed differences in their self-perceptions and application of TPACK. For example, participants' experiences with the FPI's demonstration principle may have evidenced a potential shift in participants' frame of reference related to the intervention. Modeling various technologies may have increased their knowledge, but the increased awareness of the tools may also have provided a new frame of reference for what comprises moderate to expert technological knowledge. Preservice teachers' experiences learning new technologies strongly suggest increased technological knowledge although the F2F group's self-perceptions of TK growth were only marginally significant.

Preservice teachers' experiences with the FPI's the problem-centered principle may have their statistically significant growth in the application of TPACK to technology integrated lesson designs and provide support for applying the principle with fidelity. Many participants perceived the principle's corollaries to have positively influenced their learning, application of skills, and integration. Prior studies of the FPI applied to flipped courses, however, used a different definition of "problem" and inconsistently applied the problem progression corollary (Hoffman, 2014; Lo & Hew, 2017). As participants' experiences of the problem-centered principle align with the model's prescriptions and appear to have positively impacted their TPACK, application, these findings support the application of this principle consistent with model's conceptualization (Merrill, 2012).

Supplementing the previous explanations of growth in TPACK application, preservice teachers' experiences with iterative lesson designs may have influences their alignment of technology with content goals. Participants emphasized that this continuous practice helped them isolate and focus on key design elements. The TIAR data display that preservice teachers selected more appropriate technologies in their post-course lesson designs, and the themes in chapter five show that their iterative design experiences helped them learn the "ins" and "outs" of new tools as a mechanism for selecting technologies more aligned with curricular goals and integrated with instructional strategies.

Participants in both groups significantly increased their TPACK self-perceptions (F2F p=.001; Flipped p=.020) and application to technology-integrated lesson designs (F2F p=.000; Flipped[a] p=.000). Preservice teachers' experiences with the FPI's application and integration phases included many opportunities for knowledge construction through the creation and display of tangible artifacts (Merrill, 2002; Papert & Harel, 1991). Both the flipped and F2F groups engaged in these design activities and exhibited significant TPACK development. The critical nature of the authentic design activities in preservice teachers' experiences may warrant further investigations of this strategy within educational technology courses.

Contributions to Theoretical Understandings

Findings from this study do not disconfirm the following proposed properties of the FPI. “First, learning from a given program will be promoted in direct proportion to its implementation of first principles. Second, first principles of instruction can be implemented in any delivery system or using any instructional architecture (Merrill, 2002, p. 44).” While this study does not assign a value to the degree of the FPI’s implementation in each course, the intent was to equivalently apply the FPI in both F2F and flipped approaches. The documentation course designs in Table 4 and the manipulation checks detailed in chapter three substantiate these attempts toward equivalent implementation. The non-significant differences between the F2F and flipped group’s quantitative outcomes, therefore, is consistent with Merrill’s proposition. It is also noteworthy that the participants’ increases were larger in this study than the pilot study (Hall, n.d.). While several confounding factors warrant caution when comparing these studies, the intent of the current study was to increase the strength of the intervention by implementing the FPI with greater fidelity than was done in the pilot study. Although not providing confirmatory evidence, had the current study’s measures indicated lesser gains or even equivalent results, it would be cause for questioning the proposed property of proportionate implementation and learning.

The second property, denoting FPI’s universal applicability, claims they apply to any instructional environment (Merrill, 2012). This study and others aimed to test this claim and the model in flipped courses (Hall, n.d.; Lo & Hew, 2017; Lo et al., 2018). Clearly, the presence of studies testing the FPI in various environment evidence that it can be applied to these environments. Yet, knowing something can be done does not support that is should be done.

Similarly, this study's findings of the FPI-based course designs positive influence on participants' TPACK development does not exclude the possibility of stronger results occurring had another instructional design model been applied.

Given the broad nature of principles and their claims, Merrill notes they can be easily misinterpreted and applied (Merrill, 2012). One may also argue, as Merrill did, that the FPI are well supported by what is already known about learning and instruction. Rather than focusing on the general principles, which may lead to may vague designs supporting widely applicable and commonly excepted rules, it may be better for future studies to focus on specific prescriptions for implementing the principles. Are there certain prescriptions that more effectively leverage the FPI? What FPI-based prescriptions best support learning in specific environments? How do learners these experience these varying prescriptions? Emphasizing prescriptions in future studies will likely shift attention from the FPI's universality to situationalities (Reigeluth, 2013), yet this shift may result in more finely tuned, context specific, and replicable studies for extending our knowledge of instructional design.

Closing Thoughts

In a world that is constantly changing, this study lent support to an instructional design model built upon the premise that effective, efficient, and engaging instruction may not be radically different today than it was before the term "flipped" was ever conceived. As this study sought to develop preservice teachers' technology integration competencies, it seems to have also effectively modeled educational technology well. Educational technology has been defined as "the disciplined application of scientific principles and theoretical knowledge to support and enhance human learning and performance (Spector, Merrill, van Merriënboer, & Driscoll, 2008,

p. 820). Since educational technology, then, was integrated in both groups to support their statistically significant TPACK development, it may not be such a surprise that both were significant yet not significantly different.

Appendices

Appendix A: Survey of Preservice Teachers' Knowledge of Teaching and Technology (SPTKTT)

Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential *and will not influence your course grade.*

DEMOGRAPHIC INFORMATION

1. Your SU e-mail address (e.g., username@syr.edu)

   Items 2-8 below on pre-questionnaire only

2. Gender
   a. Female
   b. Male

3. Age range
   a. 18-22
   b. 23-26
   c. 27-32
   d. 33+

4. Major
   a. Inclusive Early Childhood Special Education
   b. Inclusive Elementary and Special Education
   c. Other

5. Liberal Arts Major/Concentration
   a. African American Studies
   b. Anthropology
   c. English and Textual Studies
   d. Fine Arts/Art or Music History
   e. French Language, Literature, and Culture
   f. Geography
   g. History
   h. International Relations
   i. Mathematics
   j. Philosophy
   k. Political Science
   l. Sociology
   m. Spanish Language, Literature, and Culture
   n. Women's Studies
   o. Other
   p. None

6. Year in College
   a. Freshman

b. Sophomore
c. Junior
d. Senior
e. Other

7. Are you currently enrolled or have you completed a practicum experience in a PreK-6 classroom?
   a. Yes
   b. No

8. What semester and year (e.g. Spring 2008) have you taken or will take the following?

Pre-Block	
Professional Block I	
Professional Block II	
Professional Block III	
Student teaching	

Items 2 and 3 below on post-questionnaire only

2. In hours, how much time do you spend on a computer every day?

3. Which of the following devices do you own? Select all that apply.
   - ☐ Desktop computer
   - ☐ Laptop computer
   - ☐ Tablet computer (ex. iPad)
   - ☐ Smartphone (ex. iPhone, Blackberry)
   - ☐ MP3 player (ex. iPod)
   - ☐ None of the above

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select "Neither Agree or Disagree"

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
TK (Technology Knowledge)					
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					

CK (Content Knowledge)					
Mathematics					
7. I have sufficient knowledge about mathematics.					
8. I can use a mathematical way of thinking.					
9. I have various ways and strategies of developing my understanding of mathematics.					
Social Studies					
10. I have sufficient knowledge about social studies.					
11. I can use a historical way of thinking.					
12. I have various ways and strategies of developing my understanding of social studies.					
Science					
13. I have sufficient knowledge about science.					
14. I can use a scientific way of thinking.					
15. I have various ways and strategies of developing my understanding of science.					
Literacy					
16. I have sufficient knowledge about literacy.					
17. I can use a literary way of thinking.					
18. I have various ways and strategies of developing my understanding of literacy.					

PK (Pedagogical Knowledge)					
19. I know how to assess student performance in a classroom.					
20. I can adapt my teaching based-upon what students currently understand or do not understand.					
21. I can adapt my teaching style to different learners.					
22. I can assess student learning in multiple ways.					
23. I can use a wide range of teaching approaches in a classroom setting.					
24. I am familiar with common student understandings and misconceptions.					
25. I know how to organize and maintain classroom management.					

PCK (Pedagogical Content Knowledge)					
26. I can select effective teaching approaches to guide student thinking and learning in mathematics.					
27. I can select effective teaching approaches to guide student thinking and learning in literacy.					
28. I can select effective teaching approaches to guide student thinking and learning in science.					
29. I can select effective teaching approaches to guide student thinking and learning in social studies.					

TCK (Technological Content Knowledge)					
30. I know about technologies that I can use for understanding and doing mathematics.					
31. I know about technologies that I can use for understanding and doing literacy.					
32. I know about technologies that I can use for understanding and doing science.					
33. I know about technologies that I can use for understanding and doing social studies.					

TPK (Technological Pedagogical Knowledge)					
34. I can choose technologies that enhance the teaching approaches for a lesson.					
35. I can choose technologies that enhance students' learning for a lesson.					
36. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
37. I am thinking critically about how to use technology in my classroom.					
38. I can adapt the use of the technologies that I am learning about to different teaching activities.					
39. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
40. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
41. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
42. I can choose technologies that enhance the content for a lesson.					

TPACK (Technology Pedagogy and Content Knowledge)					
43. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					
44. I can teach lessons that appropriately combine literacy, technologies and teaching approaches.					
45. I can teach lessons that appropriately combine science, technologies and teaching approaches.					
46. I can teach lessons that appropriately combine social studies, technologies and teaching approaches.					

Appendix B: Technology Integration Assessment Rubric (TIAR)

Criteria	4	3	2	1
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are <u>strongly aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>partially aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>not aligned</u> with any curriculum goals.
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use <u>optimally supports</u> instructional strategies.	Technology use <u>supports</u> instructional strategies.	Technology use <u>minimally supports</u> instructional strategies.	Technology use <u>does not support</u> instructional strategies.
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are <u>exemplary</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>appropriate, but not exemplary</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>marginally appropriate</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>inappropriate</u>, given curriculum goal(s) and instructional strategies.
"Fit" (Content, pedagogy and technology together)	Content, instructional strategies and technology <u>fit together strongly</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together somewhat</u> within the instructional plan.	Content, instructional strategies and technology <u>do not fit together</u> within the instructional plan.

Appendix C: Semi-structured Interview Protocol

Patton's (2002) Question Types:

1. **Experience and behavior (EB)** – Posed to reveal actions taken or descriptions of particular experiences. If I saw a video conferencing lesson, what would I observe?
2. **Opinion and value (OV)** – Meant to solicit cognitive processes and interpretations. What do you believe? What do you think about ____?
3. **Feeling (F) –** Intended to target the affective nature of the participant. How do you feel about that?
4. **Knowledge (K)-** What facts does the person know about the topic?
5. **Sensory (S)-** Attempts to get the participants to describe the stimuli experienced.
6. **Background/Demographic (BD)-** Asking open-ended questions about a person's demographics elicits the respondent's own categorical worldview.

Introduction: Thank you so much for agreeing to be interviewed. I know that finals week can be very busy, and I appreciate the time you have taken to come and chat with me. The purpose of this interview is to discuss your experiences with technology this semester, your beliefs about the flipped classroom, and what aspects of the flipped classroom this semester may have influenced your learning. There are really no "correct" answers to these questions. I am interested in your experiences, opinions, and values related to technology integration and the flipped classroom. If there is a question you do not understand or need repeated, please let me know. I am happy to repeat a question at any time. I also want to let you know that this interview will be audio recorded. This is being done so that I don't miss any information you share with me today.

Do you agree to have your interview recorded? Yes/No

I will ask for your consent once again after I turn the recording on and before I begin the interview. If at any time, however, you wish to stop the interview, please let me know. You may withdraw your consent at any time during the interview. Are there any questions you would like to ask before we start?

Opening sequence.

1. Tell me about all the ways you saw technology used this semester in your placement (EB).
    a. In this class (EB).
    b. In your others courses (EB).
2. Can you detail an experience from this semester when technology impacted your development as a teacher (EB)?
3. Based on your experiences in elementary classrooms so far and the education courses you have completed, how would you describe yourself as a teacher? (OV)
    a. Describe areas of strength (OV)?
    b. In what ways could you improve as a teacher (OV)?
    c. What do you think is technology's place in teaching (OV)?
    d. How do you believe students learn best (OV)?
4. Tell me what may make a learning experience with technology meaningful (OV).

Experiences with the Intervention.

5. Please tell me about your experience in this flipped class (EB).
    a. How does it compare with other courses you have taken that were not flipped (EB)?
6. Can you please describe a time in this course when you were introduced to a new topic (EB) (Activation)?
    a. How did you begin to gain experience with this topic (EB) (Activation)?
7. ARCS and ABCD were two mnemonic devices taught this semester. Can you talk a bit about how you may have used them this semester (EB) (Activation)?

   a. Can you recall a specific time in this course when you shared about your prior experiences with peers related to a specific topic (EB)(Activation)?

8. Please talk a bit about how new concepts and ideas were shown to you in this class (EB) (Demonstration).
   a. What did you think about the use of media in this course (OV) (Demonstration)?
9. Can you describe how you typically navigated the pre-class work (EB)?
   a. What would you say was the focus of the work before class (OV)?
10. How would you say you used some of pre-class information in your design team lesson plans (EB) (Application)?
    a. Could you talk about something learned from a model lesson that you incorporated into a design team task (EB) (Demonstration) (Application)?
11. Can you tell me about your experiences in class (EB)?
    a. What would you say was the focus of time in class (OV)?
    b. How did you connect the pre-class work with what was happening in class (EB)?
12. Please describe the process of planning technology-integrated lessons throughout this semester (EB) (Problem-Centered).
    a. If participant mentions something that they deemed beneficial/not helpful to their learning, probe further (OV).
    b. What did a typical design team task meeting look like (EB)?
13. Can you describe something specific in your final lesson plan implementation that built on knowledge from class (EB) (Integration)?
    a. How might this class have encouraged you to create, invent, or explore new ways to integrate technology (OV) (Integration)?

14. What aspects of this course helped you to succeed (OV)?

Integrating Knowledge.

15. Can you describe what a lesson might look like in your future classroom (EB)?
    a. What would you need to do to make this a flipped lesson (K)? or
    b. What aspects of this lesson make it a flipped lesson (K)?
16. What particular skills would a teacher need to be effective in a flipped classroom (OV)?
    a. What skills would students need to be successful in a flipped classroom (OV)?
17. What reasons might a teacher have for flipping a classroom (OV)?
    a. What would be the potential impact of flipping a classroom (OV)?
    b. What reasons might a teacher have for not flipping a classroom (OV)?

Closing.

18. What questions do you have for me today?
19. What most excites you about teaching (F)?

Appendix D: Lesson Plan Template

Directions: Please use the following template when completing your course project. Some of this information may be copied directly from your social studies or math lesson plan you are completing for other courses.

The italicized information can be deleted as you complete each section. It is there only to provide guidance as you fill in the template.

Name:

Grade Taught:

School:

# of Students:

Topic:

State and national standards for both content and technology.

Include at least one standard for the content you are teaching and one ISTE standard for the technology.

Remember to cite any website you use when identifying standards for you lesson.

1. Content Standard

2. ISTE Standard

Context.

1. Who are the learners?
    - Provide a general description of the students, classroom, and school environment.
    - Describe the technology skills students will need to participate in the lesson activities.
    - Describe the background knowledge they have related to the lesson you are teaching.

  - How can you adapt the lesson for students who may not have the necessary background skills and knowledge?

Lesson details.

- What are the objectives/learning outcomes?

- List any technological materials needed for this lesson (software, hardware, websites, files, media).
- How do you plan to setup the lesson?
- How will you group the students?
- What is the number of devices you have for each group of students? (i.e. 1 laptop per student or 4 iPads for the whole class)
- If applicable, describe specific assistive technologies used in the lesson.

- Describe any instructional strategies used in this lesson.

  - List and describe any ARCS strategies to be applied.
  - List and describe any UDL strategies to be applied.

- Describe how technology will be integrated in this lesson:
  - What digital technology will be integrated into this lesson?
  - At what points in the lesson will technology-integrated and how?
  - How will the technology facilitate or enhance student learning in this lesson? Why?
  - If pertinent, what will students create with the technology while learning the content?
  - How do your methods and the technology support each other?
  - How does your technology selection and content align?
  - How do you plan to adapt your behavioral/management strategies when integrating technology?

- Describe how you assessed the learning outcomes.

- How will you know the students have met the learning objective(s)?
- How will you track this information?
- How will you use it for future lessons?
- How will you inform the students of the results?

If a rubric was used to assess students' mastery, please include a copy of the rubric.

References.

Please include references in APA format (see https://owl.english.purdue.edu/owl/resource/560/01/) for any ideas, works, or images used in your lesson(s) that were not your own. This includes, but is not limited to, websites, templates, images, and books. For images found online through searches such as Google Images, be sure to cite the original site and not the Google Images link.

Appendix E: IRB Approval

SYRACUSE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
MEMORANDUM

TO:	Jing Lei
DATE:	February 1, 2017
SUBJECT:	**Expedited Protocol Review - Approval of Human Participants**
IRB #:	16-373
TITLE:	*Preparing for Blended K-12 Instruction: Examining TPACK Development through in a Flipped Technology Integration Course*

The above referenced protocol was reviewed by the Syracuse University Institutional Review Board for the Protection of Human Subjects (IRB) and has been given **expedited approval.** The protocol has been determined to be of no more than minimal risk and has been evaluated for the following:

1. the rights and welfare of the individual(s) under investigation;
2. appropriate methods to secure informed consent; and
3. risks and potential benefits of the investigation.

The approval period is **January 31, 2017** through **January 30, 2018**. A continuing review of this protocol must be conducted before the end of this approval period. Although you will receive a request for a continuing renewal approximately 60 days before that date, it is your responsibility to submit the information in sufficient time to allow for review before the approval period ends.

Enclosed are the IRB approved date stamped consent and/or assent document/s related to this study that expire on **January 30, 2018**. **The IRB approved date stamped copy must be duplicated and used when enrolling new participants during the approval period** (may not be applicable for electronic consent or research projects conducted solely for data analysis). Federal regulations require that each participant indicate their willingness to participate through the informed consent process and be provided with a copy of the consent form. Regulations also require that you keep a copy of this document for a minimum of three years after your study is closed.

Any changes to the protocol during the approval period cannot be initiated **prior** to IRB review and approval, except when such changes are essential to eliminate apparent immediate harm to the participants. In this instance, changes must be reported to the IRB within five days. Protocol changes must be submitted on an amendment request form available on the IRB web site. Any unanticipated problems involving risks to subjects or others must be reported to the IRB within 10 working days of occurrence.

Research Integrity & Protections | 214 Lyman Hall | Syracuse, NY 13244-1200 | 315.443.3013 | **orip.syr.edu**

SYRACUSE UNIVERSITY

Thank you for your cooperation in our shared efforts to assure that the rights and welfare of people participating in research are protected.

Katherine McDonald
IRB Chair

DEPT: Instructional Design, Development & Evaluation, 259 Huntington Hall **STUDENT:** Jacob Hall

Appendix F: Recruitment Script

Greetings everyone,

My name is ____________ and I'm a Doctoral student in the Instructional Design, Development, and Evaluation program at Syracuse University. I'm standing before you today because a doctoral student in our department is conducting a research study on the flipped classroom and its impact on preservice teachers' ability to integrate technology into their future instruction.

I am here to recruit subjects to participate in this study. The researcher is interested in studying the course assignments you submitted in this course. For example, the researcher will be reviewing your submitted homework reflections, lessons plans, and your pre and post course survey responses. The course assignments used in this study will be securely held in the blackboard Learning Management System. This means that by consenting to this portion study, there is no additional time commitment is needed beyond what you are devoting to your class work.

In addition, the researcher is asking you to also participate in interviews. However, interviews are not required, and you may participate in this study while also opting out of the interviews. If you do agree to be interviewed, your interview will be audio recorded. All information will be kept confidential. This means that no one will know about your specific answers except the researcher. A number will be assigned to your responses, and only the researcher will have access to the key to indicate which number belongs to which participant. This would require approximately a 30-minute time commitment. The interviews will be conducted here, in Huntington Hall's DiVA Lab.

By participating in this study, you will not be asked to do any additional work since the study focuses on the required coursework that you've already submitted for this class.

Your participation in this study is completely voluntary and you may withdraw at any time. If you choose not to participate or to withdraw from the study, you will not be penalized nor will it affect your final course grade. Any articles published and/or presentations given will use pseudonyms to protect your identity and your personal information will not be revealed.

If you have any questions concerning this research study, please contact Jacob Hall (doctoral student/ researcher) at (315) 443-3703 or email him at jahall01@syr.edu.

Appendix G: Consent Form

SYRACUSE UNIVERSITY
SCHOOL OF EDUCATION
INSTRUCTIONAL DESIGN, DEVELOPMENT AND EVALUATION

Syracuse University IRB Approved

Consent Form

JAN 3 1 2017 JAN 3 0 2018

Preparing for Blended K-12 Instruction: Examining TPACK Development through in a Flipped Technology Integration Course

My name is Jacob Hall, and I am a doctoral student in the department of Instructional Design, Development, and Evaluation (IDD & E) at Syracuse University. I am interested in learning about preservice teachers' technology integration planning and the flipped model of instruction.

I am inviting you to participate in a research study, in which participants should be 18 years or older. Participation in this study is voluntary. This consent form will explain the study to you, but if you have any additional questions please feel free to ask, and the researchers, Dr. Jing Lei and I, will be happy to explain anything in greater detail to you.

This research project is titled: *Preparing for Blended K-12 Instruction: Examining TPACK Development through in a Flipped Technology Integration Course.* For this study, I am seeking your permission to use ALL your course materials except your grades. The course materials include your weekly homework assignments, your pre- and post- course survey responses, and your course projects. In addition, I am seeking your permission to conduct one-on-one interviews with you. The interviews will last approximately 30 minutes and will be audio recorded. The recordings are for the sole purpose of data analysis, and only Dr. Jing Lei and I will have access to the recordings. They will be transcribed prior to analysis, de-identified, and destroyed once the study is complete. Interviews are not mandatory for this study, and you may opt out of the interviews without any repercussions.

From this study's findings, I plan to publish and present my findings to journals and conferences to inform my field of study on preservice teachers' technology integration development throughout their teacher preparation program. The results from this study can be used by researchers, scholars, and practitioners to benefit their future research and knowledge on the experiences and perceptions of preservice teachers. Any articles published and/or presentations given will use pseudonyms to protect your identity, and your personal information will not be revealed. There is a possibility that an aspect of your coursework that is published may be recognized by a classmate. Your name and other personally identifiable information will be removed from your work to reduce this risk.

All information will be kept confidential. This means that no one will have access to your course materials except the researchers. Your course materials will be securely held in the researchers' personal password protected computer and password protected external hard drive. Electronic data, including the portfolio of your coursework, will be kept secure on the university's Blackboard learning management system. Hard copy documents, such as the consent forms, will be stored in a secure filing cabinet located in the IDD & E office. Only Dr. Jing Lei and I will have access to the identifiable research data. The research data will be stored for the duration of the research and five years after the research is completed.

The risk to you participating in this study is that it may arouse certain anxieties related to technology integration, Furthermore, you may feel that your course grades would be affected if you choose not to participate in this study. To ensure that your grades are in no way affected by your decision to participate or not participate in this study, your consent form will be withheld from the researchers until the final course grades have been submitted to SU's registrar. Once the final course grades have been submitted to the registrar, only then will the researchers have access to see who volunteered to participate in this study. If you choose not to participate in this study, your course materials will not be used in this study, and your grade will not be affected. You may choose withdraw your consent to participate in this study at any time.

Participants who agree to participate and be interviewed for this study may feel uncomfortable during the interview. If this happens, the researcher will remind the participant they can stop the interview at any time and withdraw their participation in the interviews without any repercussions.

If you have any questions, concerns, or complaints about this study, please feel free to contact the advisor who is supervising this study (Dr. Jing Lei) or me, Jacob Hall. Our contact information is listed below. You may also contact the Institutional Review Board (contact information listed below) if you have questions regarding your rights as a participant, or if you have questions, concerns, or complaints that you wish to address to someone other than the investigator, or if you cannot reach the investigator.

Dr. Jing Lei
Email: jlei@syr.edu
Phone: 315-443-1362

Jacob Hall
Email: jahall01@syr.edu
Phone: 315-443-3703

Office of Research Integrity and Protections
Address: 121 Bowne Hall, Syracuse, NY 13244-1200
Email: orip@syr.edu
Phone: 315-443-3013

Syracuse University IRB Approved

JAN 3 1 2017 JAN 3 0 2018

Please indicate below if you agree to be interviewed, and have the interview audio recorded:

☐ I agree to be interviewed and have my interview audio recorded

☐ I do not agree to be interviewed

I am inviting you to participate in a research study. Involvement in the study is voluntary. If you choose not to participate or to withdraw from the study, you will not be penalized nor will it affect your final course grade. By signing this form, you agree with all the terms listed above, you are 18 years of age or older, you wish to participate in this research study, and that you release all the course material mentioned above for research purposes.

All of my questions have been answered and I wish to participate in this research study.

____________________________________ ______________________
Signature of participant Date

____
Printed name of participant

____________________________________ ______________________
Signature of researcher Date

____
Printed name of researcher

**A copy of this signed consent form will be provided to you.*

Appendix H: SPTKTT Item by Item Correlations

TK

	1	2	3	4	5	6
1		0.71	0.72	0.57	0.76	0.78
2	0.75		0.60	0.54	0.59	0.61
3	0.50	0.72		0.74	0.75	0.60
4	0.53	0.52	0.54		0.63	0.50
5	0.71	0.74	0.59	0.62		0.75
6	0.49	0.67	0.43	0.50	0.63	`

PK

	1	2	3	4	5	6	7
1		0.69	0.65	0.66	0.41	0.64	0.39
2	0.65		0.93	0.84	0.66	0.68	0.41
3	0.53	0.73		0.90	0.72	0.66	0.49
4	0.49	0.75	0.76		0.66	0.63	0.48
5	0.31	0.62	0.67	0.77		0.40	0.49
6	0.58	0.65	0.85	0.57	0.64		0.69
7	0.47	0.68	0.81	0.68	0.67	0.76	

CK

	1	2	3	4	5	6	7	8	9	10	11	12
1		0.83	0.85	0.65	0.58	0.65	0.56	0.49	0.45	0.41	0.29	0.34
2	0.83		0.88	0.78	0.42	0.64	0.49	0.29	0.38	0.43	0.20	0.27
3	0.78	0.81		0.63	0.33	0.58	0.39	0.28	0.31	0.40	0.22	0.28
4	0.49	0.53	0.43		0.53	0.68	0.51	0.33	0.40	0.27	0.26	0.33
5	0.33	0.52	0.36	0.81		0.70	0.57	0.52	0.38	0.50	0.41	0.52
6	0.40	0.58	0.46	0.77	0.88		0.72	0.58	0.57	0.30	0.12	0.24
7	0.35	0.46	0.44	0.41	0.66	0.69		0.81	0.80	0.15	0.01	0.12
8	0.337	0.442	0.415	0.391	0.627	0.646	0.857		0.87	0.04	0.06	0.11
9	0.281	0.354	0.278	0.296	0.473	0.497	0.785	0.84		0.13	0.11	0.11
10	0.587	0.669	0.556	0.593	0.538	0.492	0.552	0.57	0.57		0.85	0.90
11	0.425	0.515	0.483	0.587	0.56	0.519	0.514	0.43	0.47	0.84		0.95
12	0.484	0.552	0.518	0.623	0.522	0.583	0.586	0.50	0.54	0.81	0.89	

TPK

	1	2	3	4	5	6	7	8	9
1		0.82	0.72	0.53	0.49	0.65	0.73	0.65	0.77
2	0.93		0.60	0.49	0.63	0.80	0.71	0.64	0.85
3	0.58	0.58		0.54	0.58	0.72	0.64	0.54	0.74
4	0.62	0.61	0.81		0.62	0.48	0.41	0.51	0.64
5	0.78	0.78	0.64	0.75		0.68	0.52	0.34	0.60
6	0.71	0.71	0.79	0.86	0.71		0.77	0.58	0.85
7	0.63	0.61	0.69	0.81	0.85	0.77		0.79	0.77
8	0.57	0.52	0.62	0.72	0.76	0.70	0.83		0.70
9	0.67	0.60	0.74	0.81	0.72	0.86	0.78	0.81	

CK Math

	1	2	3
1		0.83	0.85
2	0.83		0.88
3	0.78	0.81	

CK SS

	1	2	3
1		0.53	0.68
2	0.81		0.70
3	0.77	0.88	

CK Science

	1	2	3
1		0.81	0.80
2	0.86		0.87
3	0.76	0.84	

PCK

	1	2	3	4
1		0.75	0.70	0.40
2	0.78		0.54	0.82
3	0.72	0.65		0.35
4	0.82	0.74	0.79	

TCK

	1	2	3	4
1		0.62	0.73	0.58
2	0.88		0.71	0.93
3	0.98	0.87		0.72
4	0.93	0.87	0.95	

CK Literacy

	1	2	3
1		0.85	0.90
2	0.84		0.95
3	0.81	0.89	

TPACK

	1	2	3	4
1		0.74	0.47	0.52
2	0.70		0.42	0.72
3	0.91	0.77		0.25
4	0.93	0.76	0.93	

TPACK Application

	1	2	3	4
1		0.61	0.66	0.75
2	0.59		0.68	0.74
3	0.77	0.62		0.80
4	0.75	0.73	0.85	

Appendix I: Mean Values for Perceptions of Technological Proficiency

	Minimum	Maximum	Mean	Std. Deviation
Programming	1	4	1.78	0.975
Creating Animation	1	4	1.88	1.008
Developing Wiki	1	4	1.91	1.146
RSS	1	4	2.09	1.088
Desktop Publishing	1	4	2.22	1.039
Diagramming Software	1	4	2.34	1.125
Databases	1	4	2.34	1.125
Developing Web Pages	1	4	2.41	1.16
Blogging	1	4	2.44	1.076
Drill and Practice Programs	1	5	2.56	1.105
Social Bookmarking	1	4	2.63	1.129
Troubleshooting	1	4	2.63	1.008
Advanced Search Strategies	1	5	2.72	0.958
Backing Up Files Online	1	5	2.72	1.143
Installing/Uninstalling	1	5	2.84	1.081
Backing Up Files Offline	1	5	2.84	1.221
Editing Multimedia	1	5	2.91	1.027
Publishing Multimedia	1	5	2.94	1.162
Content Specific Software	1	5	2.94	1.076
Idea Processors (Concept Mapping)	1	5	2.97	1.121
Assistive Technology	2	5	2.97	0.897
Playing Computer Games	1	5	3	0.803
Publishing Pictures	1	5	3.09	1.228
Exploring New Technology	1	5	3.09	0.893
Course Management Software	1	5	3.19	1.23
Spreadsheets	2	5	3.19	0.896
SMART Board	1	5	3.28	0.958
Searching Library Databases	2	5	3.38	0.907
Recording Devices	1	5	3.44	0.948
Digital Video Cameras	1	5	3.5	1.164
Editing Pictures	2	5	3.88	0.907
Web Searches (Evaluating Information)	2	5	3.94	0.716
Web-based Word Processor	1	5	4.06	0.948
Web Searches (Finding Information)	2	5	4.13	0.751
Instant Messenger	2	5	4.16	0.723
Collaborative Tools	2	5	4.16	0.723
Internet Phone (Skype)	2	5	4.25	0.803
Music Players	2	5	4.25	0.842
Presentation Software	2	5	4.31	0.78
Maintaining Social Networking Site	3	5	4.44	0.716
Smart Phone	2	5	4.53	0.671

Appendix J: Reflections of an Instructor and Course Designer

Prior to the current study, I conducted a pilot study to examine the impact of the FPI when applied to a flipped course. As part of that design case (Hall & Lei, 2018), reflection on the design process and implications for future design of flipped courses were shared. It seemed that problem-centered principle had been misinterpreted and applied to less effect. The following reflection from this pilot study offers an instructor-designer's perspective on the intentional design modifications that were made for a more efficacious problem progression and situated tasks.

Contextualizing each component skill and topic in the larger problem was essential. In prior iterations of the course, students learned the skills as separate entities. While their relationship to certain other component skills was discussed, it was not until the last half of the semester that students were regularly shown all component skills as part of the whole. At this late point in the semester, students expressed confusion about how each skill fit within the problem, how they were supposed to coordinate all the skills, and they appeared frustrated.

In the most recent course iteration, students were shown a different version of the completed problem each week. The problem's degree of completion varied as the component skill(s) students were responsible to execute was blank. However, they began to see how each skill fit within the context of the larger problem. Students responded positively to this strategy in their reflections, "It helps us master each step of the planning process before moving onto the next step and eventually completing a full lesson. Also as the lessons get harder and more extensive, we have prior knowledge from our previous lessons to include in the current lesson we are planning. It is helpful to draw upon prior knowledge because it makes the level of complexity seem not as hard and challenging (Participant in pilot study, 2016)." Continually displaying diverse versions of the whole problem served as a model and scaffold for the students. Gradually removing components of the model and requiring more of students urged them to become more independent and engaged them in increasingly complex problem solving.

Although the benefit of showing the learners the problem early and often may be beneficial, the implementation of this corollary in a flipped approach was more challenging than anticipated. In our pilot study iteration, the whole problem was first shown to learners and explained in the initial face-to-face class meeting. It was in this same class meeting that they were first engaged in applying a component skill when completing a partially worked version of the whole problem.

As additional problems were introduced to learners in subsequent modules, the instructional events became more complex, and it was difficult to know best when to introduce learners to the module's whole problem in this flipped approach (Merrill, 2012). As the online portion of each module initiated the instructional sequence, it may have been advantageous to introduce the problem in the learning management system yet there was concern that learners would be overwhelmed. Responding to the problem in the face-to-face class engaged learners in higher order thinking, but displaying the problem online may have helped frame the lower-order learning objectives and show learners where they were heading.

In this course iteration learners were still introduced to the whole problem during the face-to-face class time. Reflecting on this decision led me to consider the difference between introducing a problem as a framework versus a problem as an assignment and the difference between task levels: problem, task, operation, action (Merrill, 2002).

Although this design introduced learners to a new problem each week and required them to apply component skills within the problem, it became clear that problems were more often introduced as an assignment to be completed versus an anchor for contextualizing the learning (van den Berg, Wallace, & Pedretti, 2008). Emphasizing the whole problem only as a means for higher order thinking rather than a framing for all levels of cognitive engagement led to introducing the problem in the face-to-face class after the learners had completed the online pre-class activities. As the whole problem was told or shown to learners in class, they were simultaneously introduced to what they would do (Merrill, 2012). This singular perspective of the problem, however, may have limited its potential for instruction and may not have fully leveraged the flipped model.

More consistent with the FPI and anchored instruction, the whole problem can be a meaningful context that sets the stage for thinking and situating future learning (van den Berg et al., 2008). Emphasizing this aspect of the problem-centered principle in a flipped approach would have led to a design that introduced learners to the whole problem in the online class space. While a whole problem was shown to learners during the first face-to-face class meeting, this case's design would have likely improved had each module shown learners the subsequent problems as a context for learning. Designers of flipped courses should consider how this introduction to the problem online may differ from how it is discussed in the face-to-face meeting prior to application and integration of the skills.

Although it was ultimately determined not to introduce learners to the whole problem during the pre-class activities in the current stud, the design was revised to place greater emphasis on the tasks and their relationship with the problem. Participants clearly identified these components and the place within the whole problem. Further, they recognized the repetition of the problem's component as part of the process and appreciated the progression toward independence and mastery.

References

Abbitt, J. T. (2011). Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education*, *43*(4), 281–300.

Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *Higher Education Research & Development*, *34*(1), 1–14.

After Moore's Law: The future of computing. (2016). *The Economist*. Retrieved from http://www.economist.com/news/leaders/21694528-era-predictable-improvement-computer-hardware-ending-what-comes-next-future

Anderson, J., Young II, W., & Franklin, T. (2014). Brief reflections on flipping the college classroom. *The Journal of World Universities Forum*, *6*, 21–29.

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., & Pintrich, P. R. (2001). *A taxonomy for learning, teaching, and assessing*. NY: Longman.

Andre, T. (1997). Selected microinstructional methods to facilitate knowledge construction: Implications for instructional design. In R. D. Tennyson, F. Schott, N. Seel, & S. Dijkstra (Eds.), *Instructional-design: Internationial perspective: Theory, research, and models* (pp. 243–267). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Angeli, C., Valanides, N., & Christodoulou, A. (2016). Theoretical considerations of technological pedagogical content knowledge. In M. C. Herring, M. J. Koehler, & P. Mishra (Eds.), *Handbook of technological pedagogical content knowledge (TPACK) for educators* (2nd ed., pp. 11–32). New York, NY: Routledge.

Archambault, L. M. (2011). The practitioner's perspective on teacher education: Preparing for the K-12 online classroom. *Journal of Technology and Teacher Education*, *19*(1), 73–91.

Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education*, *55*(4), 1656–1662.

Archambault, L. M., & Crippen, K. J. (2009). K–12 distance educators at work : Who' s teaching online across the United States. *Journal of Research on Technology in Education*, *41*(4), 363–391.

Archambault, L. M., DeBruler, K., & Freidhoff, J. (2014). K-12 online and blended teacher licensure: Striking a balance between policy and preparedness. *Journal of Technology and Teacher Education*, *22*(1), 83–106.

Archambault, L. M., & Kennedy, K. (2014). Teacher preparation for K-12 online and blended learning. In R. Ferdig & K. Kennedy (Eds.), *Handbook of research on K-12 online and blended learning* (pp. 225–244). ETC Press.

Baggaley, J. (2015). Distance education flips and flops. *Distance Education*, *36*(3), 437–447. doi:10.1080/01587919.2015.1041677

Bakir, N. (2015). An exploration of contemporary realities of technology and teacher education: Lessons learned. *Journal of Digital Learning in Teacher Education*, *31*(3), 117–130.

Bakir, N. (2016). Technology and teacher education: A brief glimpse of the research and practice that have shaped the field. *TechTrends*, *60*(1), 21–29.

Banas, J. R., & York, C. S. (2014). Authentic learning exercises as a means to influence preservice teachers' technology integration self-efficacy and intentions to integrate technology. *Australasian Journal of Educational Technology*, *30*(6), 728–746.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review*. doi:10.1037/0033-295X.84.2.191

Bart, M. (2013). Survey confirms growth of the flipped classroom. Retrieved October 10, 2017, from https://www.facultyfocus.com/articles/edtech-news-and-trends/survey-confirms-growth-of-the-flipped-classroom/

Basak, S. K., & Govender, D. W. (2015). Development of a conceptual framework regarding the factors inhibiting teachers' successful adoption and implementation of ICT in teaching and learning. *International Business & Economics Research Journal*, *14*(3), 431–438.

Becker, L. A. (2000). Analysis of pretest and posttest scores with gain scores and repeated measures. Retrieved February 13, 2018, from https://www.uccs.edu/lbecker/gainscore.html

Bednar, A., Cunningham, D., Duffy, T., & Perry, J. D. (1991). Theory into practice: How do we link? In G. J. Anglin (Ed.), *Instructional technology: Past, present, and future* (pp. 88–101).

Beloit College. (2016). The Beloit College mindset list for the class of 2020. Retrieved September 19, 2016, from https://www.beloit.edu/mindset/2020/

Bergmann, J., & Sams, A. (2012). Flipping the classroom. *WWW.TECHLEARNING.COM*, 42–44.

Betrus, A. K. (2012). Historical evolution of instructional technology in teacher education programs: A ten-year update. *TechTrends*, *56*(5), 42–45.

Betrus, A. K., Molenda, M., & Saettler, A. M. (2002). Historical evolution of instructional technology in teacher education programs. *TechTrends*, *46*(5), 18–21,33. doi:10.1007/BF02818303

Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals: Cognitive Domain*. Longman.

Bowen, J. A. (2012). *Teaching naked: How moving technology out of your college classroom will improve student learning*. Jossey-Bass.

Branch, R., & Gustafson, K. L. (2002). *Survey of instructional development models* (Fourth).

Syracuse, NY: ERIC Clearinghouse on Infromation & Technology.

Brantley-dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK: Is the construct "just right?" *Journal of Research on Technology in Education*, *46*(2), 103–128.

Brenner, A. M., & Brill, J. M. (2016). Investigating practices in teacher education that promote and inhibit technology integration transfer in early career teachers. *TechTrends*, *60*(2), 136–144. doi:10.1007/s11528-016-0025-8

Bristol, T. (2014). Flipping the classroom. *Teaching and Learning in Nursing*, *9*(1), 43–46. doi:10.1016/j.teln.2013.11.002

Brubaker, J. (2013). SAMR: Model, metaphor, mistakes. Retrieved January 6, 2017, from http://techtipsedu.blogspot.com/2013/11/samr-model-metaphor-mistakes.html

Bruce, B. C., & Levin, J. a. (1997). Educational technology: Media for inquiry, communication, construction, and expression. *Journal of Educational Computing Research*, *17*(1), 79–102.

Bull, G., Ferster, B., & Kjellstrom, W. (2012). Connected classroom: Inventing the flipped classroom. *Learning & Leading with Technology*, *40*(1), 10–11.

Bullock, D. (2004). Moving from theory to practice: An examination of the factors that preservice teachers encounter as the attempt to gain experience teaching with technology during field placement experiences. *Journal of Technology and Teacher Education*, *12*(2), 211–237.

Callison, D. (2015). Classic instructional notions applied to flipped learning for inquiry, *31*(6).

Cargile, L. A., & Karkness, S. S. (2015). Flip or flop: Are math teachers using Khan Academy as envisioned by Sal Khan? *TechTrends*, *59*(6), 21–27.

Catalano, F. (2015). Can you count to $2 billion? Educational technology investment hits new record. Retrieved July 19, 2018, from http://www.geekwire.com/2015/can-count-2-billion-education-technology-investment-hits-new-record/

Cavanaugh, C., Maor, D., & McCarthy, A. (2014). K-12 mobile learning. In R. E. Ferdig & K. Kennedy (Eds.), *Handbook of research on K-12 online and blended learning* (pp. 391–413). ETC Press.

Cengiz, C. (2015). The development of TPACK, technology integrated self-efficacy and instructional technology outcome expectations of pre-service physical education teachers. *Asia-Pacific Journal of Teacher Education*, *43*(5), 411–422. doi:10.1080/1359866X.2014.932332

Center for Digital Education. (2016). *Making blended work: School district chief academic officers sound off on best practices for blended learning*.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2011). Exploring the factor structure of the constructs of technological, pedagogical, content knowledge (TPACK). *The Asia-Pacific Education Researcher*, *20*(3), 595–603.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2013). A review of technological pedagogical content knowledge. *Educational Technology & Society*, *16*(2), 31–51.

Chai, C. S., Koh, J. H. L., Tsai, C.-C., & Lee Wee Tan, L. L. W. (2011). Modeling primary school pre-service teachers' technological pedagogical content knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education*, *57*(1), 1184–1193. doi:10.1016/2011.01.007

Chai, C. S., Koh, J. H. L., & Tsai, C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *International Forum of Educational Technology & Society*, *13*(4), 63–73.

Chen, R. J. (2010). Investigating models for preservice teachers' use of technology to support student-centered learning. *Computers & Education*, *55*(1), 32–42.

Chen, Y., Wang, Y., Kinshuk, & Chen, N. S. (2014). Is FLIP enough? Or should we use the FLIPPED model instead? *Computers & Education*, *79*, 16–27.

Cheung, W. S., & Hew, K. F. (2015). Applying "first principles of instruction " in a blended learning course. In K. C. Li, T.-K. Wong, S. K. S. Cheung, J. Lam, & K. K. Ng (Eds.), *Technology in education:Transforming educational practices with technology* (pp. 127–135). Springer-Verlag Berlin Heidelberg. doi:10.1007/978-3-662-46158-7

Christensen, C. M., Horn, M. B., & Staker, H. (2013). *Is K-12 blended learning disruptive? An introduction to the theory of hybrids*.

Cilesiz, S. (2009). Educational computer use in leisure contexts: A phenomenological study of adolescents' experiences at Internet Cafes. *American Educational Research Journal*, *46*(1), 232–274. doi:10.3102/0002831208323938

Cilesiz, S. (2011). A phenomenological approach to experiences with technology: Current state, promise, and future directions for research. *Educational Technology Research and Development*, *59*(4), 487–510. doi:10.1007/s11423-010-9173-2

Cilesiz, S., & Spector, J. M. (2014). The philosophy of science and educational technology research. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of research on educational communications and technology* (4th ed., pp. 875–884). Springer. doi:10.1007/978-1-4614-3185-5

Clark, C. (2013). *A phenomenological study of the impact of pre-service and in-service training regarding the integration of twenty-first centruy technologies into selected teachers' instruction*. Liberty University.

Clark, C., & Boyer, D. D. (2015). A phenomenological study of pre-service teachers regarding

21st century technology integration training. *International Journal on Integrating Technology in Education*, *4*(1), 1–16. doi:10.1093/ajae/aau087

Clark, C., & Boyer, D. D. (2016). Twenty-first-century technology integration staff development: A phenomenology. *Journal of Computers in Education*, *3*(1), 1–20. doi:10.1007/s40692-015-0053-y

Clark, R. E. (1983). Media will never influence learning. *Educational Technology Research and Development*, *42*(2), 21–27.

Clark, R. E. (2011). Reconsidering research on learning from media. *Educational Research*, *53*(4), 445–459.

Cole, C. (2016). All together now: Integration standards are easing the transition to cloud-based technologies for K-12. *Converge*, *Q1*, 6–10.

Coles, P., Cox, T., Mackey, C., & Richardson, S. (2006). *The toxic terabyte: How data-dumping threatens business efficiency*. *IBM Global Technology Services*.

Cox, S. (2008). *A conceptual analysis of technological pedagogical content knowledge*. Brigham Young University. Retrieved from http://contentdm.lib.byu.edu/ETD/image/etd2552.pdf

Creswell, J. W., & Plano Clark, V. L. (2006). Choosing a mixed methods design. In *Designing and conducting mixed methods research* (pp. 58–89). Thousand Oaks, CA: Sage Publications, Inc.

Cullen, T. A., & Greene, B. A. (2011). Preservice teachers' beliefs, attitudes, and motivation about technology integration. *Journal of Educational Computing Research*, *45*(1), 29–47. doi:10.2190/EC.45.1.b

Curry, K., & Cherner, T. (2016). Social studies in the modern era: A case study of effective teachers' use of literacy and technology. *The Social Studies*, *107*(4), 123–136.

doi:10.1080/00377996.2016.1146650

Darling-Hammond, L. (2006). Constructing 21st century teacher education. *Journal of Teacher Education*, *57*(3), 300–314.

Darling-Hammond, L. (2010). Teacher Education and the American Future. *Journal of Teacher Education*, *61*(1–2), 35–47. doi:10.1177/0022487109348024

Darling-Hammond, L. (2014). Strengthening clinical preparation: The holy grail of teacher education. *Peabody Journal of Education*, *89*(4), 547–561. doi:10.1080/0161956X.2014.939009

David Merrill, M. (2016). My 50+ year search for effective, efficient and engaging instruction. Bloomington, IN: Association for Educational Communications and Technology. Retrieved from http://www.aect.org/movies/2016Speakers.asp?l=0

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*, *49*(3), 182–185.

Dede, C. (2008). Theoretical perspectives influencing the use of information technology in teaching and learning. In J. Voogt & G. Knezek (Eds.), *Instructional handbook of information technology in primary and secondary education* (pp. 43–62). Springer Science + Business Media LLC.

DeMarrais, K. (2004). Qualitative interview studies: Learning through experience. In *Foundations for research: Methods of inquiry in education and the social sciences* (pp. 51–68).

Dewey, J. (1923). *Democracy and Education*. NY: MacMillan.

Dewey, J. (1943). *The Child And The Curriculum /The School And Society*. Chicago: University of Chicago Press.

Dimitrov, D. M., & Rumrill, P. D. (2003). Pretest-posttest designs and measurement of change. *Work (Reading, Mass.)*, *20*(2), 159–165. doi:10.1017/CBO9781107415324.004

Dolan, J. E. (2016). Splicing the divide: A review of research on the evolving digital divide among K–12 students. *Journal of Research on Technology in Education*, *48*(1), 16–37. doi:10.1080/15391523.2015.1103147

Donaldson, J. A. (2017). Emerging technology: Instructional strategies for nailing Jell-O to a tree. In Y. Li, M. Zhang, C. J. Bonk, & W. Zhang (Eds.), *Learning and knowledge analytics in open Education* (pp. 89–97). Springer International Publishing.

Dorner, H., & Kumar, S. (2016). Online collaborative mentoring for technology integration in pre-service teacher education. *TechTrends*, *60*(1), 48–55. doi:10.1007/s11528-015-0016-1

Ely, D. P. (1998). *An evolution of educational technology*. Syracuse, NY.

Ertmer, P. A., & Newby, T. J. (1993). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *6*(4), 50–72.

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, *59*(2), 423–435. doi:10.1016/j.compedu.2012.02.001

Figg, C., & Kamini, J. (2011). Exploring teacher knowledge and actions supporting technology-enhanced teaching in elementary schools: Two approaches by pre-service teachers. *Australasian Journal of Educational Technology*, *27*(7), 1227–1246.

Flipped Learning Network. (2014). The four pillars of F-L-I-P. *Flipped Learning Network*. Retrieved from http://www.flippedlearning.org/definition

Foldnes, N. (2015). The flipped classroom and cooperative learning: Evidence from a randomised experiment. *Active Learning in Higher Education*, *17*(1), 39–49. doi:10.1177/1469787415616726

Foley, L. S. (2011). Exploring K-3 teachers' implementation of comprehension strategy instruction (CSI) using expectancy-value theory. *Literacy Research and Instruction*, *50*(3), 195–215. doi:10.1080/19388071.2010.505680

Francl, T. J. (2014). Is flipped learning appropriate? *Journal of Research on Innovative Teaching*, *7*(1), 119–129.

Frick, T. W., Chadha, R., Watson, C., Wang, Y., & Green, P. (2009). College student perceptions of teaching and learning quality. *Educational Technology Research and Development*, *57*(5), 705–720. doi:10.1007/s11423-007-9079-9

Frick, T. W., Chadha, R., Watson, C., & Zlatkovska, E. (2010). Improving course evaluations to improve instruction and complex learning in higher education. *Educational Technology Research and Development*, *58*(2), 115–136. doi:10.1007/s11423-009-9131-z

Fulton, K. (2012). Upside down and inside out : Flip your classroom to improve student learning. *Learning & Leading with Technology*, *39*(8), 12–17. Retrieved from http://eric.ed.gov/?id=EJ982840

Gagne, R. M. (1965). *Conditions of Learning*.

Gagne, R. M. (1982). Learning outcomes and their effects: Useful categories of human performance. *American Psychologist*, 377–385.

Gardner, H., & Davis, K. (2014). *The app generation: How today's youth navigate identity, intimacy, and imagination in a digital world*. Yale University Press.

Gardner, J., & Belland, B. R. (2012). A conceptual framework for organizing active learning experiences in biology instruction. *Journal of Science Education and Technology*, *21*(4), 465–475.

Gemin, B., Pape, L., Vashaw, L., & Watson, J. (2015). *Keeping pace with K–12 digital learning: An annual review of policy and practice*.

Gilboy, M. B., Heinerichs, S., & Pazzaglia, G. (2015). Enhancing student engagement using the flipped classroom. *Journal of Nutrition Education and Behavior*, *47*(1), 109–114. doi:10.1016/j.jneb.2014.08.008

Goodwin, B., & Miller, K. (2013). Evidence on flipped classrooms is still coming in. *Educational Leadership*, *March*, 78–80.

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education*, *57*(3), 1953–1960. doi:10.1016/j.compedu.2011.04.010

Gray, L., Thomas, N., & Lewis, L. (2010). *Teachers' use of educational technology in U.S. public schools: 2009. National Center for Education Statistics*.

Gronseth, S., Brush, T., Ottenbreit-leftwich, A., Strycker, J., Abaci, S., Easterling, W., … Leusen, P. Van. (2010). Equipping the next generation of teachers: Technology preparation and practice. *Journal of Digital Learning in Teacher Education*, *27*(1), 30–36. doi:10.1080/21532974.2010.10784654

Gross, B., Marinari, M., Hoffman, M., DeSimone, K., & Burke, P. (2015). Flipped @ SBU: Student satisfaction and the college classroom. *Education Research Quarterly*, *39*(2), 36–52.

Grossman, P., Hammerness, K., & Mcdonald, M. (2009). Redefining teaching, re-imagining teacher education. *Teachers and Teaching*, *15*(2), 273–289. doi:10.1080/13540600902875340

Gullen, K., & Zimmerman, H. (2013). Saving time with technology. *Educational Leadership*, 63–66.

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J. S., & Dicke, T. (2017). Extending expectancy-value theory predictions of achievement and aspirations in science: Dimensional comparison processes and expectancy-by-value interactions. *Learning and Instruction*, *49*, 81–91. doi:10.1016/j.learninstruc.2016.12.007

Hall, J. A. (n.d.). Flipping with the first principles of instruction: An examination of preservice teachers' technology integration development. *Journal of Digital Learning in Teacher Education*. doi:10.1080/21532974.2018.1494520

Hall, J. A., & Lei, J. (2017). Examining the Impact of the First Principles of Instruction in a Technology Integration Course. In *5th International Conference on Education*. Nairobi, Kenya.

Hall, J. A., & Lei, J. (2018). Conceptualization and application of a model for flipped instruction: A design case. Manuscript submitted for publication.

Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The substitution augmentation modification redefinition (SAMR) model: A critical review and suggestions for its use. *TechTrends*, *60*, 433–441. doi:10.1007/s11528-016-0091-y

Hammond, T. C., & Manfra, M. M. (2009). Digital history with student-created multimedia. *Social Studies Research and Practice*, *4*(3), 139–150.

Hancock, D. R. (2001). Effects of test anxiety and evaluative threat on students' achievement and motivation. *The Journal of Educational Research*, *94*(5), 284–290. doi:10.1080/00220670109598764

Hao, Y., & Lee, K. S. (2016). Teaching in flipped classrooms: Exploring pre-service teachers' concerns. *Computers in Human Behavior*, *57*, 250–260.

Harris, J., Grandgenett, N., & Hofer, M. J. (2010). Testing a TPACK-based technology integration assessment rubric. In C. D. Maddux, D. Gibson, & B. Dodge (Eds.), *Research Highlights in Technology and Teacher Education 2010* (pp. 323–331). Society for Information Technology and Teacher Education. Retrieved from https://publish.wm.edu/bookchapters/6

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. doi:10.3102/003465430298487

Herold, B. B., & Doran, L. (2016). U.S. ed-tech plan calls attention to “digital-use divide.” Retrieved September 14, 2016, from http://www.edweek.org/ew/articles/2016/01/06/us-ed-tech-plan-calls-attention-to-digital-use.html

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*(3), 223–252.

Hibbard, L., Sung, S., & Wells, B. (2015). Examining the effectiveness of a semi-self-paced flipped learning format in a college general chemistry sequence. *Journal of Chemical Education*, *93*, 24–30. doi:10.1021/acs.jchemed.5b00592

Hill, D. J. (2013). Khan Academy update: It’s hard to imagine how much hotter this tech can get. Retrieved September 20, 2016, from http://singularityhub.com/2013/01/21/khan-academy-update-its-hard-to-imagine-how-much-hotter-this-tech-can-get/

Hofer, M., & Grandgenett, N. (2012). TPACK development in teacher education: A longitudinal study of preservice teachers in a secondary M.A.Ed. program. *Journal of Research on Technology in Education*, *45*(1), 83–106. doi:10.1080/15391523.2012.10782598

Hoffman, E. S. (2014). Beyond the flipped classroom: Redesigning a research methods course for e3 instruction. *Contemporary Issues in Education Research*, *7*(1), 51–62.

Hokenson, B., & Hooper, S. (2010). Integrating technology in classrooms: We have met the enemy, and he is us. In G. J. Anglin (Ed.), *Instructional Technology: Past, present, and future* (pp. 137–144). Libraries Unlimited.

Horn, M. B., & Staker, H. (2011). *The rise of K-12 blended learning*.

Howland, J. L., Jonassen, D., & Marra, R. M. (2011). *Meaningful Learning with Technology*. Pearson Education Inc.

Hur, J. W., Cullen, T. A., & Brush, T. (2010). Teaching for application : A model for assisting pre-service teachers with technology integration. *Journal of Technology and Teacher Education*, *18*(1), 161–182.

Hur, J. W., Shannon, D., & Wolf, S. (2016). An investigation of relationships between internal and external factors affecting technology integration in classrooms. *Journal of Digital Learning in Teacher Education*, *32*(3), 105–114.

Husserl, E. (1931). *Ideas: General introduction to pure phenomenology*. London: George Allen & Unwin.

Hwee, J., & Koh, L. (2013). A rubric for assessing teachers' lesson activities with respect to TPACK for meaningful learning with ICT. *Australasian Journal of Educational Technology*, *29*(6), 887–900.

International Society for Technology in Education. (2008). ISTE standards for teachers. Retrieved from istehttp://www.iste.org/standards/standards

Jaikaran-Doe, S., & Doe, P. E. (2015). Assessing technological pedagogical content knowledge of engineering academics in an Australian regional university. *Australasian Journal of*

Engineering Education, *20*(2), 157–167. doi:10.1080/22054952.2015.1133515

Jaipal, K., & Figg, C. (2010). Unpacking the "Total PACKage ": Emergent TPACK characteristics from a study of preservice teachers teaching with technology. *Journal of Technology and Teacher Education*, *18*(3), 415–441.

Johnson, L. (2012). *The Effect of Design Teams on Preservice Teachers' Technology Integration*. Syracuse University.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015a). *NMC horizon report: 2015 higher education edition*. Austin, Texas.

Johnson, L., Adams Becker, S., Estrada, V., & Freeman, A. (2015b). *NMC horizon report: 2015 K-12 edition*. Austin, Texas.

Jonassen, D. (1999). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 215–239). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Jonathan, B., & Sams, A. (2013). Flipping for mastery. *Educational Leadership*, *December 2*, 24–29.

Judson, E. (2006). How teachers integrate technology and their beliefs about learning: Is there a connection? *Journal of Technology and Teacher Education*, *14*(3), 581–597.

Kay, R. H. (2006). Evaluating strategies used to incorporate technology into preservice education: A review of the literature. *Journal of Research on Technology in Education*, *38*(4), 383–408. doi:10.1080/15391523.2006.10782466

Keengwe, J., Onchwari, G., & Wachira, P. (2008). Computer technology integration and student learning: Barriers and promise. *Journal of Science Education and Technology*, *17*(6), 560–565. doi:10.1007/s10956-008-9123-5

Keller, J. M. (1983). Motivational design of instruction. In C. M. Reigeluth (Ed.), *Instructional - design theories and models* (pp. 386–434). Lawrence Erlbaum Assoc.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development*, *10*(3), 2–10.

Kennedy, K., & Archambault, L. M. (2012). Offering preservice teachers field experiences in K-12 online learning: A national survey of teacher education programs. *Journal of Teacher Education*, *63*(3), 185–200. doi:10.1177/0022487111433651

Kennedy, K., & Archambault, L. M. (2013). Partnering for success : A 21 st century model for teacher preparation. *INACOL*. Retrieved from http://www.inacol.org/cms/wp-content/uploads/2013/10/iNACOL-Partnering-for-Success-October-2013.pdf

Khan Academy. (2016). Khan Academy. Retrieved January 12, 2017, from https://www.khanacademy.org/

Khan, S. (2011). Let's use video to reinvent education. Retrieved January 12, 2017, from https://www.ted.com/talks/salman_khan_let_s_use_video_to_reinvent_education

Khanova, J., Roth, M. T., Rodgers, J. E., & Mclaughlin, J. E. (2015). Student experiences across multiple flipped courses in a single curriculum. *Medical Education*, *49*, 1038–1048. doi:10.1111/medu.12807

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, *29*, 76–85. doi:10.1016/j.tate.2012.08.005

Kim, M. K., Kim, S. M., Khera, O., & Getman, J. (2014). The experience of three flipped classrooms in an urban university: An exploration of design principles. *Internet and Higher Education*, *22*, 37–50.

Kimmons, R. (2015). Examining TPACK's theoretical future. *Journal of Technology and Teacher Education*, *23*(1), 53–77.

Kleiner, B., Thomas, N., Lewis, L., & Greene, B. (2007). *Educational technology in teacher education programs for initial licensure*. *Statistical analysis report*. Washington, DC. Retrieved from https://nces.ed.gov/pubs2008/2008040.pdf

Koehler, M. J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education*, *21*(3), 94–102.

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

Koehler, M. J., Mishra, P., Kereluik, K., Shin, T. S., & Graham, C. R. (2014). The technological pedagogical content knowledge framework. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology* (4th ed., Vol. 13, pp. 260–263). New York, NY: Springer Science + Business Media LLC. doi:10.1007/978-1-4614-3185-5

Koehler, M. J., Shin, T. S., & Mishra, P. (2011). How do we measure TPACK? Let me count the ways. In R. N. Ronau, C. R. Rakes, & M. L. Niess (Eds.), *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 16–31). Hershey, PA: Information Science Reference.

Koh, J. H. L., & Frick, T. W. (2009). Instructor and student classroom interactions during technology skills instruction for facilitating preservice teachers' computer self-efficacy. *Journal of Educational Computing Research*, *40*(2), 211–228. doi:10.2190/EC.40.2.d

Kopcha, T. J., & Sullivan, H. (2007). Self-presentation bias in surveys of teachers' educational technology practices. *Educational Technology Research and Development*, *55*(6), 627–646.

doi:10.1007/s11423-006-9011-8

Koszalka, T. A. (2001). Effect of computer-mediated communications on teachers' attitudes toward using web resources in the classroom. *Journal of Instructional Psychology*, *28*(2), 95–103.

Kozma, R. B. (1994). Will media influence leraning? Reframing the debate. *Educational Technology Research and Development*, *42*(2), 7–19.

Krahenbuhl, K. S. (2017). An engaging, yet failed flip. *InSight*, *12*, 132–144.

Kramarski, B., & Michalsky, T. (2010). Preparing preservice teachers for self-regulated learning in the context of technological pedagogical content knowledge. *Learning and Instruction*, *20*(5), 434–447. doi:10.1016/j.learninstruc.2009.05.003

Krathwohl, D. R. (1998). *Methods of education and social science research: An integrated approach*. Long Grove, IL: Waveland Press, Inc.

Krathwohl, D. R. (2002). A revision of Bloom 's taxonomy : An overview. *Theory Into Practice*, *41*(4), 212–218.

Kvashnina, O. S., & Martynko, E. A. (2016). Analyzing the potential of flipped classroom in ESL teaching. *International Journal of Emerging Technologies in Learning*, *11*(3), 71–73. doi:10.3991/ijet.v11i03.5309

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *The Journal of Economic Education*, *31*(1), 30–43.

Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. New York, NY: Routledge.

Lee, C.-J., & Kim, C. (2014). An implementation study of a TPACK-based instructional design model in a technology integration course. *Educational Technology Research and*

Development, *62*(4), 437–460.

Lee, E., & Hannafin, M. J. (2016). A design framework for enhancing engagement in student-centered learning: own it, learn it, and share it. *Educational Technology Research and Development*, *64*(4), 707–734. doi:10.1007/s11423-015-9422-5

Lee, J., Lim, C., & Kim, H. (2017). Development of an instructional design model for flipped learning in higher education. *Educational Technology Research and Development*, *65*(2), 427–453.

Lee, K. S. (2014). Pre-service teachers' technological pedagogical knowledge: A continuum of views on effective technology integration. *International Journal of E-Learning & Distance Education*, *29*(2), 1–18.

Lee, S. (2013). *A relationship between course-level implementation of first principles of instruction and cognitive engagement: A multilevel analysis*. Syracuse University.

Lee, S., & Koszalka, T. A. (2016). Course-level implementation of First Principles, goal orientations, and cognitive engagement: A multilevel mediation model. *Asia Pacific Education Review*, *17*(2), 365–375.

Lei, J. (2009). Digital natives as preservice teachers: What technology preparation is needed? *Journal of Computing in Teacher Education*, *25*(3), 87–97.

Lei, J., & Zhao, Y. (2008). One-to-One Computing: What Does It Bring to Schools? *Journal of Educational Computing Research*, *39*(2), 97–122. doi:10.2190/EC.39.2.a

Lin, M. H., Groom, N., & Lin, C. Y. (2013). Blog-assisted learning in the ESL writing classroom: A phenomenological analysis. *Educational Technology and Society*, *16*(3), 130–139.

Linderoth, J. (2013). Open letter to Dr. Ruben Puentedura. Retrieved January 6, 2017, from http://spelvetenskap.blogspot.com/2013/10/open-letter-to-dr-ruben-puentedura.html

Little, C. (2015). The flipped classroom in further education: Literature review and case study. *Research in Post-Compulsory Education*, *20*(3), 265–279.

Liu, C. (2016). A creative design and implementation of student-led flipped classroom model in english learning. *Theory and Practice in Language Studies*, *6*(10), 2036–2043.

Lo, C. K., & Hew, K. F. (2017). Using "First Principles of Instruction" to design secondary school mathematics flipped classroom: The findings of two exploratory studies. *Educational Technology & Society*, *20*(1), 222–236.

Lo, C. K., Lie, C. W., & Hew, K. F. (2018). Applying "First Principles of Instruction" as a design theory of the flipped classroom: Findings from a collective study of four secondary school subjects. *Computers & Education*, *118*, 150–165. doi:10.1016/j.compedu.2017.12.003

Long, T., Cummins, J., & Waugh, M. (2016). Use of the flipped classroom instructional model in higher education: Instructors' perspectives. *Journal of Computing in Higher Education*, *29*(2), 1–22.

Lu, L., & Lei, J. (2012). Using live dual modeling to help preservice teachers develop TPACK. *Journal of Digital Learning in Teacher Education*, *29*(1), 14–22.

Lux, N., & Lux, C. (2015). The influence of technology-rich early childhood field experiences on preservice teachers. *Journal of Technology and Teacher Education, 23*(2), 213–240.

Maderick, J. A., Zhang, S., Hartley, K., & Marchand, G. (2016). Preservice teachers and self-assessing digital competence. *Journal of Educational Computing Research*, *54*(3), 326–351. doi:10.1177/0735633115620432

Mager, R. (1997). *Preparing instructional objectives: A critical tool in the development of* *effective instruction* (3rd ed.). Center for Effective Performance.

Mangram, J. A., Haddix, M., Ochanji, M., & Masingila, J. (2015). Active learning strategies for complementing the lecture teaching method in large classes in higher education. *Journal of Instructional Research*, *4*, 57–68.

Margulieux, L. E., McCracken, W. M., & Catrambone, R. (2016). A taxonomy to define courses that mix face-to-face and online learning. *Educational Research Review*, *19,* 104–118.

Marks, D. B. (2015). Flipping The classroom: Turning an instructional methods course upside down. *Journal of College Teaching & Learning*, *12*(4), 241–248.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement.* Alexandria, VA: Association for Supervision and Curriculum Development.

Matua, G., & Van Der Wal, D. (2015). Differentiating between descriptive and interpretative phenomenological research approaches. *Nurse Researcher*, *22*(6), 22–27. doi:10.7748/nr.22.6.22.e1344

Maxwell, J. (2006). Re-situtating constructionism. In J. Weiss, J. Nolan, J. Hunsinger, & P. Trifonas (Eds.), *The international handbook of virtual learning environments* (Vol. I, pp. 279–298). Netherlands: Springer.

Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*(1), 43–52. doi:10.1207/S15326985EP3801

McCarthy, B. (2000). *About learning* (2nd ed.). About Learning Inc.

McGivney-Burelle, J., & Xue, F. (2013). Flipping calculus. *Primus*, *23*(5), 477–486. doi:10.1080/10511970.2012.757571

Means, B., Toyoma, Y., Murphy, R., & Baki, M. (2013). The effectiveness of online and blended learning: A meta-analysis of the empirical literature. *Teachers College Record*, *115*(3), 1–47.

Mennella, T. A. (2016). Comparing the efficacy of flipped vs. alternative active learning in a college genetics course. *The American Biology Teacher*, *78*(6), 471–479. doi:10.1525/abt.2016.78.6.471.THE

Merriënboer, J. J. G., Clark, R. E., & Croock, M. B. M. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational Technology Research and Development*, *50*(2), 39–61.

Merrill, M. D. (1983). Component display theory. In *Instructional-design theories and models: An overview of their current status* (1st ed., pp. 282–333).

Merrill, M. D. (2002). First principles of instruction. *Educational Technology Research and Development*, *50*(3), 43–59.

Merrill, M. D. (2012). *First principles of instruction* (1st ed.). Pfeiffer.

Miles, C. A., & Foggett, K. (2016). Supporting our students to achieve academic success in the unfamiliar world of flipped and blended classrooms. *Journal of University Teaching & Learning Practice*, *13*(4), 1–14.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

Mishra, P., & Koehler, M. J. (2008). Introducing technological pedagogical content knowledge. In *Paper presented at the Annual Meeting of the American Educational Research Association* (pp. 1–16).

Mishra, P., & Koehler, M. J. (2009). Too cool for school? No way! Using the TPACK framework: You can have your hot tools and teach with them, too. *Learning and Leading with Technology*, *36*(7), 14–18.

Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2012). *Designing effective instruction* (7th ed.). Wiley.

Moustakas, C. (1994a). Epoche, phenomenological reduction, imaginative variation, and synthesis. In *Phenomenological research methods* (pp. 84–102). Thousand Oaks, CA: Sage Publications, Inc. doi:10.4135/9781412995658

Moustakas, C. (1994b). Transcendental phenomenology: Conceptual framework. In *Phenomenological research methods* (pp. 25–42). Thousand Oaks, CA: Sage Publications, Inc. doi:10.4135/9781412995658

Mouza, C. (2016). Developing and assessing TPACK. In M. C. Herring, M. J. Koehler, & P. Mishra (Eds.), *Handbook of technological pedagogical content knowledge (TPACK) for Educators* (Second, pp. 169–190). New York, NY: Routledge.

Myrold, R. L., & Ullrich-French, S. (2017). Expectancy-value theory outcomes of a school-based bicycling programme. *International Journal of Sport and Exercise Psychology*, *15*(2), 207–220. doi:10.1080/1612197X.2015.1079922

Nagengast, B., Marsh, H. W., Scalas, L. F., Xu, M. K., Hau, K. T., & Trautwein, U. (2011). Who took the “x” out of expectancy-value theory?: A psychological mystery, a substantive-methodological synergy, and a cross-national generalization. *Psychological Science*, *22*(8), 1058–1066. doi:10.1177/0956797611415540

National Center for Education Statistics. (2003). *Overview and inventory of state education reforms: 1990 to 2000*. Washington, DC.

National Commission on Teaching & America’s Future. (2016). *What matters now: A new compact for teaching and learning*. Arlington, VA.

Nelson, K. R. (2015). Application of Merrill’s first principles of instruction in a museum education context. *Journal of Museum Education*, *40*(3), 304–312.

Nelson, L. M. (1999). Collaborative problem solving. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 241–267). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Noonoo, S. (2012). Flipped learning founders set the record straight. Retrieved January 12, 2017, from https://thejournal.com/articles/2012/06/20/flipped-learning-founders-q-and-a.aspx

Nordin, H., Morrow, D., & Davis, N. (2011). Pre-service teachers' experience with ICT integration in secondary schools: A case study of one New Zealand context. In *Society for Information Technology & Teacher Education International Conference* (pp. 3915–3920). Association for the Advancement of Computing in Education.

Nouri, J. (2016). The flipped classroom: For active, effective and increased learning - especially for low achievers. *International Journal of Educational Technology in Higher Education*, *13*(1), 1–10. doi:10.1186/s41239-016-0032-z

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education*, *25*, 85–95.

Office of Educational Technology. (2016). *Future ready learning: Reimagining the role of technology in education*.

Oliver, K. M., & Stallings, D. T. (2014). Preparing teachers for emerging blended learning environments. *Journal of Technology and Teacher Education*, *22*(1), 57–81.

Özgün-Koca, S. A., Meagher, M., & Edwards, M. T. (2011). A teacher's journey with a new generation handheld: Decisions, struggles, and accomplishments. *School Science and Mathematics*, *111*(5), 209–224. doi:10.1111/j.1949-8594.2011.00080.x

Papert, S. (1988). A critique of technocentrism in thinking about the school of the future. In B.

Sendov & I. Stanchev (Eds.), *Children in the information age: Opportunities for creativity, innovation and new activities* (pp. 3–18). Pergamon Press.

Papert, S., & Harel, I. (1991). Situating Constructionism. *Constructionism*, 1–11. doi:10.1111/1467-9752.00269

Partnership for 21st Century Learning. (2015). Framework for 21st century learning. Retrieved September 19, 2016, from http://www.p21.org/our-work/p21-framework

Patahuddin, S. M., Lowrie, T., & Dalgarno, B. (2016). Analysing mathematics teachers' TPACK through observation of practice. *Asia-Pacific Education Researcher*, *25*(5–6), 863–872. doi:10.1007/s40299-016-0305-2

Patton, M. (2002). Qualitative interviewing. In *Qualitative research and evaluation methods* (3rd ed., pp. 339–418). Thousand Oaks, CA: Sage Publications.

Peterson, D. J. (2015). The flipped classroom improves student achievement and course satisfaction in a statistics course : A quasi-experimental study. *Teaching of Psychology*, *43*(1), 10–15. doi:10.1177/0098628315620063

Picciano, A. G. (2002). Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *Journal of Asynchronous Learning Network*, *6*(1), 68–81. doi:10.1006/ceps.1999.1015

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

Pierson, M., & Thompson, M. (2005). The re-envisioned educational technology course. *Journal of Computing in Teacher Education*, *22*(1), 31–36.

Powell, A., Rabbitt, B., & Kennedy, K. (2014). *iNACOL blended learning teacher competency framework*. Retrieved from https://www.inacol.org/wp-content/uploads/2014/10/iNACOL-

Blended-Learning-Teacher-Competency-Framework.pdf

Puentedura, R. R. (2015). SAMR : A brief introduction. Hippasus.

Reigeluth, C. M. (2013). Instructional theory and technology for the new paradigm of education. *The F.M. Duffy Reports*, *18*(4), 1–21.

Reiser, R. A. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology Research and Development*, *49*(2), 57–67. doi:10.1007/BF02504928

Reyes, J. A. (2006). Transactional distance theory: Is it here to stay? *Distance Learning*, *10*(3), 43–50.

Richey, R. C. (Ed.). (2013). *Encyclopedia of terminology for educational communications and technology*. New York: Springer.

Roffey, T., Sverko, C., & Therien, J. (2016). The making of a makerspace: Pedagogical and teaching transformations of teaching and learning. Retrieved January 6, 2017, from http://www.makerspaceforeducation.com/

Rogers, S. E. (2016). Bridging the 21st century digital divide. *TechTrends*, *60*(3), 197–199.

Romrell, D., Kidder, L. C., & Wood, E. (2014). The SAMR model as a framework for evaluating mlearning. *Journal of Asynchronous Learning Networks*, *18*(2), 79–93.

Rosenberg, J. M., & Koehler, M. J. (2015). Context and technological pedagogical content knowledge (TPACK): A systematic review. *Journal of Research on Technology in Education*, *47*(3), 186–210. doi:10.1080/15391523.2015.1052663

Rowley, J., Dysard, G., & Arnold, J. (2005). Developing a new technology infusion program for preparing tomorrow’s teachers. *Journal of Technology and Teacher Education*, *13*(1), 105–123.

Sahin, A., Cavlazoglu, B., & Zeytuncu, Y. E. (2015). Flipping a college calculus course : A case study. *Journal of Educational Technology & Society*, *18*(3), 142–152.

Schaffhauser, D. (2015). Laptops expected to be biggest K-12 tech expense in 2015. Retrieved July 19, 2018, from http://thejournal.com/articles/2015/05/13/laptops-expected-to-be-biggest-k12-tech-expense-in-2015.aspx?admgarea=News1

Schank, R. C., Berman, T. R., & Macpherson, K. A. (1999). Learning by doing. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 161–181). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Schmidt, D. A., Baran, E., Thompson, A. D., Koehler, M. J., Mishra, P., & Shin, T. S. (2010). Survey of preservice teachers' knowledge of teaching and technology, 1–8.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK). *Journal of Research on Technology in Education*, *42*(2), 123–149.

Schwartz, D. L., Lin, X., Brophy, S., & Bransford, J. D. (1999). Toward the development of flexibly adaptive instructional designs. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: A new paradigm of instructional theory* (pp. 183–213). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Shepherd, C. E., Bolliger, D. U., Dousay, T. A., & Persichitte, K. (2016). Preparing teachers for online instruction with a graduate certificate program. *TechTrends*, *60*(1), 41–47. doi:10.1007/s11528-015-0015-2

Shih, W., & Tsai, C.-Y. (2017). Students' perception of a flipped classroom approach to facilitating online project-based learning in marketing research courses. *Australasian Journal of Educational Technology*, *33*(5), 32–49.

Shrock, S. a. (1994). The media influence debate: Read the fine print, but don't lose sight of the big picture. *Educational Technology Research and Development*, *42*(2), 49–53. doi:10.1007/BF02299092

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *American Educational Research Association*, *15*(2), 4–14. doi:10.1017/CBO9781107415324.004

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–22.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153–189. doi:10.3102/0034654307313795

Simpson, V., & Richards, E. (2014). Flipping the classroom to teach population health: Increasing the relevance. *Nurse Education in Practice*, (2014), 1–6. doi:10.1016/j.nepr.2014.12.001

Smith, B., & Mader, J. (2015). Science 2.0: Using web tools to support learning. *The Science Teacher*, *82*(9), 8.

Smolkowski, K. (2013). Gain score analysis. Retrieved July 16, 2018, from https://homes.ori.org/keiths/Tips/Stats_GainScores.html

Spector, J. M., Merrill, M. D., van Merriënboer, J. J. G., & Driscoll, M. P. (Eds.). (2008). *Handbook of research on educational communications and technology* (3rd ed.). New York, NY: Lawrence Erlbaum Assoc.

Spuches, C. (2017, January). A tribute to David. *IDD&E Newletters,* p. 8.

Straumsheim, C. (2013). Still in favor of the flip. Retrieved December 2, 2015, from https://www.insidehighered.com/news/2013/10/30/despite-new-studies-flipping-classroom-still-enjoys-widespread-support

Straumsheim, C. (2016). Become a doctor, no lectures required. Retrieved January 12, 2017, from https://www.insidehighered.com/news/2016/09/26/u-vermont-medical-school-get-rid-all-lecture-courses

Svihla, V., Reeve, R., Sagy, O., & Kali, Y. (2015). A fingerprint pattern of supports for teachers designing of technology-enhanced learning. *Instructional Science*, *43*(2), 283–307. doi:10.1007/s11251-014-9342-5

Svinicki, M. (2013). Flipped classrooms-Old or new? *The National Teaching & Learning Forum*, *22*(5), 12.

Swart, W., & Wuensch, K. L. (2016). Flipping quantitative classes : A triple win. *Decision Sciences Journal of Innovative Education*, *14*(1), 67–89.

Tate, R. (1998). *An introduction to modeling outcomes in the behavioral and social sciences* (2nd ed.). Edina, MN: Burgess Publishing.

Tech Learning. (2014, July). Big Ideas: The latest news and stats affecting the K-12 edtech community. *WWW.TECHLEARNING.COM*, 6.

Tennyson, R. D. (1994). The big wrench vs. integrated approaches: The great media debate. *Educational Technology Research and Development*, *42*(3), 15–28.

Teo, T. (2012). Examining the intention to use technology among pre-service teachers: An integration of the technology acceptance model and theory of planned behavior. *Interactive Learning Environments*, *20*(1), 3–18. doi:10.1080/10494821003714632

Thai, T. N. T., Wever, B. De, & Valcke, M. (2017). The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback. *Computers & Education*, *107*, 113–126. doi:10.1016/j.compedu.2017.01.003

The White House. (2013). Education knowledge and skills for the jobs of the future. Retrieved March 28, 2016, from https://www.whitehouse.gov/issues/education/k-12/connected

Tiruneh, D. T., Weldeslassie, A. G., Kassa, A., Tefera, Z., De Cock, M., & Elen, J. (2016). Systematic design of a learning environment for domain-specific and domain-general critical thinking skills. *Educational Technology Research and Development*, *64*(3), 481–505.

Touchton, M. (2015). Flipping the classroom and student performance in advanced statistics: Evidence from a quasi-experiment. *Journal of Political Science Education, 11*(1), 28–44. doi:10.1080/15512169.2014.985105

Tournaki, N., & Lyublinskaya, I. (2014). Preparing special education teachers for teaching mathematics and science with technology by integrating the TPACK framework into the curriculum: A study of teachers' perceptions. *Journal of Technology and Teacher Education*, *22*(2), 243–259.

Ullman, E. (2013). Tips to help you flip your classroom: Teachers offer their strategies for making the most out of the flipped classroom model. *Education Update*, *55*(2), 4–6.

van den Berg, E., Wallace, J., & Pedretti, E. (2008). Multimedia cases, teacher education and teacher learning. In J. Voogt & G. Knezek (Eds.), *International Handbook of Information Technology in Primary and Secondary Education* (pp. 475–487). New York, NY: Springer Science + Business Media LLC.

Vaughan, M. (2014). Flipping the learning: An investigation into the use of the flipped classroom model in an introductory teaching course. *Education Research and Perspectives*, *41*(1), 25–41.

Voogt, J., Fisser, P., Pareja Roblin, N., Tondeur, J., & van Braak, J. (2013). Technological pedagogical content knowledge: A review of the literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. doi:10.1111/j.1365-2729.2012.00487.x

Vroom, V. H. (1964). *Work and Motivation*. NY: John Willey & Sons.

Vygotsky, L. S. (1978). Interaction between learning and development. In M. Gauvain & M. Cole (Eds.), *Readings on the development of children* (2nd ed., pp. 29–36). Cambridge, MA: Harvard University Press.

Waldrop, J. B., & Bowdon, M. A. (2015a). *Best practices for flipping the college classroom*. *Best Practices for Flipping the College Classroom*. doi:10.4324/9781315777542

Waldrop, J. B., & Bowdon, M. A. (Eds.). (2015b). *Best Practices for Flipping the College Classroom*. Routledge.

Ward, A. F., Duke, K., Gneezy, A., & Bos, M. W. (2017). Brain drain: The mere presence of one's own smartphone reduces available cognitive capacity. *Journal of the Association for Consumer Research*, *2*(2), 140–154. doi:10.1086/691462

Ward, G., & Overall, T. (2011). Technology integration for pre-service teachers: Evaluating the team-taught cohort model. *Journal of Technology and Teacher Education*, *19*(1), 23–43.

West, R. E., & Graham, C. R. (2007). Benefits and challenges of using live modeling to help preservice teachers transfer technology integration principles. *Journal of Computing in Teacher Education*, *23*(4), 137–147. doi:10.1080/10402454.2007.10784573

Wetzel, K., & Marshall, S. (2011). TPACK goes to sixth grade: Lessons from a middle school teacher in a high-technology-access classroom. *Journal of Digital Learning in Teacher Education*, *28*(2), 73–82.

Whitacre, M., & Peña, C. (2011). From the classroom to the field: Pre-service teachers integration of technology during field placement. *International Journal of Instructional*

Media, *38*(3), 237–245.

Wittrock, M. C. (1990). Generative processes of comprehension. *Educational Psychologist*, *24*(4), 345–376.

Yatani, K. (2014). Wilcoxon signed-rank test. Retrieved February 20, 2018, from http://yatani.jp/teaching/doku.php?id=hcistats:WilcoxonSigned#effect_size

Yilmazel-Sahin, Y., & Oxford, R. (2010). A comparative analysis of teacher education faculty development models for technology integration. *Journal of Technology and Teacher Education*, *18*(4), 693–720.

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college- and university-based teacher education. *Journal of Teacher Education*, *61*(1–2), 89–99. doi:10.1177/0022487109347671

Zhao, Y., Zhang, G., Lei, J., & Qiu, W. (2016). *Never send a machine to do a human's job: Correcting the top 5 edtech mistakes*. Thousand Oaks, CA: Corwin.

Vita

Jacob A. Hall

252 Huntington Hall
Syracuse, New York 13244
315.443.3703 (office) 315.506.2439 (cell)
jahall01@syr.edu

Education

Doctor of Philosophy – Instructional Design, Development and Evaluation 2018
Syracuse University, Syracuse, NY
Advisor: Jing Lei, Ph.D., Associate Professor, IDD&E

Master of Arts – Computing in Education 2012
Teachers College, Columbia University, New York, NY

Bachelor of Science – Elementary Education 2008
University of Central Florida, Orlando, FL

Publications

Hall, J.A., Lei, J., & Wang, Q. (2018) The First Principles of Instruction: An Examination of their Impact on Preservice Teachers' TPACK. Manuscript in preparation.

Hall, J.A. & Cheng, J. (2018) Exploring preservice teachers' experiences with the first principles in a flipped course. Manuscript in preparation.

Freedman, J. & **Hall, J.A.** (2018) From concepts of universal design for learning to its application in instructional design: Considerations for a postsecondary education instructional model. Manuscript in preparation.

Hall, J. A., & Lei, J. (2018). Conceptualization and application of a model for flipped instruction: A design case. Manuscript submitted for publication.

Hall, J. A. (2018) Flipping with the first principles of instruction: An examination of preservice teachers' technology integration development. *Journal of Digital Learning in Teacher Education*. Advance online publication. 10.1080/21532974.2018.1494520

Hall, J.A. & Lei, J. (2017). Examining the impact of the first principles of instruction in a technology integration course. *Proceedings for the International Conference on Education*. Nairobi, Kenya.

Hall, J.A.. Koszalka, T.A., Souid, L., & Wu, Y. (2014). Designing feedback to increase interaction and learning in an online self-study course. *Proceedings for the Association for Educational Communications and Technology Convention*. Jacksonville, FL.

Souid, L., Koszalka, T. A., Wu , Y., & **Hall, J. A.** (2014). Collaborative design of an online self-directed course: An example of a cognitive apprenticeship. *Proceedings for the Association for Educational Communications and Technology Convention*. Jacksonville, FL.

Souid, L., Wu , Y., **Hall, J. A.**, & Koszalka, T. A. (2014). Computers as critical thinking tools: Primarily self-directed, online capstone course. *Proceedings for the Association for Educational Communications and Technology Convention*. Jacksonville, FL.

Wu, Y., Koszalka, T. A., Souid, L., & **Hall, J. A.** (2014). Course design features that can reduce academic procrastination in self-directed online courses. *Proceedings for the Association for Educational Communications and Technology Convention*. Jacksonville, FL.

Technical Reports

Hall, J.A. (2017). *South Jefferson Central School District Adventures in Education.* Annual technical report to the Department of Defense Education Activity (DoDEA) (Year 3).

Shablak, S., **Hall, J.A.**, & Hall, K. (2017) *Ticket to Ride Pilot Program Evaluation.* Final report prepared for the Erie Canalway Heritage Fund, Inc.

Hall, J.A., Hall, K., & Shablak, S. (2017) *Camillus Erie Canal Park Developmental Evaluation.* Final report prepared for the Erie Canalway Heritage Fund, Inc.

Shablak, S., **Hall, J.A.**, & Hall, K. (2017) *Chittenango Landing Canal Boat Museum Developmental Evaluation.* Final report prepared for the Erie Canalway Heritage Fund, Inc.

Hall, K., Shablak, S., & **Hall, J.A.** (2017) *Erie Canal Museum Developmental Evaluation.* Final report prepared for the Erie Canalway Heritage Fund, Inc.

Tornberg. R. E. & **Hall, J.A.** (2017). *Cornell University Engineering Success Program (CUES).* Report prepared for the College of Engineering, Cornell University.

Hall, J.A. (2017). *Reviving Place Evaluation Report*. Report prepared for the Onondaga Environmental Institute.

Presentations

Research Presentations

Hall, J.A. (2019, *Proposal Submitted*). A Descriptive Phenomenological Analysis of Preservice Teachers' Experiences with the First Principles of Instruction. Proposal submitted for the annual meeting of the American Educational Research Association (AERA – Division K). Toronto, Canada.

Hall, J.A. (2018, *Accepted*). Developing Preservice Teachers' Technology-Integrated Design: Comparing a Problem-Centered Approach in Face-to-Face and Flipped Courses. Poster to be presented at annual convention of the Association for Educational Communications and Technology (AECT). Kansas City, MO.

Hall, J.A. & Lei, J. (2018, April). Applying the First principles of instruction in flipped and face-to-face approaches: A mixed methods comparison. Paper to be presented at the annual meeting of the American Educational Research Association (AERA – Division K). New York, NY.

Hall, J.A. & Lei, J. (2017, November). A Change in design: Comparing a traditional and flipped approach to technology integration instruction in teacher preparation. Paper to be presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Hall, J.A. & Lei, J. (2017, July). Examining the impact of the first principles of instruction in a technology integration course. Paper presented at the 5th International Conference on Education (ICE). Nairobi, Kenya.

Hall, J.A. & Lei, J. (2017, April). A case study of flipping a technology integration course with the first principles of instruction. Paper presented at the annual meeting of the American Educational Research Association (AERA – Division K). San Antonio, TX.

Chen, Y. & **Hall, J.A.** (2017, April). Online learners' cognitive presence and peer facilitators' contribution: When facilitation scripts are used. Paper presented at the annual meeting of the American Educational Research Association (AERA). San Antonio, TX.

Hall, J.A. & Lei, J. (2016, November). Flipping the technology integration classroom for pre-service teachers. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Las Vegas, NV.

Hall, J.A. & Lei, J. (2016, November). Learning through media: Communication for learning. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Las Vegas, NV.

Sun, D. & **Hall, J.A.** (2015, November). A measure of student engagement in online courses. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Indianapolis, IN.

Hall, J.A. (2015, November). Engaging learners in participatory culture through web 2.0 tools. Poster presented at annual convention of the Association for Educational Communications and Technology (AECT). Indianapolis, IN.

Hall, J.A., Koszalka, T.A., Souid, L., & Wu, Y. (2014, November). Designing feedback to increase interaction and learning in an online self-study course. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Souid, L., Wu, Y., **Hall, J. A.**, & Koszalka, T. A. (2014, November). Computers as critical thinking tools: Primarily self-directed, online capstone course. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Souid, L., Koszalka, T. A., Wu, Y., & **Hall, J. A.** (2014, November). Collaborative design of an online self-directed course: An example of a cognitive apprenticeship. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Wu, Y., Koszalka, T. A., Souid, L., & **Hall, J. A.** (2014, November). Course design features that can reduce academic procrastination in self-directed online courses. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Hall, J. A. (2014, April). *Evaluator competencies: In theory and in practice*. Paper presented at the annual meeting of the Eastern Evaluation Research Society (EERS). Galloway, NJ.

Additional Presentations

Hall, J.A. & Maricle, K. (2018). *Flipping the PBL course*. Invited workshop for the faculty at the State University of New York College at Cortland. Cortland, NY.

Hall, J.A. & Wilhelm-Chapin, M. (2017). *Images of assessment: Focusing on learning*. Invited workshop presented to the Syracuse University teaching assistants. Syracuse, NY.

Hall, J.A. (2016). *Engaging with flip and avoiding the flop: Best practices for designing a flipped course*. Presentation to the Future Professoriate Program Annual Conference. Hamilton, NY.

Lei, J. & **Hall, J.A.** (2016). *Digital Citizenship: Technology Competencies in the Digital Era*. Invited presentation for the Terra Educational Technology Conference. Syracuse, NY.

Hall, J.A. & Rebman, S. (2016). *Motivating students*. Workshop presented at the Teaching Assistant Orientation Program. Syracuse, NY.

Koszalka, T.A, Souid, L. & **Hall, J.A.** (2015). *Instructional design foundations for distance learning*. Invited seminar presented to the Hartwick College Faculty. Oneonta, NY.

Hall, J.A. & Woosang, H. (2014). *Blackboard for teaching assistants*. Workshop presented at the Teaching Assistant Orientation Program. Syracuse, NY.

Hall, J.A. (2013). *Integrating technology in the elementary classroom*. Invited presentation to the Blue Ribbon Schools of Excellence Conference. Orlando, FL.

Grants

- *IDD&E Professional Development Fund Travel Grant ($2,000)* 2013-2017
  IDD&E Department, School of Education, Syracuse University
- *Graduate Student Travel Grant ($2,000)* 2013-2017
  School of Education, Syracuse University
- *GSO Travel Grant ($300)* 2017
  Graduate Student Organization, Syracuse University
- *Graduate Council Travel Grant ($250)* 2017
  School of Education Graduate Council, Syracuse University
- *Research and Creative Grant ($1,000)* 2017
  School of Education, Syracuse University
- *Sol Hirsch Education Fund ($900)* 2012
  National Weather Association
- *Progress Energy and Walt Disney World Mini-Grant ($1,500)* 2011
  The Walt Disney Company

Honors and Awards

Society of International Chinese in Educational Technology 2017
Best Student Paper Award

- Awarded for: Hall, J.A. & Lei, J. (2017, November). Examining the Impact of the First Principles of Instruction in a Technology Integration Course. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Syracuse University Graduate School Future Professoriate Program 2017
Certificate in University Teaching

- Awarded after two years participation in the Future Professoriate Program, completion of a professional development series focused on university teaching, documentation of a faculty mentored teaching experience, and presentation of a teaching portfolio to peers and faculty

Syracuse University Graduate School 2017
Outstanding Teaching Assistant Award

- Awarded for excellence in instruction and a commitment to quality undergraduate education. After being nominated by a supervising faculty member for this award, I crafted a teaching portfolio composed of student and faculty recommendation letters, teaching evaluations, teaching artifacts and evidences of scholarship integrated with teaching. An anonymous panel of faculty from across campus selected me for this award after review of my teaching portfolio

Association for Educational Communications and Technology (AECT) 2017
Design and Development Competition Semi-finalist

Society of International Chinese in Educational Technology 2016
Award of Best Student Presentation

- Awarded for: Hall, J.A. & Lei, J. (2016, November). Learning through media: Communication for learning. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Las Vegas, NV.

Syracuse University Graduate School 2014 and 2016
Teaching Mentor Award

- Awarded after a competitive selection process intended to identify highly effective teaching assistants across campus. Selection for this award includes completing an application, training, teaching portfolio, and interview.

Syracuse University Department of Instructional Design, Development and Evaluation 2014
Outstanding Service to the Department Award

- Awarded in recognition of service to the department as a doctoral student representative and for coordination of events intended to develop a sense of community among students

Eastern Evaluation Research Society (EERS) 2014
Notable student submission

- Awarded for: Hall, J. A. (2013). Evaluator competencies: In theory and in practice. Paper proposal to the EERS annual conference. Stipend and registration fees awarded.

Association for Educational Communications and Technology (AECT) 2014
Design and Development Showcase Award

- Awarded for: Souid, L., Wu , Y., Hall, J. A., & Koszalka, T. A. (2014, November). Computers as critical thinking tools: Primarily self-directed, online capstone course. Paper presented at annual convention of the Association for Educational Communications and Technology (AECT). Jacksonville, FL.

Koa Elementary School 2009 -2010
Rookie Teacher of the Year

University Teaching Experience

Teaching Assistant 2013- 2018
Instructional Design, Development and Evaluation
Syracuse University, Syracuse, NY

Inclusive Elementary and Special Education Courses

- Integrating Technology into Instruction I, II, and III Course Series Instructor
  - Managed nine course sections and oversaw three teaching assistants during supervising faculty member's research leave
  - Collaborated with team of four teaching assistants and a faculty supervisor, Dr. Jing Lei, to teach a series of required one-credit courses for inclusive elementary and special education majors.
  - Taught over twenty sections in this course series and have consistently received strong teaching evaluations

- IDE 301 Integrating Technology into Instruction II (Junior-level course)
    - Independently taught 14 sections
    - Proposed new blended course design
    - Redesigned face-to-face course as a blended course
    - Co-taught three face-to-face sections with a fellow doctoral student

- IDE 201 Integrating Technology into Instruction I (Sophomore-level course)
    - Co-taught three sections with a fellow doctoral student
    - Developed new lessons that focused on iPads as assistive technology tools

<u>Graduate Education Courses</u>

- IDE 736 Motivation in Learning and Instruction
    - Facilitated discussions and provided feedback in this fully online course

<u>Teaching and Mentoring</u>

- Syracuse University Graduate School Teaching Mentor (TM)
    - Selected to help train the university's approximately 300 new teaching assistants (TA) after completing a competitive application process that included the construction of a teaching portfolio, teaching statement, and interview
    - Developed programming with fellow TMs for the TA orientation
    - Mentored small groups of international and domestic TAs
    - Presented at large group sessions (up to 150 TAs)
    - Co-led workshop for incoming international graduate students to ease transition to Syracuse
    - Video-taped micro-teaching sessions, provided constructive feedback to help new TAs improve their teaching, and facilitated peer feedback

- IDE 712 Analysis of Human Performance Technology (2 sections)
    - Face-to-face flex course that met five Saturdays for eight hour sessions
    - Coordinated and conducted discussion sessions for groups unable to attend weekend session
    - Mentored small groups who needed additional guidance for the three front-end analysis course projects

- EDU 791 Advanced Seminar in Quantitative Research Methods (1 section)
    - Provided SPSS tutoring as needed
    - Advised students on quantitative research designs

- EDU 647 Statistical Thinking and Application (1 section)
    - Transitioned paper based assessment to online learning management system to ease grading load on faculty member in large graduate section

- IDE 656 Computers as Critical Thinking Tools (1 section)
    - Collaborated with Tiffany Koszalka, Ph.D., Professor, IDD&E, and two doctoral student colleagues to develop assessment items with targeted feedback as part of an online test bank for a self-directed online capstone course

- IDE 741 Concepts and Issues in Educational Evaluation (2 sections)

- Co-facilitated a class with a doctoral student colleague, provided feedback on final papers, and tips for crafting conference proposals based on coursework

K-12 Teaching Experience

Elementary Teacher 2009-2013

Koa Elementary

Osceola County School District, Kissimmee, FL

- Taught 4th and 5th grade at a Title 1 school serving a diverse community
- Redesigned 5th grade schedule to facilitate educator content specialization
- Increased the overall passing rate by 100% on Florida standardized science assessment and increased highly proficient rate by 900%
- Awarded $1,500 (in-kind donations) from the Orlando Science Center that funded a school wide on-site field trip which increased community involvement in science education

Professional Experience

Evaluation Consultant 2014 - Present

Office of Professional Research and Development

Syracuse University, Syracuse, NY

- Contributed to evaluations for grants funded by the EPA, DoDEA, and NSF
- Conducted observations, interviews, and literature reviews
- Analyzed data with MAXQDA, Excel, and SPSS
- Developed a field guide, created questionnaires, and observed community meetings to support a 3-year EPA grant funded, environmental program, Reviving Place.

R/E/D Group, LLC

Penfield, NY

- Crafted successful evaluation proposal in response to client RFP
- Worked with Erie Canal National Heritage Corridor to develop an evaluation framework to build capacity at twelve sites for engaging new school districts, planning professional development for staff, and identifying strategies for sustainability
- Co-authored technical reports with literature based considerations for museum education best practices
- Collaborated with literacy specialist to create grade-level specific social studies literature guide for local district's professional development

LPB Consulting, LLC

Penfield, NY

- Conducted site observations for grant-funded informal learning environments in local school districts
- Contributed to annual technical reports and collaborated with evaluation team to analyze data

Instructional Design Intern 2014-2016

Syracuse University Project Advance

Syracuse University, Syracuse, NY

- Managed survey data in Access for a longitudinal study of concurrent enrollment participation through SUPA and its relationship to college retention and graduation

- Analyzed yearly student surveys and reported results
- Automated processes in Access and drafted handbook to guide data management

Assessment Consultant 2015-2016

Division of Student Affairs
Syracuse University, Syracuse, NY

- Collaborated with Assistant Provost for Academic Affairs and assessment team to draft templates for reporting program goals, outcomes, assessment measures, and results
- Contributed to a handbook focusing on assessment in higher education and the Middles States accreditation process at Syracuse University

Instructional Design Consultant 2015-2016

Division of Extended Learning
SUNY Oswego, Oswego, NY

- Assessed online M.B.A. program with the SUNY OSCQR rubric
- Assisted with the faculty's transition from the Angel learning management system to Blackboard by co-facilitating Blackboard workshops
- Created a project management system to estimate time needed for course updates and to track what course revisions were complete
- Migrated select course materials to Blackboard

Service

University

***Member** – International Conference on Education Pre-Conference Planning Committee* 2016-2017

- Contributed to the development of workshop topics
- Secured resources and prepared materials

IDD&E Department Student Representative to Faculty Assembly 2016-2017

- Appointed as the sole IDD&E student representative at monthly School of Education faculty meetings

Member – School of Education (SOE) Strategic Plan Steering Committee 2015-2017

- One of two graduate students in the SOE to serve on this school-wide committee of faculty, staff, and student representatives and only student to serve multiple years on the committee
- Generated SOE students' input via forums and survey, presented findings to SOE faculty and staff, and worked to ensure students' contributions were represented in the strategic planning process
- Contributed to SOE faculty and staff retreat planning and facilitation to promote a collaborative environment and capture ideas for enriching the strategic plan
- Collaborated with the committee to guide SOE toward drafting vision and mission statements, core commitments and a strategic plan
- Spoke to guests at the biannual SOE Board of Visitors meeting about how students were involved in the strategic planning process and how the outputs reflected their participation

Graduate Student Representative for Admitted Student Program 2015- 2016

- Served on a schoolwide panel that shared experiences with incoming School of Education graduate students and answered their questions about Syracuse and graduate student life

IDD&E Department Social Committee Chair 2014-2015

- Coordinated social events for orientation week
- Marketed and managed events for a visiting scholar

IDD&E Brown Bag Chair 2014-2015

- Scheduled brown bag sessions and speakers
- Marketed events to current students and alumni
- Hosted the face to face presentations and managed synchronous virtual participation and recordings

IDD&E Doctoral Student Representative 2013-2014

- Only doctoral student that year to attend faculty meetings and contribute to the department's decision-making processes
- Gathered input from doctoral students and shared this feedback at monthly faculty meetings to increase awareness of students' needs and ideas for the department
- Surveyed students about their intent to enroll in summer courses and reported data to faculty

Professional

Manuscript Reviewer for Peer- Reviewed Journals 2017 - Present

- Teaching and Teacher Education
- Research Issues in Contemporary Education

Consultant – Quantitative Analysis 2015-Present

- Washington Yu Ying Public Charter School, Washington, DC
- Office of Professional Research and Development, Syracuse University
- The R/E/D Group, LLC, Penfield, NY
- Living Classrooms Foundation, Baltimore, MD

Student volunteer at AECT's annual convention 2014 - 2017

- Equipment and volunteer supervisor
- Registration volunteer supervisor
- Job Center volunteer

Public Schools 2009-2013

- Proposed and led STEM focused workshops for Osceola County School District
- Coached the Koa Elementary Science Olympiad team
- Coordinated an after-school STEM program
- Created and managed grade level website
- Teaching American History Grant participant
    - Developed social studies lessons for Osceola County School District
    - Facilitated Document Based Inquiry workshop for Koa Elementary

Professional Memberships

Association for Educational Communications and Technology (AECT) 2013 – Present
Society of International Chinese in Educational Technology (SICET) 2016 – Present
American Educational Research Association (AERA) 2015 – Present

Professional Licensure

NY State Teacher Certification - Childhood Education (Grades 1-6), Professional Certificate