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A Problem-Centered Approach to Designing Blended Courses: Unifying Online and Face-to-Face Modalities

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Abstract: After experimenting with emergency remote teaching during the COVID-19 pandemic, K-12 schools have retained select online instruction by incorporating blended teaching models. In response, teacher education must respond in innovative ways to prepare future educators with blended teaching competencies. This article presents a problem-centered model for designing flipped courses and discusses how this can demonstrate blended teaching practices that pre-service teachers can observe and experience. Applying a descriptive phenomenological research design, the author iteratively prompted 12 pre-service teachers to reflect on their experiences in a flipped, technology integration course, designed according to this problem-centered model. The results indicate that pre-service teachers experienced the online space as a place to experiment with novel technologies; the in-person class as time for practicing challenging skills and reflecting on future possibilities; and the problem-centered nature of the course as a unifying element and scaffold for their learning.

Keywords: teacher preparation; flipped model; first principles of instruction; descriptive phenomenology

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1. Introduction

Widespread attempts to facilitate instruction during the COVID-19 pandemic prompted many innovations (e.g., digital escape rooms, virtual field experiences, mixed reality lessons) and led some to attempt online and blended approaches for the first time [1,2]. Yet, Blended Teaching (BT)—the integration of online and face-to-face modalities where learners have some control over the time, place, path, and/or pace of their learning —was predicted to significantly impact education years ago [3,4]. While the pandemic may have hastened the adoption of BT in some form, scholars have now predicted that future BT will more closely resemble pre-pandemic implementations than the emergency BT adoption observed during the COVID-19 pandemic [5]. Therefore, investigating pre-pandemic BT may offer valuable insights on how to address barriers, and as enablers to pre-service teachers' (PSTs) adoption of blended practices. Since scholars anticipate BT will persist, increase, and evolve, in the U.S. K-12 education system, it is essential to consider how to prepare PSTs for BT [5,6]. Modeling effective BT and blended course design in teacher education programs may be one method for effectuating this preparation [7,8].

Amidst the increased presence of BT, the call to prepare future teachers for blended environments has been longstanding [9,10]. In response, blended learning experts have published open educational resources as textbooks and have offered massive open online courses to support teacher development for BT in K-12 contexts [11,12]. Recognizing that BT necessitates distinct knowledge and skills, Archibald et al. created the Blended Teaching Readiness Instrument to help teachers, PSTs, and teacher preparation programs, analyze gaps in BT competencies [13]. While this instrument can help teacher education programs more strategically identify where to focus instructional resources in the future, some programs have already added courses to develop PSTs' blended and online pedagogies [13,14]. However, these resources and courses do not ensure that PSTs experience effective blended course design, or critically observe the intentional modeling of BT practices.

Several scholars have noted the importance of implementing BT in higher education as a model for what PSTs will need to be able to do when entering the K-12 classroom [15–17]. Hao and Lee noted that experiencing BT models encourages PSTs' construction of mental models as foundations for pedagogical growth [18]. Furthermore, experiencing BT may raise awareness of new teaching models, promote the adoption of blended pedagogies, and facilitate the connection of theory to practice [15,17]. Hayward et al.'s live modeling of BT support this premise that modeling BT with PSTs can support student learning within the course and serve as an exemplar for future teaching practice [8]. Drawing from experiential learning theory, Shand and Farrelly wrote that: "pre-service teachers need to engage in a blended learning course to understand first-hand the benefits and challenges of such an instructional design" [16] (p. 2). Learning from PSTs experiences with BT in this study can thus contribute unique knowledge to the field's understanding of blended course design. Specifically, knowing the benefits and struggles students encountered with BT can inform future blending of online and face-to-face modalities [16].

Given this need for PSTs to experience BT and observe strong modeling of BT practices and the unique understanding of blended course, which may come from an investigation of PSTs' experiences with BT, this study sought to examine the following research questions: What were pre-service teachers' experiences like in a blended technology integration course designed with the First Principles of Instruction? What elements of the problem-centered, blended course design did PSTs relate to their learning? These questions were investigated through the design of a problem-centered, blended course, which focused on preparing PSTs to integrate technology in elementary school settings. Through a descriptive phenomenological research design, the researcher generated data through iterative reflection prompts, which were analyzed to distill the essence of PSTs' learning experiences in this course design.

In the first part of this article, previous research on BT in teacher education will be explored. Next, the conceptual foundations for this study's blended model will be discussed and the application of the model to the design of the course in this study will be detailed. Following the background section, the study design will be outlined, and the results will be presented, analyzed, and discussed, alongside relevant literature. The article will conclude with implications for design research, problem-centered BT, and PSTs' technology integration development.

1.1. Blended Courses in Teacher Education

Initial applications of BT in teacher education programs have reported a variety of outcomes. Multiple studies have reported students' appreciation for the increased flexibility which BT often affords, with association of BT with higher positive emotions (i.e., "fun" and "enthusiasm"), lower indications of boredom, and increased perceptions of and confidence with BT [6,15,19,20]. Cihad's quasi-experimental study of a blended learning model in teacher education found that PSTs in the blended group demonstrated statistically significant growth in their twenty-first skills as compared to the control group [21]. However, empirical research has also evidenced cases where PSTs in blended and in-person courses performed similarly on course learning outcomes, and studies in which PSTs in the BT condition outperformed their traditional counterparts [7,20,22].

The mixture of findings across studies of blended courses may be due to the wide range of BT implemented by the faculty as college students have reported that their experiences with BT differed from professor to professor [17]. Graduate students in a BT program also expressed the need for a more cogent relationship between online and in-person components, stronger connections of theory to practice, and explicit modeling of how to apply BT in K-12 settings [17]. Corresponding with these students' perspectives, Nortvig et al.'s literature review detailed how the learning context, student identity, course design, and the instructor's role, can all influence BT outcomes [6]. Finally, research with PSTs has highlighted the critical role that students' motivation and self-regulation play in students' outcomes and experiences within online settings [23]. Therefore, many factors should be considered when designing, implementing, and evaluating BT.

In summary, the potential for improved course outcomes is one justification for incorporating BT in teacher education, but others have argued that incorporated BT in teacher education may be equally important as a model for what PSTs will need to be able to do when entering the K-12 classroom [15–17]. The call to prepare future teachers for blended environments has been longstanding, and the number of blended classrooms continued to increase even prior to the COVID-19 pandemic [9,10]. Although some teacher education programs have added courses to specifically address blended and online pedagogies, this coursework does not ensure that PSTs experience BT. Given the potential benefits of PSTs experiencing BT, observing strong modelling of BT practices, and the critical role that course design plays in the influence of BT on course outcomes, this descriptive phenomenological study examines PSTs experiences in a blended course design, which was based upon a widely applied instructional design model [24,25].

1.2. First Principles of Instruction's Problem-Centered Model

One systematic approach for designing blended courses is a problem-centered instructional design model known as the First Principles of Instruction (FPI) [24,25]. Although Merrill acknowledges the wide range of definitions for problem, he posits the underlying essence of problem-centered instruction is that learners engage a whole task, rather than isolated skills and knowledge, and the task is characteristic of what learners may expect beyond the course [24]. Therefore, situating the online and face-to-face instruction within complex problem can provide learners with multiple demonstrations of the underlying skills and knowledge required for solving the problem, and varied opportunities for practice, feedback, and revision [26]. It is thus proposed that problem-centered instruction's holistic, interconnected, and iterative nature, can help learners clearly observe the connection of the face-to-face and online modalities, and the associated instruction.

Several researchers have documented significant learning gains for students enrolled in flipped courses that were designed with the FPI [26–28]. These studies, however, focused on student achievement or teachers' perceptions of designing flipped classrooms, and not on how students engaged in the FPI within their blended course experience. When discussing the FPI's potential for designing blended courses, Cheung and Hew underscore that the principles do not: "provide any actual guidance or instructional designers to decide if the instructional activities should be face-to-face sessions or e-learning activities" [29] (p. 134). Therefore, the application of FPI to blended course design varies greatly. For example, Cheung and Hew engaged learners in all FPI phases—activation, demonstration, application, and integration—in both the face-to-face and online settings [29]. Conversely, Lo et al. engaged learners only in the activation, demonstration, and application phases while online, but then involved learners in all phases during the face-to-face meetings [26]. Given the dynamic nature of BT, the complexity of problem-centered instruction, and the varying ways designers can apply the FPI, it is essential to explicate how the FPI are applied within a specific BT context.

1.3. A First Principles Approach to Blended Teaching

Figure 1 illustrates the problem-centered model for a flipped approach to BT [25]. Problem-centered is designate by the P-C in the center of the figure, and highlights the focus of the pre-class, in-class, online, and face-to-face instruction. The overarching problem is segmented into component tasks, which inform learning outcomes in the online and face-to-face spaces. As learners practice component tasks within the larger problem, they should develop greater proficiency, which should build toward eventual success with the entire problem.

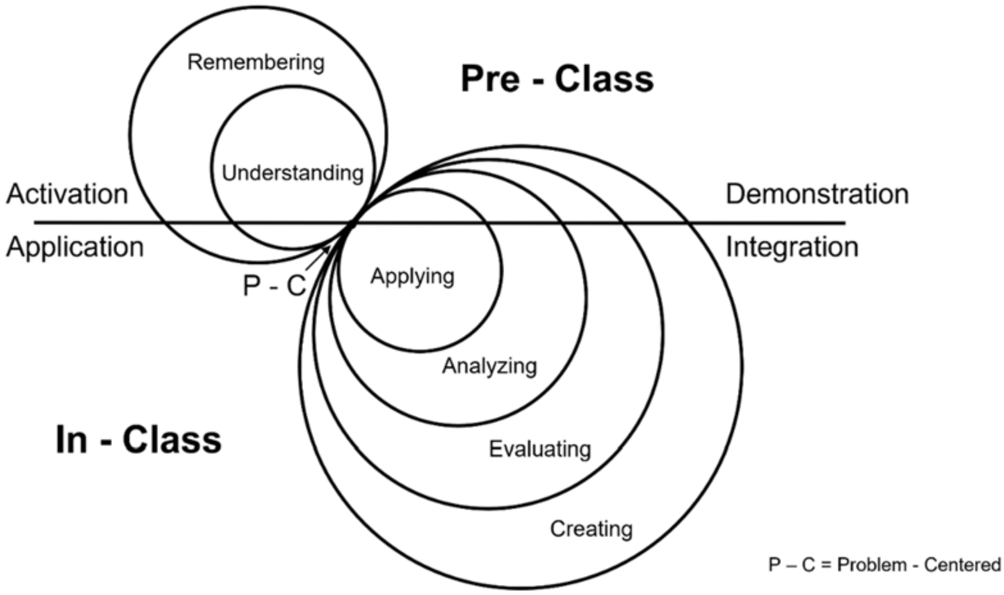

Figure 1. Problem-centered model for a flipped approach to blended teaching [25]. (CC BY-NC-ND 4.0).

The verbs within the embedded circles indicate the potential cognitive domains, which will be emphasized during the instruction in the online and face-to-face modalities. In this flipped model for BT, the pre-class portion would typically occur online; the in-class instruction would be face-to-face. A solid horizontal line separates the pre- and in-class instruction in this figure. The larger the circle (e.g., creating), the more time that should be devoted to learning outcomes in this domain during that portion of class time (i.e., face-to-face). Although lower levels of Bloom's Revised Taxonomy are more heavily emphasized in the online class time and higher levels stressed during face-to-face instruction, this is not intended to insinuate that higher levels of cognitive engagement are not achievable or should not be a goal of online instruction. In this flipped model of BT, the in-class portion was designed to serve as an introduction to the content, and this introduction would occur online. While the lower levels of Bloom's revised cognitive domains appear mostly in the pre-class zone of this model, and upper levels of the domains are primarily located in the in-class zone, part of every circle representing the cognitive domains crosses the horizontal line. Although a flipped approach to BT may differentiate the focus of instruction in the online and face-to-face spaces on the varying cognitive domains, instructors should ultimately consider the appropriate focus for their design context [25]. More importantly, Figure 1 demonstrates that all the circles cross at the P-C point; this is intended to highlight that all learning outcomes, regardless of domain or level or modality or sequence, should be directly connected to the overarching problem.

Finally, the FPI phases are placed to the right and left of the figure and on the upper and lower part of the horizontal line. In a flipped approach to BT, the activation and demonstration phases may be predominantly situated online as preparation for the face-to-face instruction, which will prompt learners to apply and integrate knowledge and skills. However, the FPI principles need not be confined to the pre- or in-class phases or to online and face-to-face modalities, but the: "affordances of technology leveraged by the flipped approach may be best utilized for those phases" [25] (p. 11). To communicate flexibility in the design process, the horizontal line does not extend the entire length of the image; as designers analyze their instructional problem and its associated outcomes, they may determine it more appropriate to shift the prioritization of these phases between the pre- and in-class portions, or the face-to-face and online modalities.

In this study, each FPI phase (i.e., Activation, Demonstration, Application, and Integration) was applied to helping PSTs learn to teach with technologies. The FPI phases were situated within the real world, the complex problem of designing technology-integrated lesson plans and accompanying digital resources. Experiences learning about different forms of technology were commonly discussed by participants 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 the tool could be integrated into teaching, or with the actual use of the tool in a lesson. These steps in the process describe how PSTs experienced elements of the FPI. The activation phase of the FPI introduced PSTs to new digital tools and structured experiences for them to build new knowledge about, and with, these tools. During the demonstration phase, PSTs observed the modeling of procedures for using the tool. Once the application phase began, PSTs practiced using the tool with a partner or within a group. During the integration phase, PSTs considered how the novel form of technology could be incorporated in their teaching as they designed a lesson integrating the new tool.

1.3.1. Activation and Demonstration

In the activation phase of the course, PSTs gained new experience with technologies as they explored these tools online, before coming to the physical class space. Upon arriving to class, PSTs would observe a demonstration of procedures for using the technologies and a modeling of how to teach with a specific technology. Through a step-by-step demonstration of the processes for using the technology, PSTs were expected to develop procedural knowledge for using the technologies [30]. Through the explicit modeling of how to teach with a specific technology, PSTs were also expected to observe how to integrate this technological, procedural knowledge with pedagogical and content knowledge [31]. Observing this modeling of technological, pedagogical, and content knowledge within specific scenarios, was intended to build prerequisite knowledge for supporting PSTs' practice in the application phase.

1.3.2. Application and Integration

During the application phase, PSTs extended their practice with new technologies. As part of the model lesson, PSTs 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. In this way, the application and the integration of phases of instruction merged within the problem-centered environment. After they practiced with the technology, PSTs reflected on what they had learned and considered its potential future use. Additionally, PSTs would apply some of these ideas in the technology-integrated lessons they would design and implement during the final integration phase of this FPI-based blended course design.

1.3.3. Problem-Centered Focus

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 PSTs 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 [24]. 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 [24], technology integration design components were separated into their own modules. The individual components, referred to as component skills, were provided as worked examples until they were taught by the instructor. 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. In this course design, selecting the sequence of the first component skill was based on the degree of importance and opportunity for variation [25].

Further, strategically selecting the sequence of skills to be learned afforded opportunities to highlight significant relationships among the skills. To emphasize 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 [24]. 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. Based on this corollary, PSTs engaged a problem in a real world setting and did not merely learn actions or skills that were not relevant to solving the problem [32]. Instruction should guide learners as they learn actions and complete tasks, but it should ultimately lead toward engaging a real problem. As PSTs in these courses were taught specific technological operations and pedagogical skills, the instruction was meant to match these task levels and always intended to situate the skills within an authentic design problem.

2. Materials and Methods

Descriptive phenomenology: "is concerned with wholeness, with examining entities from any sides, angle, and perspectives until a unified vision of the essences of a phenomenon or experience is achieved" [33] (p. 58). Therefore, this phenomenological study of a problem-centered blended course may offer a unique perspective as it does not take for granted that learners experienced the blended course as the designers intended. Furthermore, phenomenology can richly describe the teaching and learning processes within a problem-centered course [34]. Understanding learners' lived experiences can thus yield insights into how to better support, motivate, and engage them. Knowing the essence of a learning experience within an effective FPI-based blended course, therefore, can inform problem-centered literature and promote more effective blended course designs [35].

This section will begin by detailing the context for this study and describing the participants. Next, an overview of the data and the analysis process will be discussed. Following the methodology section, results will be presented as themes from learners' experiences with the problem-centered decision. A discussion of these results will then follow along with implications for problem-centered, blended course design, and the development of PSTs for BT.

2.1. Context and Participants

This study took place in the fall 2017 semester at a mid-size, private university in the Northeastern United States. A series of three, one-credit courses, was instituted at this university to develop PSTs' technology integration knowledge, skills, and attitudes, through the creation of digital learning objects and lesson plan [36]. The three courses were completed in sequence and required for inclusive elementary and early childhood majors. The course in this study had six, 150-minute, in-person meetings throughout the semester; students spent the remaining weeks completing field placements in local elementary classrooms. The culminating activity for the course coincided with their field placement. PSTs were required to design and implement a lesson that successfully integrated the technology available in their assigned classroom. Students in this course 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 but was delivered face-to-face with enhancements on the learning management system.

Twelve students enrolled in the course, and all students consented to participate in the study per the approved IRB protocol. PSTs were informed of the study and recruited to participate at the end of the semester by a graduate student with no ties to the course. All participants were female. Five participants were inclusive early childhood and special education majors, and seven were inclusive elementary and special education majors. Eleven participants were junior-level students, and one was a senior.

2.2. Data Overview

Student reflections were utilized in this study to document PSTs' experience and learning in this course. As part of the integration phase of instruction, PSTs reflected on the technology-integrated lessons designed with their peers and the lesson they designed individually. These reflections offered a glimpse into PSTs' design thinking, their perspectives on technology integration at various phases of the semester, and their experiences with course design elements. PSTs wrote five reflections throughout the semester, one after each class meeting, responding to prompts about course activities. A sixth reflection was written after the final class meeting, as a response to prompts about their lesson design, implementation, and experience in the field.

Reflection and sharing are critical to arriving at more formalized thinking and an essential aspect of PST development [37,38]. 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" [24] (p. 51). As PSTs constructed tangible artifacts and knowledge in this course, they were guided to share artifacts with peers and reflect on these learning and design experiences. The prompted reflections were written by students throughout the semester to promote and to document their learning. Therefore, the reflections served an instructional purpose, while generating data for this phenomenological study.

2.3. Phenomenological Analysis

Reflection data were exported from the university's learning management system, de-identified, and imported into the MAXQDA—a computer assisted, qualitative data analysis software that was used to organize, manage, code, categorize, and analyze the data. Data sources were analyzed using a descriptive phenomenological approach [39]. The descriptive phenomenological method was selected for its alignment with the research questions, that focused on exploring participants' experiences with the FPI in a blended course. Further, a phenomenological approach has been applied to similar studies in educational technology to explore pre- and in-service teachers' learning experiences and technology integration development [40,41].

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 [42]. Thus, this study sought to represent the phenomena of experiencing a blended technology integration course intended for PSTs that was 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, nor representative of 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" [33] (pp. 101–102). As a researcher continues to study a phenomenon, an infinite number of experiences may be discovered [43], 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 [44]. 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 [45]. The analysis plan that follows was intended to explore these experiences and to do so in a rigorous manner, consistent with the philosophical tradition of descriptive phenomenology and corresponding methodological framework.

2.3.1. Epoche/Bracketing

The first step engaged in this descriptive phenomenological analysis was epoche, or bracketing. This step is intended to help the researcher reduce bias when representing the experiences of the participants [46]. 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 [47]. As the designer and instructor of the blended course in this study, the researcher brought many prior experiences and prejudgments to the data due to this close relationship to the phenomena. To help maintain an openness to the participants, the researcher bracketed experiences before engaging the analysis process. Bracketing occurred by the researcher writing about previous technology integration coursework and relationship with technology. Additionally, the researcher kept memos of subjectivities while analyzing the data.

2.3.2. Phenomenological Reduction

For the next step of the analysis, the researcher read the data multiple times. During the first iteration, the researcher wrote only memos and reflected on his subjectivities. In the second iteration, the researcher 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, the MAXQDA was used to investigate the presence of meaning units in each participant's data and group together similar meaning units; at other times, data were printed and physically spread across a room for manual highlighting and notetaking.

2.3.3. Imaginative Variation and Synthesis

During imaginative variation, participants' clustered experiences were analyzed for the underlying structures of the experiences. These themed meaning units were analyzed through different perspectives to discover the essence of the experience. Sifting the participants' experiences through these variations was an attempt to uncover the common structures of experiencing elements of the blended course based on the FPI—the invariant constituent of the experience. These common essential structures [45] 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.

3. Results

This study focused on examining PSTs' learning experience in a problem-centered technology integration course that blended online and face-to-face modalities. Three themes cogently elucidate the essence of their experiences in this problem-centered, blended course. These themes were the following:

- In the online modules, PSTs gained experience with new technologies that they viewed as congruent with the in-person activities and the overarching problem;
- In-class practice was a space for PSTs to overcome technology integration fears;
- Repeated engagement with increasingly complex variations of the problem helped PSTs focus on specific skills and gain confidence amidst diminishing guidance.

In the following sections, each theme will be explored in more detail and illustrated through quotes from PSTs' reflections.

3.1. Having the Time to Just Explore Things Hands-On

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 PSTs to new digital tools, and to build a foundation for application and integration. These explorations occurred online as a preview of the upcoming in-person instruction. Overall, learners viewed these online modules as helpful and closely connected to in-person activities and the overarching problem. In Brooke's words: "I liked having the time to just explore things hands-on . . . the modules were helpful . . . cause it really just prepared you for what we were going to be discussing in class. You could start thinking about the ideas beforehand." The ideas mentioned by participants included resources for planning, features of devices, pedagogical strategies, and new digital applications.

When using the term "new" as it relates to technology, Beverly captured it well when she wrote: "I have realized how easy because of the numerous ways there are that technology can be incorporated so seamlessly into a curriculum. Before I had no idea how to incorporate technology into the curriculum because of my lack of knowledge about what was available for me". 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 were unaware of what was available to them.

In this blended model, new technologies were introduced to students online through introductory videos, opportunities for exploration, and examples of use. Participants often referred to this online work as "pre-assignment", "pre-work", or "modules". In this quote, Brianna described this pre-assignment experience:

> "During the pre-assignment work, we learned about Web 1.0, and Web 2.0. We began to understand the differences and how much Web 2.0 accomplished for education. While also watching the videos we learned about the different resources that a lot of teachers use that are from Web 2.0 to help enhance, modernize, and integrate interactivity in the classroom." (Brianna)

Brianna describes learning about Web 2.0 technologies and the ways they could be incorporated in classrooms. Furthermore, she perceived the resources to be relevant to her teaching as they were used by many teachers and have specific connections to teaching, such as increasing interactivity. These experiences with new tools in the online portion of the course were also related to the in-person experiences since the problem was their central focus. Beverly and Brianna further explained what happened with these pre-assignment resources:

> "For our lesson we utilized a lot of aspects we saw in the video. For example, the whole point was to use resources that qualified under Web 2.0 in order to create a lesson plan that engages and enhances our student's learning while using them . . . Therefore, many of the resources that were clearly defined in the videos were utilized during the creation of the lesson we made during class." (Brianna)

> "The activities that we completed online before coming to class were of great benefit to my group when creating the lesson plan. This is because from this past homework we each learned about different Web 2.0 strategies to use that would help students learn. Some of these strategies were Google sites, Lino, etc. We used this information as a way to create a lesson plan for students about different communities such as rural, city, and suburban." (Beverly)

Brianna noted that the "whole point" of exploring these resources online during the activation phase was to better engage the problem (i.e., planning a technology-integrated lesson). Since this connection was clearly defined, learners could incorporate these skills, resources, and information from the online exploration, with the in-person application.

3.2. Technology Integration Doesn't Have to Be a Scary Thing

Practicing with educational technologies was a key element of the demonstration and application phases of this problem-centered model. Much of this practice occurred during the in-person meetings after PSTs had completed their online pre-work. PSTs practiced individually, in pairs, and in groups referred to as design teams. As part of this practice during the in-person meetings, they participated in a model lesson where they would engage in the lesson as if they were elementary students. The lesson, a component of the demonstration principle, modeled the behavior of teaching with the technology and the procedures for using the technology. After this model lesson, PSTs designed a lesson with the same technology they had just observed and applied their knowledge of teaching with the technology and skills for using the technology to the lesson components.

PSTs' practice with these technologies were anchored to the design of lessons and digital resources based on the problem-centered principle. Experiencing the problem-centered principle through their application of technological knowledge and skills in authentic design tasks was perceived as relevant to their professional goals. As PSTs communicated the process of practicing with the technologies, they regularly contemplated the difficulty level of the technology for themselves and students. This practice helped them hone their skills and begin to address concerns they had about using technology in their future teaching.

3.2.1. Experiencing Discomfort and Accomplishment during Application

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 planned a technology-integrated lesson, the technology would fail. "Although there have definitely been moments during this course where I have felt very frustrated and confused by technology," Brynne reflected, "there have also been many more moments of feeling accomplished and enlightened by the use of technology." Time spent practicing may have been frustrating, uncomfortable, hard to do, and confusing, especially for PSTs who self-identified as technological novices. Evaluating technologies and confronting potential anxieties was the essence of PSTs' journeys of developing technological skills and knowledge during the in-person class meetings.

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 technology components would typically reduce the feelings of confusion. Other technological tools, such as a collaborative sticky note website called Lino, were perceived as simple. While inherent features or the design of tools may have contributed to perceptions of difficulty, some PSTs expressed a general anxiety related to the use of technology that was not isolated to practicing the use of a specific tool. Confronting these fears through in-class practice was part of the experience Bridget described when she wrote: "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."

Through working with these technologies, Bridget experienced shifts in her perception of difficulty. She closed her reflection by stating that technologies could be used in simple ways. 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, PSTs noted they were more likely to use the technologies they had explored in the modules or 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 educational technologies within an authentic problem. A possible connection to shifting perceptions of difficulty may offer an additional rationale for designing these environments.

3.2.2. A Space for Reflection on Barriers and Possibilities

In addition to practicing with novel technologies and considering perceptions of difficulty, PSTs evaluated digital tools' potential for future use. Evaluation, an important component of the integration principle in this problem-centered model, was intentionally structured in assignments by prompting PSTs to reflect on a 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 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:

> "I think it was to introduce new ideas but then give us a chance to try them out ourselves . . . 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 at least try it out...even if you couldn't in the classroom . . . we were able to decide what things we would use or . . . 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. 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 PSTs as they entered their field placements. Brooke mentioned limits imposed by resources or by her own conceptions of what she could see herself doing.

The in-class limits and the barriers PSTs faced in their placements produced potential frustration due to the dichotomy of experiences. When describing the placement context for lesson plan which she implemented with first grade students, Brooke wrote the following:

> "The school itself does not have the best access to technology for both teachers and students. Most classrooms have a set of laptops, but there are not enough for each student to use their own . . . .Each classroom has a SmartBoard, but it varies whether the teacher knows how to utilize it effectively or not . . . When I was doing my technology audit, I quickly realized that I would not be able to have students using the laptops during my lesson, because the chances of the internet connection working was unpredictable . . . Most students do not know how to access the internet without the help of an adult, and a small group of students still cannot log into their school account with 100% accuracy. Despite these factors, I still wanted to find a way to incorporate engaging technology use into my lesson that would enhance student learning." (Brooke)

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. Taking this practice into the real world of actual K-5 classrooms presented new challenges, and these barriers contributed to PSTs' attitudes toward technology. Yet despite these factors, Brooke noted that she still wanted to find ways to enhance student learning with technology.

When considering the in-person portion of this college course as a place for testing and imagining digital tools' potential, idea generation characterized this creative space. PSTs wrote of Web 2.0′s potential for students to publish their work and the variety of technologies that could support assessment practices. 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, although often lacking a complete context and a specific purpose, were foundations for PSTs' initial design considerations.

Besides considering the different forms of technology they had learned for future teaching, PSTs also considered their beliefs about technology's place in teaching, and what they believed constituted effective technology integration. In the next section, PSTs' experiences with the problem-centered principle and its problem progression corollary will be presented. These design principles were essential to the structure of the course and the systematic implementation of the previously outlined design principles.

3.3. The Process … Helps Teachers Break down Where the Integration of Technology Starts

Within the problem-centered approach to this blended course, learners were given many opportunities to apply and integrate their learning within the context of an overarching problem. In this study, learners designed five technology-integrated lessons with their peers, and they individually designed and implemented one technology-integrated lesson during their field experience.

PSTs' reflections indicated an awareness of an overall course structure, and they attributed this structure to helping them know what to expect, comprehend assignments' relevance, and connect the various course experiences. The course structure of six meetings over the span of 14 weeks resulted in lengthy gaps between meetings. Amidst this intermittent schedule, it was essential for PSTs 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 PSTs recalled the ways in which they made connections between classes. Their reflections revealed experiencing a repetitive process of designing lessons in class and a sense of comfort that this structure afforded. While the previous theme focused entirely on how PSTs learned about different forms of technology, this theme focuses on how they experienced course design elements which supported their connection of technological skills with their teaching practices.

3.3.1. Increasing Complexity and Diminishing Guidance

Following the guidance of the FPI's problem progression corollary, this blended course design presented PSTs with the problem of designing a technology-integrated lesson on the first in-person day of class. This first design task iteration only required PSTs to design a single component, but each subsequent lesson design required the original component and an additional element until PSTs were designing an entire technology-integrated lesson. While Merrill refers to this process as the problem progression corollary of the problem-centered principle [32], the PSTs used the term scaffolding. As such, the term scaffolding will be used throughout this section instead of problem progression, to incorporate participants' language for describing their experiences.

PSTs noted this scaffolding process when they contrasted their most recent design experience with their initial design task:

> "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)

While they recognized the increasing complexity of the tasks and the waning support, they also perceived how this was authentic preparation for teaching:

> "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)

Concerning their first design team experiences, PSTs recalled initially designing only the assessment portion of the lesson plan, or being given more parameters for their lessons (e.g., learning outcomes and content standards). In following classes, they increasingly designed more lesson components, until the final week, when they designed an entire technology-integrated plan. PSTs perceived the scaffolding 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 contributed her teams' ability to replicate the design process and plan a technology-integrated lesson "from scratch" to both increasing "independence and freedom" and the many iterations of practice.

While they may have experienced the progression as "practiceing the task so many times ... " (Beverly), they observed its benefits and even noted that as future teachers they should provide repeated opportunities for practice with diminishing guidance to help students understand the lesson's objective and the processes of learning. The goal of such an approach, according to the PSTs, is for their future students to be able to independently create and achieve higher levels of cognitive complexity.

3.3.2. Focus and Confidence

From their experiences with this scaffolded approach to technology integration development, PSTs 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 increasing complexity of each design iteration supported PSTs' confidence with designing technology-integrated lessons.

Presented in Table 1, representative quotes have been selected and labeled as focus and confidence. These terms were selected from Brittney's quote, which detailed how adding one new element to the problem helped her to focus; and repeated practice with the problem gave her confidence. 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 more confident.

Table 1. Participants' perceptions of benefits offered by 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 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.

Table 1. *Cont.*

Participant	Perceived Benefit	Reflection Excerpt
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.
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.

Each participant's experience emphasized 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 became 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.

4. Discussion

In this study, PSTs designed technology-integrated, instructional solutions for six instructional problems throughout a semester-long course. PSTs experienced the problem-centered principle and its corollary of problem progression as a process of increasing complexity and diminishing guidance [32]; PSTs perceived that progressively adding component tasks helped them to focus on learning new tasks and build confidence amidst the challenge. This iterative progression was perceived as unifying not only the course modalities, but also the dispersed class meetings of this one-credit course. Scholars have emphasized that high quality BT is not simply virtual tools appended onto pre-existing practices, but rather, it is a purposeful combination of online and in-person instruction [48] that is founded upon a "theoretically sound instructional model" [49] (p. 43). These aspects of quality BT align with our findings as PSTs did not attribute their increasing confidence and focus to novel technologies that facilitated the BT. Rather, PSTs credited the problem-centered learning process [32], a process informed by theory, to strategically unifying the online and face-to-face modalities.

Effectively bridging online and in-class components has been a perennial problem when designing blended courses in higher education, especially those attempting rotation models, such as the flipped approach [6,17,50]. Yet, this purposeful combination of online and in-person instruction is foundational to the nature of BT [48,51]. In this study, the problem of designing a technology-integrated lesson served as the bridge between the online and in-person instructional spaces. PSTs' explorations and play with digital tools in the online space, therefore, were seen as essential preparation for class and facilitative of constructing prerequisite knowledge for engagement with the problem.

The Teacher Response Model of Technology Integration (TRM) [52] is helpful for further understanding the role that the online and in-person components may have had in PSTs problem-centered experiences and development in this course. "Teacher decision making about technology," as framed in the TRM, "is an ongoing, emergent process" [52] (pp. 735–736). One key in this process is what a teacher may imagine as possible when using technology in their context. Iteratively engaging the problem of designing technology integration may have supported the ongoing process of developing teacher decision making. PSTs' conceptualizations of technology use were dynamic and evident of negotiations with various internal and external factors. PSTs observed that exploring technology online before class helped them start thinking about ideas. Since the technology use during these explorations had little context, there were few external factors to negotiate when imagining possibilities. These initial explorations then progressed to more in-depth practice with the technology and application of the tool within a design problem that had a context and goal. While practice was perceived as challenging and potentially uncomfortable, PSTs felt a sense of accomplishment, perceived the tools as simpler to use, and noted they were more likely to use these tools in the future. Again, the dynamic nature of decision making emerged as PSTs' knowledge, beliefs, and experiences shaped their perceptions of what is possible [53–55].

In this problem-centered model, the PSTs extended their in-class decisions about technology use to their implementation of a technology-integrated lesson, and to their reflection on this experience. Their experiences with the problem served to provide a space for negotiating the internal and external factors of a real-world context [52]. As Brooke wrote in her lesson plan reflection: "Despite these factors, I still wanted to find a way to incorporate engaging technology use into my lesson that would enhance student learning." She listed many barriers to technology integration in her placement classroom (e.g., inadequate access to devices, unstable internet, and limited teacher and student proficiency), yet she still imagined there to be some possibility for technology use that could facilitate the learning goal.

While online explorations and in-class practice were spaces to test and become more proficient with technologies, implementation in the field brought external factors to the forefront. In a study of PSTs' intentions to integrate robots, researchers found that PSTs who implemented a robotics lesson with first grade students had statistically significant greater perceptions of the ease of using robots in teaching than PSTs who only experienced a similar robotics lesson in their college course [56]. Therefore, the impact of the problem-centered BT approach may be further enhanced when students can practice the problem within an authentic context.

As an essential component of teachers' technology integration decision making, reflection was also a critical element of participants' experience with the problem in this authentic context [52]. PSTs' reflections on their technology-integrated lessons revealed their experiences with first-order barriers (e.g., resources, policies, infrastructure) and their beliefs about technology integration [53]. Teachers' beliefs, referred to as second order barriers (e.g., beliefs, knowledge, and skills), tend to be stronger predictors of technology integration practice than first-order barriers, as pedagogical beliefs can be strong enough to overcome many first-order barriers [53]. Some pre-service teachers did surmount barrier thresholds and attempted technology integration practices consistent with their pedagogical beliefs. Reflecting on these practices, therefore, is one way to improve technology integration decisions and aligns with Merrill's claim that reflection is necessary if learners are to integrate their learning into their future actions and decisions [24].

While reflection alone will not garner computer access or improve internet connections (i.e., overcome first-order barriers), it can support how PSTs and teachers approach these challenges. Complications are inevitable to situated, authentic, complex problems. When given opportunities to reflect on how to address these contextual complications, share decisions with peers, and discuss alternatives, PSTs may build a stronger repertoire of strategies to employ in future technology-integrated decisions. Reflection, therefore, can further unify a problem-centered learning experience in a blended course by facilitating the construction of knowledge during engagement with the problem; by supporting connections between iterations with the problem; and by prompting learners to consider how their knowledge can be applied to a future context.

4.1. Future Research Directions

Engaging the problem in this BT model was an iterative and scaffolded process, which supported the dynamic and emergent nature of technology integration decision making [52]. As this study occurred within a one-credit course, future research should examine the impact of this problem-solving approach to BT within longer courses. Design research could focus on whether a single overarching problem remains effective for a three-credit course, or whether multiple complex problems are needed. Additionally, instead of emphasizing pre-post outcomes within this iterative problem-solving process, collecting time series data could offer insights on how successive engagement with the problem interacts with changes in beliefs, attitudes, and knowledge.

Based on the relationships proposed between constructs in the TRM, it is likely that experiences with similar problems and increasing perceptions of technology knowledge influenced PSTs' decision making in their final plan [7,52]. Using the problem as a bridge between online and in-person instruction thus provided a unified course experience that engaged students in multiple and varied iterations of technology integration decision making. While technology-integrated lesson designs served as the central problem in this study, researchers and designers in other disciplines should seek to identify complex problems in their fields, which may also serve to unify BT modalities. Furthermore, this study applied a flipped approach to BT, but future research could focus on the efficacy of problem-centered instruction within other BT approaches.

While the connections between the online and face-to-face instruction were evident in PSTs' reflections, more research should be conducted on how BT in teacher education can help bridge coursework and field experiences [6]. PSTs in this study designed, implemented, and reflected, upon only one technology integrated lesson in the field. Given the importance of the integration principle in the FPI and the role of enactment in teachers' future decision making, there is much potential for exploring how blended design can better support the connection between on campus learning and field experiences [6,32,52].

4.2. Limitations

The researcher attempted to abate the impact of limitations in this study, but there are inherent limitations in the selected research methodologies and other potentially limiting factors specific to this study. First of all, scholars have questioned the notion of researchers removing themselves from descriptive phenomenological studies through the process of bracketing [57]. The limitation of researchers' bracketing their biases lies in whether it is possible for researchers to remove their biases entirely from a study and the question of whether it may be more beneficial for a researcher to acknowledge and incorporate their perspectives through an interpretivist approach. Therefore, a limitation in this descriptive phenomenological study was the researchers' inability to entirely remove biases from the data collection and analysis process. To minimize the impact of biases in the analysis of participants' experiences with the phenomenon, the researchers did engage in bracketing experiences and judgments related to the phenomenon. A possible methodological improvement for this specific phenomenological study would have been the integration of additional data sources. Although the collection of six reflections throughout the semester generated descriptions from participants to sufficiently address the study's research questions, including semi-structured interviews, in the data collection it would have afforded researchers the opportunity to probe more deeply into aspects of participants' experiences with the phenomenon.

5. Conclusions

Instructional design models applied to blended learning design have been shown to inform a seamless integration of modalities, guide course development that better engages students, and foster improved learning outcomes [27,29].This study sought to describe the essence of PSTs' learning experiences in a blended technology integration course designed with the FPI and to elucidate which components of problem-centered BT the PSTs related to their learning. PSTs described learning about different forms of technology in the course as a process which began with an introduction or exposure to new technologies in the online portion of the course. Next, they were given opportunities to practice the new technologies during the in-class instruction, and the process ended with their contemplation of how they could integrate the technologies in a lesson, which would eventually occur in the field.

PSTs also characterized learning how to integrate technology in this problem-centered 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 engagement with varying problems, increasing complexity, and diminishing support. Pre-service 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.

In essence, participants perceived the "problem" as unifying the online and face-to-face course modalities, and as a bridge between topics in the course. This problem-centered model for BT, therefore, offers a strategic approach to leveraging the affordances of each modality in a coherent manner. Centering BT around problems in other disciplines may also foster a fusion of modalities and avoid further confusion from competing or disconnected instructional spaces.

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