Conceptualization and Application of a Model for Flipped Instruction: A Design Case within Teacher Education

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Abstract

Amidst the significant optimism for blended learning and flipped classrooms, there is a need for a model to guide the systematic design of flipped instruction. An effective flipped model could potentially improve learning outcomes and provide guidelines for designing future blended instruction. This paper presents a model for designing flipped instruction that integrates the First Principles of Instruction and Bloom's Revised Taxonomy. Application of the model is examined through a design case conducted in a technology integration course in a teacher preparation program. This context was selected as the growth of blended learning in K-12 schools has made increasingly evident the gap in preservice teachers' technology integration development related to inadequate preparation for these emerging environments. The model's applicability to flipped design in broader contexts is made clear through the analysis of the underlying principles and lessons learned from the design case. Recommendations for future research include studying the model's influence on specific learning outcomes and applying it to the design of instruction in varying contexts.

Keywords: flipped model development; instructional design; teacher preparation; educational technology

Introduction

In response to the rapid growth of online learning in K-12 education (Watson et al., 2014), the Office of Educational Technology implored institutions of higher education to prepare teachers for online and blended instruction (Office of Educational Technology, 2016). Online and blended learning have clearly contributed to shifts in K-12 education (Molnar et al., 2019), yet their influence is perhaps even more evident in higher education. Blended approaches were predicted to be highly impactful strategies in higher education and their increased prevalence has been well documented (Johnson et al., 2015), yet there has been a gap in robust models for designing blended learning and the empirical evidence to support their impact (Means et al., 2013; O'Flaherty &

Phillips, 2015). Highlighting the importance of higher education's effective implementation of blended approaches, the New Media Consortium concluded that institutions lacking strategies for integrating blended learning may not be sustainable (Adams Becker et al., 2017). The purpose of this paper, then, is to propose a model for designing a blended approach, commonly referred to as flipped instruction, that may be applied by faculty and instructional designers in higher education. To illustrate the model's application, this paper will detail how it guided the design of a flipped course intended to develop preservice teachers' technology integration knowledge and skills (Hall, 2018).

Review of Literature

Blended instruction is the integration of face-to-face and online pedagogical approaches that merge the affordances of technology- and instructor-mediated environments (Hall, 2018; Margulieux et al., 2016). In their Mixed Instructional eXperience (MIX) taxonomy, Margulieux et al. (2016) categorize *flipped* as a type of blended instruction. They acknowledge that while this categorization is common (Christensen et al., 2013), scholars tend to define *blended* by how instruction is delivered while defining *flipped* by instructional location. The creation of the MIX taxonomy, therefore, is intended to clarify three commonly used blended approaches: flipped blend, supplemental blend, and replacement blend. All these approaches mix instructor-transmitted and technology-mediated methods for receiving and interacting with content, but the flipped blend transmits a majority of content online and provides instructor feedback for student application in class (Margulieux et al., 2016).

Flipped, inverted, or flipped blend instruction places the traditionally lectured content online before class and prioritizes active learning activities in an instructor-mediated environment during the face-to-face class time (Margulieux et al., 2016). While flipped classrooms represent a significant factor in the rise of blended learning in higher education, gaps in the pedagogical integrity, empirical support, and instructional design of flipped courses have been noted (Lundin et al., 2018). In their review of flipped courses in higher education, O'Flaherty and Phillips (2015) found that only three of the twenty-eight studies in their analysis discussed how the results related to flipped design principles. They also noted the dearth of studies that investigated robust educational outcomes such as critical thinking and problem solving and documented the need for stronger conceptual frameworks and course design that better integrates the pre- and in-class course components.

Additionally, higher education instructors, when interviewed about their experiences with flipped instruction, expressed the importance of course organization and attention to instructional design (Long et al., 2016). Researchers have responded by proposing and validating an instructional systems model for flipped course design (Lee et al., 2017), but flipped design could yet be informed by a model based on a problem-centered approach (Merrill, 2012). Furthermore, the model proposed by Lee et al. (2017) assumes there is a team of instructional designers, teacher, teaching assistants, and technology staff working together to design the course and develop the materials. It also assumes the course being designed with the model is a 10 to 15-week course. As this model does not make these assumptions, it may present a leaner and possibly more flexible approach to flipped course design.

To further address this design gap, this paper will present a model for flipped instruction through a design case in the context of teacher preparation. Boling defines a design case as "a description of a real artifact or experience that has been intentionally designed" (2010, p. 2). In this manner, design cases are used as precedent for future designs. This precedent, while concrete and situated within the context of the design case, is fluid in that the knowledge contained in the precedent may vary in its application and usefulness both to the original designer and the reader of the design case. This design case, therefore, intends to explore and describe the conceptualization and application of a model for flipped instruction that is based on the First Principles of Instruction (FPI) and Bloom's Revised Taxonomy (Krathwohl, 2002; Merrill, 2002). From the examination of the intentional design process with this model, this design case will conclude with recommendations for future application of this model by instructors and designers in higher education and potential directions for empirical research.

To begin, we will discuss theories that have informed the flipped approach and its assumptions for teaching and learning. Next, we will describe the context for this case and detail a rationale for implementing this model for flipped instruction within teacher education. While the use of the FPI and Bloom's Revised Taxonomy to design a course in this context may alone have resulted in effective instruction for preservice teachers, a flipped approach held potential for modeling blended instruction and increased time for learning by design. These opportunities will be discussed further below. We will then introduce the model's theoretical foundations, detail its development, and examine its application within the design case. Lastly, we will offer recommendations based on our experiences with this model for those interested in designing flipped courses and propose ideas for utilizing this model in future empirical studies.

Foundations of Flipped Instruction

The flipped approach has been defined as a model of instruction that presents self-paced instruction to the learner online before the face-to-face class meeting. This online instruction replaces the traditional lecture, and face-to-face class time is spent applying the concepts collaboratively in an active learning environment (Flipped Learning Network, 2014). 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 often viewed as a tenet of a flipped approach, active learning is arguably not unique to a flipped approach (Schank et al., 1999).

Carr-Chellman posits that flipped approaches are not new at all, but rather are based on pedagogies espoused by Dewey, Montessori, and Socrates (2016). 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 the active nature of a child and an inclination to learn. The Montessori method also prioritizes the learner's autonomy and impulses to learn. Documentation of a 19th century general who sent materials home to students and utilized class time for collaboration and problem solving is resounding evidence that tenets of flipped instruction have long been practiced (Gross et al., 2015). Still others (Chen et al., 2014) point to many additional theories that inform flipped approaches (i.e. transactional distance theory, cognitive load theory, and self-determination theory). With these in mind, the model for flipped instruction presented through this design case is not assumed to be a novel approach to instruction but rather is meant to detail a means for designing effective flipped instruction based on what has been known for some time (Merrill, 2012).

Situating Flipped Instruction in the Context of Teacher Education

Lack of teaching experience and technology integration practice for preservice teachers is a challenging barrier to technology integration knowledge and skill development, and it continues to reduce the effectiveness of teacher preparation programs (K. S. Lee, 2014; Whitacre & Peña, 2011). Modeling technology integration and effective pedagogies have also been shown to be a critical factor in the learning outcomes for preservice teachers (Bakir, 2016; West & Graham, 2007). However, logistical hurdles and lack of mentor modeling in field placements persist as barriers to preservice teachers technology integration (Nelson, 2017). Preservice teachers also may integrate technology most effectively in teaching models familiar to them but display comparatively low levels of technological pedagogical knowledge in unfamiliar teaching models (K. S. Lee, 2014).

One proposed method for preparing preservice teachers to plan effective technology-integrated lessons is to model technology integration through the flipped classroom approach (Hao & Lee, 2016; Vaughan, 2014). While the flipped approach cannot address all the barriers traditionally experienced by preservice teachers, having preservice teachers experience additional teaching models, such as flipped instruction, allows for them to build mental models for future pedagogical development (Hao & Lee, 2016). Furthermore, authentic learning experiences with technology, such as learning by design, may promote preservice teachers' technology integration development (Banas & York, 2014; Johnson, 2012). Since the flipped approach moves information delivery to the online space, more time can be allocated for these hands-on design activities.

A flipped classroom may provide more face-to-face class time for in depth authentic learning experiences and could be an effective way to model technology integration practices for preservice teachers. While these components are not unique nor requisite to the flipped approach, it may support them via its reallocation of time, space, and learning activities to promote active learning environments in class and information delivery prior to class, often through the affordances of emerging technologies (Lage et al., 2000). This restructuring may enhance authentic learning experiences by allocating more class time to these activities, and the modeling of technology integration can now occur in face-to-face and online spaces (Vaughan, 2014).

Although modeling technology integration has been used in face-to-face teacher preparation (Brenner & Brill, 2016; 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 (Archambault & Kennedy, 2014), but this modeling may not be adequate for the changing landscape of K-12 education. 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).

In a flipped classroom, time that is typically devoted to lecture can be allocated to authentic learning experiences (Baepler et al., 2014). Students can prepare for the authentic exercises prior to coming to class in a way that is measurable (Li et al., 2015). The preparation and activities done prior to class occur online in the design case outlined in this article and in the remaining sections will be referred to as “pre-class” activities. Once arriving to 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 case 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; C.-J. Lee & Kim, 2014). It is not 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.

This paper aims to explain a model for flipped instruction and explore its application within a course for preservice teachers. The course’s learning outcomes emphasized pre-service teachers’ development of technology integration knowledge and skills. It was believed that the flipped approach, based on the aforementioned affordances, presented a valid instructional method. The course participants, however, were not expected to apply the model themselves nor design a flipped lesson. Through the ensuing discussion of this model, the course will be presented as context for illustrating the model’s application and the lessons learned from the design iteration. We will first discuss the FPI, Bloom’s Revised Taxonomy, and their role in the flipped model of instruction (Krathwohl, 2002; Merrill, 2002). Next, we will present how these guided the design of the flipped course in this case and further discuss the rationale for this design. Finally, we offer suggestions for practice with the flipped model and recommendations for future research.

Framework for Course Design: A Flipped Model

Within this inversion of class time and space, the FPI (Merrill, 2002) guided the flipped design of this technology integration course for pre-service teachers. The founding premise of the FPI 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" (p. 43). Briefly stated, the five FPI 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.

Founding the course on these principles aligns with scholars' observations that the effectiveness of a flipped classroom relates directly to the pedagogical strategies used (Bull et al., 2012). There are many ways to design a flipped classroom, just as there are innumerable ways to structure online and face-to-face courses (Waldrop & Bowdon, 2015). Merrill's (2012) principles provide a well-grounded model, and their focus on problem-centered instruction aligned with the primary learning outcomes of the course being discussed. The FPI have been widely accepted by the field and have been identified 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 (Gardner & Belland, 2012; Nelson, 2015).

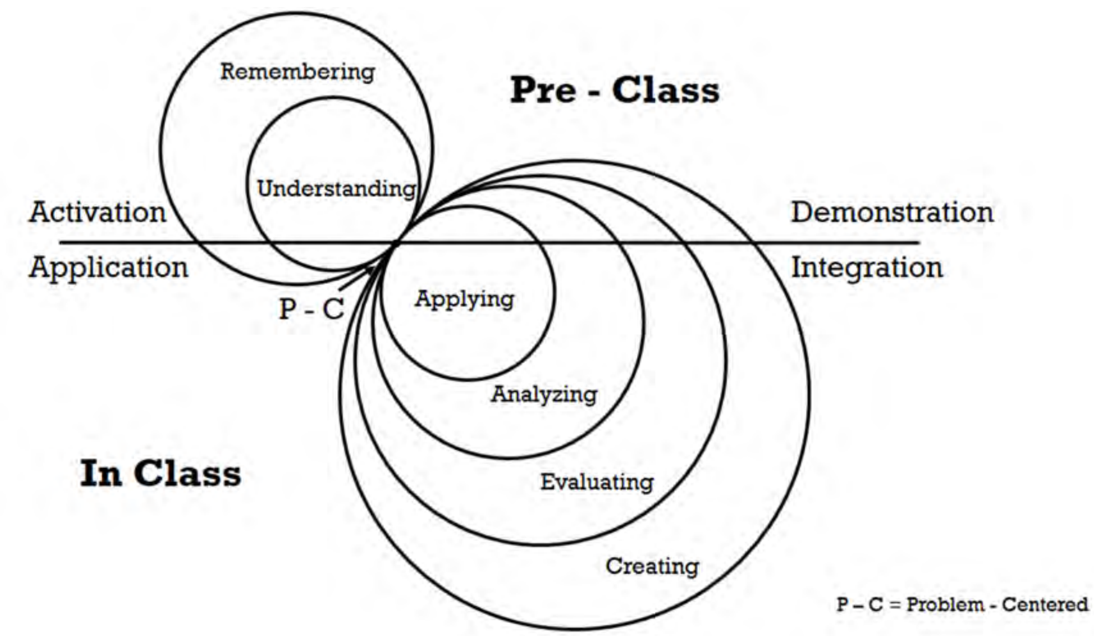
Bloom's Revised Taxonomy was another critical dimension of the design of this course. This framework helps to provide a common language for statements of what students are intended to learn (Krathwohl, 2002). A key component in this design case was determining how and when each learning outcome would be targeted in phases of instruction, and the revised taxonomy framed this decision process. The content sequencing and delivery decisions were based on Bloom's Revised Taxonomy's cognitive learning domain. This approach has often been used and is argued as the hallmark of the flipped model (Little, 2015; Touchton, 2015). 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. These outcomes were then situated in the problem-centered strategy and addressed by the FPI (Merrill, 2012).

Figure 1 (below) demonstrates how Bloom's Taxonomy and the FPI informed the design of this flipped course. First note the circles embedded within one another. The increasing size connotes the increased emphasis each level of the taxonomy was given during the pre- and in-class portions of the course. Most instruction designed for pre-class activities is focused on the lowest level of the taxonomy, while instruction for in-class learning targeted 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 Understanding and Remembering circles are mostly above this line, and Applying, Analyzing, Evaluating, and Creating are mostly below, parts of all circles cross the line. This represents that while designing a flipped course using this model, 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 et al., 2012).

Figure 1

Flipped Model Based on Bloom's Revised Taxonomy and First Principles of Instruction



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. However, the premature ending of the horizontal line is intended to communicate the potential fluidity of dividing these phases into 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. Basing a flipped approach on the FPI means that the instruction should situate learning within authentic problems (Merrill, 2002). Showing the whole problem to the learners provides the context for learning and can be motivational (Keller, 1987). Merrill (2012) argues that learning outcomes devoid of context may not be comprehensible to learners. A problem progression also helps relate learning outcomes to one another. The learning outcomes define the learning that occurs within each component of the problem, and each component subsequently scaffolds learners toward mastery of the whole problem. The following sections will describe in more detail the course design decisions in the context of teacher preparation.

Applying the Model: A Design Case

The context for this design case was a one-credit integrating technology into instruction course in a teacher preparation program in a School of Education at a Northeastern University. The course met six times over the course of a semester as the students spent approximately half of the semester completing their field placements in local elementary classrooms. 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. Students had 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 university's web-based learning management system.

Problem-Centered

In this case, 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" (2002, p. 45). As indicated in the model, a significant portion of class time was dedicated to the Creating level of thinking per Bloom's Revised Taxonomy (Krathwohl, 2002). 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 traditional 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 component of the whole problem.

In each module, the students were taught a component of the lesson planning process. For example, in the standards phase, the students analyzed the International Society for Technology in Education (ISTE) standards for students and compared them with standards for a selected content area. They looked for areas of synergy, and had 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 designed an assessment to 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 students applied more component skills. The increased complexity of subsequent problems and 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 component skill was assessment, the students planned an assessment during this module and each subsequent one. Module two's component skill, writing learning objectives, was provided to students in module one, but required of students in module two and remaining modules. In this way, students could develop mastery of isolated component skills as they navigated toward the final module when they completed the whole problem and all its component skills. This was still a scaffold for their final project, when they were expected to plan an entire technology-integrated lesson plan for implementation in their field placement.

Activation

During the pre-class activities in this design case, structural frameworks were presented and discussion of student experiences with the content were 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. The following examples were selected to display how the activation principle was considered in this design case.

To begin, a mnemonic is a form of a structural framework that is shown to aid learners in remembering procedures and components (Merrill, 2012). In this case, Mager's Audience, Behavior, Condition, and Degree (ABCD) mnemonic for writing learning objectives provided structure for students during a module focused on writing learning objectives (1997). Many students had prior experience with learning objectives but had not utilized Mager's mnemonic. The focus of this activity prior to class was to connect these components of writing an objective with prior experiences and to have knowledge of this specific structure when arriving to class.

Having peers share about previous related experiences is another way to activate prior knowledge (Merrill, 2012). The Universal Design for Learning (UDL) activity facilitated virtual peer sharing about students' prior knowledge and experiences. It challenged them to think about the role of technology in designing instruction based on UDL principles. As inclusive education majors, students in this course customarily have prior knowledge of UDL. Using Google Slides, the instructor created a shared presentation that served as a virtual, multimodal gallery walk of pre-service teachers' prior knowledge of UDL. To organize the virtual UDL gallery, each slide was assigned a letter of the alphabet, and the slides were arranged alphabetically. Students were asked to incorporate the letter that had been assigned to their slide. For example, the student with the *R* slide may have demonstrated their prior UDL knowledge of multiple means of "Representation". Thus, students displayed what they knew about UDL by creating a poster slide for their letter of choice and observing peers' slides. Optional resources were available in the learning management system for students 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' work. Elaborating on this phase's activation of prior knowledge, the demonstration phase ensued to provide clear portrayals of new information.

Demonstration

Although demonstration occurred throughout the pre- and in-class portions of the design case being described, it constituted the bulk of the pre-class activities. Relevant media and multiple representations of the content provided various portrayals of the information for the learners. Multimedia for the pre- and in-class activities were evaluated for their relevance, to diminish the distraction of competing modalities, and to align with the learning goals (Mayer et al., 2001; Mayer & Morena, 2003).

The demonstration consistency corollary posits that there should be alignment between the type of demonstration and the intended learning (Merrill, 2002). In this design case, there were varying types of demonstration incorporated that were intended to match the specific learning outcomes as framed by Bloom's Revised Taxonomy (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 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 inadequately written objectives. This type of demonstration was consistent with the goal of remembering and understanding concepts prior to class. Modeling was used in both pre- and in-class activities to prepare students for planning their technology-integrated lessons.

Modeling was 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 were subsequently elicited during class. Students were assigned to write their own learning objectives (Applying), break down scenarios and standards during the planning process (Analyzing), justify decisions made during the lesson design (Evaluating), and develop activities and assessments consistent with the learning objectives (Creating). Discussed next are times when modeling was used to demonstrate the desired behavior.

After working through the module's foundational concepts before class, it was anticipated that students 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 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 class, preservice teachers applied their knowledge of each component skill needed to effectively plan a technology-integrated lesson. Referred to as the "let-me" phase of instruction, it encourages the practice of a new skill or application of knowledge (Merrill, 2002). As such, this phase can incorporate practice for a learning outcome at any level of Bloom's Revised Taxonomy. 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, most of the application occurring in class targeted the Applying and Creating levels of the taxonomy.

After a modeled lesson, students created digital artifacts and lesson plans to apply their technological, pedagogical, and content knowledge (TPACK; Koehler & Mishra, 2009). Applying this knowledge to increasingly complex tasks also evidenced 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 course design as critical elements for 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 groups during the design of their lessons and gradually removed as the semester progressed. The instructor offered suggestions for a lesson component or think aloud about how a piece could be designed.

Similar to the consistency corollary for demonstration, the application phase should be consistent with the intended skill (Merrill, 2012). An example of a how-to application activity in this case was when students designed a lesson and incorporated a multimodal presentation. The goal of this activity was two-fold. First, preservice teachers would design a technology-integrated lesson that met the assigned content standard. 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. Secondly, they would create a presentation utilizing multiple modalities to support student learning.

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 (Kimmons et al., 2015). 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 design case. In class, students were challenged to reflect, discuss, defend, explore, and create. Students also kept a reflection journal 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 Bloom's Revised Taxonomy 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 decision, and by using the feedback to improve their lesson.

An example of how the reflection corollary was applied in this case was how students individually reflected after each module on what they had learned about designing the technology-integrated lesson plan. Reflection prompts were provided to facilitate students' thinking about critical aspects of the design process. Prompts asked about what instructional strategies and tools were used to support learning 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.

All these principles functioned to develop preservice teachers' TPACK and their mastery of component skills. The whole problem, a technology-integrated lesson to be implemented during their field placement, was then completed, reflected upon, and shared with the class. During the design, development, and implementation of these phases of instruction in a flipped course, lessons were learned that will shape future course iterations and may benefit others considering similar course designs.

Methodology

Research Setting

Participants in this study were preservice teachers completing a required technology integration course as part of their teacher preparation program. Per the IRB protocol, preservice teachers in the two course sections offered to inclusive elementary and early childhood majors were informed of the study and recruited at the end of the course by a researcher who was not the course instructor. Of the 24 preservice teachers enrolled in the two course sections during the 2016 Spring semester, all agreed to participate.

The course was the second in a series of three one-credit courses that were created at a Northeastern University to develop preservice teachers' technological, pedagogical, content knowledge. The course series must be taken in sequence, and all sections met in a lab containing seventeen Mac computers along two rows with an interactive whiteboard at both ends of the room. An iPad and PC cart were available for check out when needed. Each course met six times for two hours and fifteen minutes. Typically, students complete the first course during their first year, the third course during their senior year, and the middle course is completed sometime in between.

The course in which this design case is situated was the second course in the series. As a cohort, students concurrently completed courses on math methods, social studies methods, inclusive teaching, and creative movement. Additionally, 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.

Data Collection

The primary source of data was prompted reflections written by students throughout the 2016 Spring semester, although the instructor's memos from implementing the course in the previous semester are referenced as background for issues this design iteration sought to address. Students' reflections intended to document their learning and course experiences and were incorporated into the course design. 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). Students wrote five total reflections. Four reflections responded to prompts about course activities, and a final reflection was written about their lesson design, implementation, and experience in the field. The researcher as instructor also documented field notes in a journal after the class meetings.

Data Analysis

All reflections were first imported into MAXQDA as this computer assisted qualitative data analysis software was used to organize, manage, code, and categorize the data. Following a grounded theory approach, the constant comparative method was used to analyze themes as they emerged from the data (Glaser, 1965; Kolb, 2012). Memos were written throughout the process to define codes (Saldana, 2009), elaborate on themes (Jang, 2019), highlight relationships, and minimize researcher bias in the analysis. Codes were first checked by a second researcher, then organized into categories, analyzed alongside the memos, and presented with illustrative cases as themes.

Findings and Discussion

While the design model offered a guide to our process, the implementation did not go entirely as planned. Several valuable lessons were drawn from each iteration of this design. The first issue faced when designing this flipped course with the FPI was segmenting the whole problem into component skills in a logical and instructionally effective way. A second challenge presented itself in prior iterations of the course, because students were not clear how all aspects of the pre- and in-class activities fit together. These issues were accounted for in this design iteration and recommendations are discussed in the following paragraphs.

Segmenting the Whole Problem

During prior iterations of this course, the component skills appeared too complex, and we realized they still contained multiple component skills. Student reflections illustrated the need to segment the whole problem, "In the beginning of the class, we were not ready to create lesson objectives and to plan full activities for the class. However, now that we have learned more about these topics…we can begin to take more of these responsibilities" (P11). For example, one module had students learning to write objectives and design a corresponding assessment. This task was really two component skills that were being required of students simultaneously. This appeared to overwhelm students and did not provide as much depth or time to develop mastery.

Based on the problem progression corollary from the FPI (Merrill, 2002), the aforementioned component skills in the current design iteration were separated and each given more attention. Further, the problem was segmented into five distinct component skills, and each given their own module. Students commented on the benefits of this strategy in their reflections:

> By practicing the technology integrated lesson plans I feel like I am growing in my abilities. We've built on each week and the practice is helping me to become more confiden[t] in lesson planning. The difference from the first week of class to the third week of class is noticeable to me already. (P5)

This participant noted the importance of practicing the planning process and the increased sense of confidence that came from "building on". Many participants used the term "scaffolding" to describe the process they were experiencing and discussed how this type of scaffolding could be applied in their own teaching practice:

> We are being scaffolded and so each week, I feel more comfortable with the sections I have done in the past, so I am able to take more onto my plate. This really prepares me for when

> I have to do my lessons by myself in the field. It is nice to know that I have done it a few times in our class and I know I am able to do it. (P3)

The comfort this student felt from mastering previous skills is noted as enabling them to address more parts of the whole problem. P3 recognizes this as beneficial for succeeding both in class and when this authentic problem is presented in their field placements. Segmenting promoted confidence by allowing students to focus on achieving mastery of distinct skills, practice skills multiple times, and link subtasks together as their comfort increased. Determining the order for these subtasks and skill progression was yet another important design decision.

Sequencing Component Skills

Sequencing the component skills was another critical lesson learned. The current problem-centered course with the flipped model differed from the course's formerly topic-centered design. While course topics were supportive of the component skills, they were not actually the component skills. We had to rethink the sequencing of our course, and this became a messy process due to its rippling effect. Moving a component skill to a different place in the course meant the worked examples had to be revised, because each worked example needed to include component skills that had not been mastered. Since our students were part of a cohort, another factor we had to consider was what students were learning in concurrent courses that would support the skill development in this course.

Finally, an unanticipated but equally important sequencing consideration based on the problem progression corollary was that the first component skill introduced to the learners received the most practice. Since all 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. In the third reflection, P6 described how he experienced the additional practice:

> This process allows us to work on different aspects of technology-based instruction while reinforcing the ideas already learned. It gives us practice and the ability to improve our work on areas that we may have deficits in. I personally have been able to work with and improve on my assessment strategies and tools. (P6)

One may consider having students first learn the most difficult skills and thereby practice these skills the most, but this decision has students learning the most difficult component skills at the beginning of the semester when they may be least prepared. Determining the best sequence for the problem progression must account for learners' prior knowledge and opportunities for varying interactions with the subtasks.

For selecting the sequence of our first component skill, we based the decision on degree of importance for our learners and opportunity for variation. Discussion with other teacher education faculty revealed that our students needed to practice the skill of assessing student learning with digital tools. Students' reflections supported the efficacy of this decision:

> I have never been responsible for typing and making a rubric or creating digital assessments…I particularly liked how we used Google Forms for an assessment because I had only ever used it for surveys, so it was intriguing to see it being used in this new light…But beyond the tools themselves is the practice. I get to see how they work, if I like them, and how I need to improve on my abilities in the future. In that sense it is very helpful and beneficial for my future classroom and myself. (P6)

As indicated by mention of rubrics and Google Forms, there were many variations of technology tools for assessment integrated and extended throughout the semester. Yet it was more than tools that were introduced, as P6 noted, but skills and strategies were developed as well. Strategically segmenting the problem progression corollary can provide more opportunities for students to engage and practice specific subskills as they build fluency with the whole problem. As we move forward with implementing this problem-centered model, we plan to continue improving the variations of problems experienced throughout the sequence as a means of improving the overall effectiveness (Merrill, 2012).

Framing Instruction with the Whole Problem

Contextualizing each component skill and topic in the larger problem was essential as well. In the first iteration, 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 problem. 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 current design 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 were not provided. 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. (P2)

> I believe that once we understand the basics of the lesson, we are able to take everything a step forward to make it more complex. We are then able to build from the knowledge that we learned in our previous lessons and use it to our advantage and think of ways that we can help all the students. (P20)

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 we acknowledge the benefit of showing the learners the problem early and often, the implementation of this corollary in a flipped approach was more challenging than anticipated. In this 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 decide 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. While responding to the problem in the face-to-face class engaged learners in higher order thinking, displaying the problem online may have helped frame the lower-order learning objectives and shown learners where they were heading.

Implications for Design

Situating Flipped Design within an Authentic Problem

Creating authentic problems as models and varied examples for students to solve is an essential component of the problem-centered principle (Merrill, 2012). In this design case, the overarching problem was the design, development, and implementation of a technology-integrated lesson. The challenge faced during the course design then was to chunk this larger problem into component skills, sequence the skills in an effective way, and plan the phases of instruction to develop mastery.

Designers of flipped courses should consider the benefits of situating instruction in a problem and showing learners varying examples of the problem throughout the course. Researchers have noted the potential disconnect that may occur between assessments and course activities in flipped courses (Bristol, 2014). They have also pointed out the potential disconnect learners may sense in traditional pedagogical models that do not incorporate students' preferred learning methods, technology, or relate the learning outcomes to students' lives (Vaughan, 2014). Displaying relevant variations of a problem early and often has potential to increase learner motivation (Keller, 1987). The problem can help learners see the relevance of instruction. Multiple interactions with the problem throughout the semester with opportunities for revision can increase their confidence (Merrill, 2012). Finally, a flipped design framed by a problem-centered progression may afford increased face-to-face, timely feedback that is informative, helpful, and motivating (Keller, 1987a). This in turn can increase the learners' satisfaction from the course learning experiences. Therefore, repetition and variations of the problems should be characteristic of flipped course design.

Strategically Sequencing Learning Experiences

When integrating a problem-centered strategy, it is essential to intentionally segment and sequence the component skills. This helps learners build competency as they are expected to undertake more of the whole problem. It also provides more opportunities for feedback than a traditional topic-centered structure, and the feedback can be targeted to the specific skill being learned (Merrill, 2012). Participants consistently related how the segmenting and sequencing in this design helped them, such as in the following statement, "Each section was easier to understand and fully learn because we did not have a bunch of new information getting taught to us at once" (P24). Further, in strategically selecting the sequence of skills to be learned, the instructor can demonstrate significant relationships among the skills. These relationships can be further highlighted by displaying the whole problem regularly throughout the course. Designers of flipped courses should also consider whether to introduce the problem online or in the face-to-face class.

Transitioning between Online and Face-to-Face Spaces

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 et al., 2008). Emphasizing the whole problem as a vehicle for higher order thinking contributed to the design decision to introduce the problem in the face-to-face class. As the whole problem was told or shown to learners in class, therefore, they were simultaneously introduced to what they would do (Merrill, 2012). This singular perspective of the problem 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 higher order thinking and may situate 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.

Traditionally, our students have had several questions about the problem during its introduction. In our course experiences, these questions have been more effectively handled in a face-to-face setting where we could promptly address problems and clarify misconceptions for the whole group. Many of these student inquiries, however, were about requirements for responding to the problem and not the components of the problem. Therefore, presenting the problem online before the face-to-face meeting as an anchor for instruction, independent of assignment requirements, may contribute to learning while inducing less confusion and anxiety.

As we have developed new problems and made significant adaptations to the older problems, it seems many of the problems are still being piloted. We wanted to observe learners' initial reactions to the problems and address any confusion before expecting the items to hold up independently as a framework for pre-class activities. This, however, may have illuminated another limitation of our online design. Providing multiple venues for student questions and feedback has been noted as an important online design component (Welker & Berardino, 2012), yet there were limited avenues for student questions and feedback. Designers of flipped courses should consider multiple means, both in face-to-face and online spaces, for expressing questions and concerns (CAST, 2018).

While this model for flipped instruction does not directly address this limitation, it may be considered as an underlying component of connecting the pre- and in-class instruction. To address this limitation, we have begun integrating a community question and answer page on a class Google Doc. We have also incorporated online discussion boards and periodic surveys to facilitate student questions and feedback. Designers of flipped courses typically discuss how the approach facilitates interaction, peer support, and instructor coaching in the face-to-face environment (DeLozier & Rhodes, 2017), but an additional discussion of how to leverage online tools for pre-class support may be needed as well.

Implications for Research

As this model is intended for flipped 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 et al., 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 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.

Conclusion

Flipping the classroom is one proposed approach for maximizing technology's affordances in education (Hall, 2018). Grounding this approach in widely validated principles further augments its potential for impacting learning. There is a need to develop design models for flipped instruction that clearly link pre- and in-class activities (O'Flaherty & Phillips, 2015). This article has presented a design case that integrated the FPI and Bloom's Revised Taxonomy within a flipped approach. We have detailed how the model was implemented in a technology integration course in teacher preparation and have laid out the process for applying the model. The process revealed areas of strength and lessons learned for improvements in successive iterations. Segmenting and sequencing the component tasks, and framing instruction with the whole problem were potentially valuable lessons for designing with this model in other contexts as well.

This design case is limited by its focus on a single context and implementation process. Future studies may contribute by examining the efficacy of this model and exploring the implementation process in other contexts. While this case applied the model to a pre-existing one-credit course, the process is likely to be considerably different when applying the model to a new course or a course bearing additional credits.

This model is not an answer for flipped design, but it may serve to further the discussion of how to structure a course, its learning outcomes, and instructional activities. While flipped approaches have had mixed results (Heyborne & Perrett, 2016; Naccarato & Karakok, 2015), it is anticipated that the use of this model will lead to more consistent positive outcomes due to its strong instructional design foundations (Krathwohl, 2002; Merrill, 2012).

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