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DESIGNING A NOVICE TEACHER TRAINING PROGRAM FOR PROJECT-BASED LEARNING

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This design case highlights how two instructional designers initiated, designed, and implemented a K-12 novice teacher training program to address three known challenges teachers face when understanding, designing, and implementing project-based learning (PBL). The design framework comprised three areas: trainees, training program design, and trainees' work environment. The training was delivered in three phases: teachers as learners, teachers as enactors, and teachers as independent designers. Over ten weeks of design implementation in the fall semester of the 2020-2021 school year, we learned three design elements that led to successful training: the phase-based design, the three-area framework, and the project's management documents. We also encountered challenges that hindered the transfer of training as novice teachers attempted to integrate PBL in their classrooms: teachers' lack of classroom management skills, heavy workload, and the impact of COVID-19. In reflection, we plan to improve our design by embedding training for classroom management, adopting multidisciplinary design if feasible, and boosting longer mentorship.

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INTRODUCTION

This design case describes design features, challenges, and reflections that two instructional designers, we, experienced while designing a teacher training program that aimed to prepare novice teachers to design and implement project-based learning (PBL) lessons. PBL has been endorsed as an effective student-centered approach that improves student engagement and achievement in K-12 classrooms (Bell, 2010; Oh et al., 2021; Shih et al.,2017; Thomas, 2000).

However, the literature also highlights some challenges K-12 teachers face with PBL pedagogy, design, and implementation (Aldabbus, 2018; Havice et al., 2018; Lesseig et al., 2016). This was the case for Ni's school, where she served as a veteran teacher who mentored novice teachers. With her understanding, concerns, and willingness to help, Ni sought to address this situation proactively. Therefore, implementing a training program to help teachers improve their practice and prepare for PBL should be considered to address these three challenges effectively.

We believe the PBL training design should be more carefully scaffolded, especially for novice teachers lacking experience in all three areas. Without such support, they could become frustrated when implementing complex teaching strategies (Karimi & Norouzi, 2017). Novice teachers, in particular, could benefit from transitioning from learners who understand PBL pedagogy to learners experiencing the design process with a mentor. Subsequently, they could progress from enactors implementing the designed lesson to independent designers who design and implement their lesson plans with confidence (Kali et al.,2018). With this belief, we embarked on a journey to design and implement a training program at a K-12 charter school, working with two novice teachers over ten weeks during a semester.

THE DESIGNERS

This training program was initially designed by Ni and reviewed by Sungwon prior to implementation. Ni served as the primary designer of the program. As a former

teacher and current university instructor, she has over ten years of experience in instructional design. She has been deeply inspired by the numerous benefits of PBL for student learning, as highlighted in extensive literature. Additionally, she participated in international teacher workshops hosted by the renowned professional development organization PBLWorks. To deepen her understanding of PBLWorks' principles, Ni decided to shadow a local PBL expert to observe day-to-day classroom operations involving PBL practices. This experience served as a pilot study for her dissertation (Clark, 2020), as outlined in the following section, "Motivation for This Project."

At the time of this project, Ni was teaching at a charter school as a technology applications teacher, where the training program was implemented. For this program, she took on three roles: (1) program designer, (2) trainer, responsible for training and mentoring the two participating teachers, and (3) participant observer, conducting research during the teachers' PBL implementation. Sungwon, Ni's mentor, brought over 15 years of instructional design experience in K-12 and teacher education settings to the project. She provided invaluable guidance to Ni, including reviewing the program design, offering feedback during implementation, assisting in communication with the teachers, and suggesting ways to improve the training program for future iterations.

MOTIVATION FOR THIS PROJECT

Before this project, Ni conducted a six-month pilot study for her dissertation, focusing on PBL mentoring within a K-12 Science, Technology, Engineering, and Mathematics (STEM) program. This study involved one mentor teacher and two mentee teachers. Ni observed the mentor teacher implementing PBL in the STEM program and identified challenges in transferring PBL skills to the mentee teachers. Ni noted that the mentor teacher often over-relied on modeling, which limited opportunities for the mentee teachers to practice and apply what they had learned. Additionally, one of the mentee teachers exhibited a lack of confidence in using PBL, skepticism about its value, and frustration with the perceived time constraints PBL imposed on her regular class schedule. Ni was determined to address these challenges in her subsequent work.

The pilot study experience validated Ni's findings from the literature review regarding the challenges teachers face during PBL design and implementation. Specifically, teachers often struggle to grasp the general pedagogical knowledge underlying PBL and to transition from teacher-directed to student-driven instruction (e.g., Han et al., 2015; Lesseig et al., 2016; Nariman & Chrispeels, 2016). Several studies have also highlighted that teachers encounter difficulties designing PBL lessons independently due to the lack of necessary materials provided in textbooks (e.g., Aldabbus, 2018; Lesseig et al., 2016; Penuel & Gallagher, 2009; Sherin, 2002). Moreover, beyond understanding and designing PBL, implementing PBL practices remains a significant challenge for many K-12 teachers (e.g., Dillon, 2008; Han et al., 2015; Smolleck & Mongan, 2011).

Ni felt a need for professional development to help novice teachers learn PBL and shift their beliefs about it, as teacher beliefs are a strong predictor of how effectively teachers implement student-centered learning (Muijs & Reynolds, 2015; Mohammed, 2022). Additionally, she realized the importance of equipping mentor teachers to effectively train novice teachers in understanding, designing, and implementing PBL. To address these needs, Ni designed a training program to meet both objectives.

DESIGN CONTEXT

School

Ni recruited two novice teachers from a small K-12 charter school in West Texas with an approximately 800-student population specializing in STEM education. Teachers at this school are strongly encouraged to incorporate PBL into their instruction. Students have half days on Fridays, allowing teachers to use the afternoons to plan "Friday Projects," implemented during Friday morning sessions in subsequent weeks.

This project was conducted during the 2020-2021 school year amid the challenges of the COVID-19 pandemic. At the beginning of the school year, students were offered three learning modes: (1) on-campus learning from Monday to Friday, (2) hybrid learning (on-campus instruction on Mondays and Wednesdays, remote learning on Tuesdays and Thursdays, and hybrid learning on Fridays), and (3) remote learning from Monday to Friday. Parents selected their children's learning modes every six weeks. Approximately 85% of sixth-grade students attended on-campus classes, 10% participated in the hybrid mode, and 5% were remote learners.

During this project, teachers faced significant challenges teaching classes that included students from all three learning modes while adapting to frequent student transitions between modes. Furthermore, the novice teachers received only two and a half hours of PBL training from the school before the start of the academic year, with no mentorship or follow-up support to guide them in designing and implementing PBL effectively.

Novice Teachers

Teachers for this training program were selected based on three criteria:

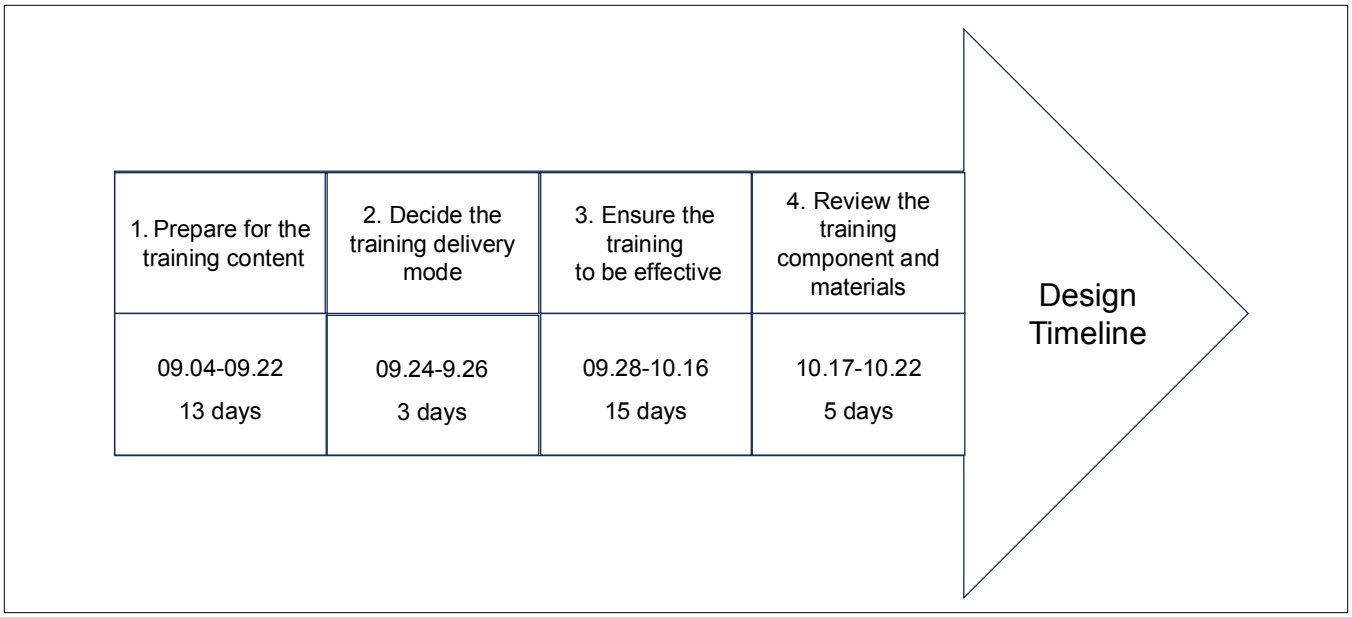

FIGURE 1. Design timeline.

1. The teacher must have three years or less of teaching experience (novice teacher);
2. The teacher must have implemented three or fewer projects (new to PBL), and
3. There was a preference for teachers teaching the same grade level (potential collaborative work).

Ni contacted five teachers who fulfilled these criteria, but only Greg and Jen (pseudonyms) were able and willing to take the training.

Greg taught engineering to sixth and twelfth graders and financial mathematics to twelfth graders. He began his career as a mathematics and engineering teacher in his late 40s. By the time of this project, Greg, a second-year teacher, had already designed three engineering projects before receiving PBL training. He expressed great interest and enthusiasm when Ni reached out to him, as he was eager to deepen his understanding of PBL and its application, mainly since his curriculum required him to engage students in PBL.

Jen taught English and social studies to sixth graders. As a newly appointed teacher in her early 30s with limited experience in PBL, she had previously collaborated with three colleagues to design and implement a Friday PBL initiative for sixth graders. When Ni proposed the training plan, Jen readily accepted the opportunity. Since Greg and Jen were teaching sixth grade, Ni decided to focus the PBL design and implementation on this grade level, allowing the teachers to share their experiences and collaborate with the same group of students.

Before implementing the program, Ni surveyed the two teachers to better understand them as learners and practitioners, focusing on their knowledge of and expectations for PBL. Both teachers expressed a strong desire to learn about PBL, particularly its design and implementation, which aligned closely with the three major challenges identified for K-12 teachers in the literature review.

TRAINING DESIGN

The training design process spanned two months (see Figure 1). It consisted of four stages: (1) preparing the training content, (2) determining the delivery mode, (3) ensuring the training's effectiveness, and (4) reviewing the components and materials. Each stage was further broken down into concrete steps, informed by Ni's prior training experience and a comprehensive literature review. Table 1 provides a detailed overview of the design process.

1. Prepare the Training Content

The training content was guided by two key sources: (1) Ni's prior training experience with PBLWorks, a renowned educational organization dedicated to helping teachers achieve mastery in PBL, and (2) the three major challenges identified in the literature review and during Ni's pilot study—teachers' struggles with PBL knowledge, design, and implementation.

Review PBLWorks Training Content

For this phase, Ni planned to adopt four critical components from her PBLWorks training: (1) PBL's seven essential design elements, (2) a design rubric, (3) a project planner, and (4) a personal workspace (Google Docs). She strongly endorsed the seven essential design elements presented by PBLWorks, as they aligned closely with findings from her literature review. These elements are illustrated in Figure 2.

DESIGN STAGES	DESIGN GOALS	DESIGN COMPONENTS
1. Prepare the training content	Review PBLWorks training content	1. PBL's seven essential design elements 2. A project planner 3. A design rubric 4. A personal workspace (e.g., Google Docs)
	Design solutions for three major teacher challenges	1. PBL knowledge 2. PBL design 3. PBL implementation
2. Decide on the training delivery mode	A framework of the training delivery	1. Teacher as a learner 2. Teacher as an enactor 3. Teacher as an independent learner
3. Ensure the training is effective	A framework to design an effective teacher training program	1. Trainee 2. Training program design 3. Trainee's work environment
4. Review the training components and materials	Review the training components and materials	

TABLE 1. Design goals and results for each stage.

FIGURE 2. Seven essential project design elements. Reproduced from *PBL works*. https://www.pblworks.org/what-is-pbl/gold-standard-project-design. Copyright 2019 by Buck Institute for Education.CC BY-NC-ND 4.0

Design Solutions for Three Major Teacher Challenges

To address the three primary challenges that teachers face in PBL, Ni planned to employ three targeted strategies: (1) utilizing Bloom's taxonomy to guide the development of teachers' PBL knowledge, (2) implementing scaffolding techniques to build teachers' design skills, and (3) using on-the-job training to help teachers develop practical implementation skills. Her rationales for using three strategies are explained below.

1. PBL knowledge. To help the teachers develop PBL knowledge, Ni considered using the first four levels of the revised Bloom's taxonomy—remembering, understanding, applying, and analyzing (Anderson & Krathwohl, 2001)—to grasp the PBL's foundational knowledge, PBL's seven essential design elements. Ni planned to use a handout with definitions and examples of the PBL's seven essential design elements, expecting the teachers to remember and understand them. Then, she would advance the teachers to the application level by asking them to identify these elements in three classroom videos. Finally, she would elevate the teachers to the analyzing level by asking them to compare their answers with each other and discuss their findings.

2. PBL design. To help teachers develop PBL lesson design skills, Ni believed in the importance of structuring the training in phases to scaffold their learning effectively. Mentors should scaffold PBL training and task structures to help K-12 teachers use PBL (Ertmer & Simons, 2006). She intended to guide the two teachers through a progression: starting with a preliminary design mindset, moving to learning the design process through her modeling and culminating in independently designing lessons. To engage the teachers in adopting a preliminary design mindset, Ni planned on having them study a classroom video case, that is, to task them with creating possible lesson plans using a PBL planner

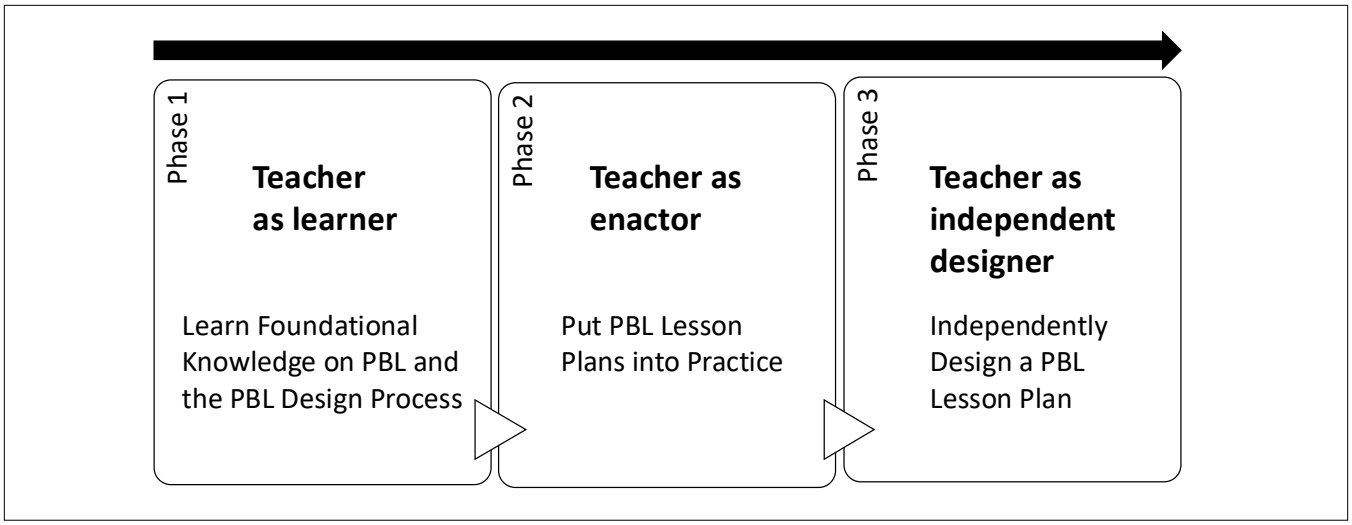

FIGURE 3. The training delivery framework.

as if they were the case teacher. In the later training phase, Ni planned to transition from case-based lesson plans to content the teachers would soon be teaching. During this phase, her goal was to model the design process by collaborating with the teachers step-by-step. She believed modeling could "make the pedagogical reasoning for practice clear, explicit, and understandable" (Korthagen et al., 2006, p. 1036). To further scaffold sharpening teachers' design skills, Ni would ask each teacher to design a new project independently at the end of the training program

3. PBL implementation. To help teachers hone their implementation skills, Ni focused on on-the-job training. This strategy emphasizes learning from colleagues (in this case, Ni) in a natural working environment, leading to higher trainee satisfaction (Georgellis & Lange, 2007). Ni planned to observe each teacher's classroom implementation, offer opportunities for individual reflection, and provide tailored feedback.

2. Decide on the Training Delivery Mode

Once the training content was finalized, Ni designed the delivery model based on Kali et al. (2018), which comprises three phases: teacher as a *learner*, *designer*, and *enactor*. However, when designing the training phases, Ni planned to integrate the designer phase into the learner phase, believing that novice teachers are not yet equipped to design independently after merely learning about PBL; she assumed that they would still require guidance and the opportunity to learn design skills through mentor modeling.

Addressing a drawback identified during the pilot study—where the mentor teacher provided minimal implementation opportunities for novice teachers—Ni designed the enactor phase into the training program. This phase was designed to provide the two teachers with hands-on experience implementing PBL. The enactor phase was considered critical to the training's success, as learning by doing is essential for PBL to be effective (Bell, 2010; Dewey, 1938; Thomas, 2000).

In addition, Ni introduced a new design phase—the teacher as an *independent designer*—following the enactor phase. This phase aimed to equip novice teachers with the ability to design PBL independently after gaining foundational knowledge, understanding the design process through modeling, and experiencing its implementation firsthand.

After consulting with Sungwon, Ni modified the training delivery mode into three phases: (1) the teacher as a learner, (2) the teacher as an enactor, and (3) the teacher as an independent designer.

- **Phase 1:** As learners, teachers learn the foundational knowledge of PBL and the design process.
- **Phase 2:** As enactors, teachers implement the lesson plans designed and modeled by Ni in their classrooms, with Ni providing feedback as needed after class.
- **Phase 3:** As independent designers, teachers develop a new lesson plan on their own within two weeks after implementing PBL.

Figure 3 illustrates the framework for delivering training.

3. Ensure the Training to Be Effective

Once we decided on the training delivery mode, Ni needed to create a framework incorporating research-supported elements for effective teacher training. Hence, Ni planned to synthesize elements from numerous studies: Bandura's (1997) self-efficacy on teachers' mastery experience, Clarke and Hollingsworth's (2002) teacher change environment model, and several other scholars' training design elements (e.g., Darling-Hammond et al., 2017; Desimone, 2009; Goldstein & Ford, 2002).

TRAINING PROGRAM COMPONENTS	CATEGORIES AND CODES REFLECTING THE TRAINING EFFECTIVENESS	LITERATURE
Trainee	1. Knowledge (acquired/increased) 2. Belief including self-efficacy (changed) 3. Job attitude (satisfied/enjoy) 4. Change in practice (able to apply new learning to practice	Bandura (1997); Clarke and Hollingsworth (2002); Desimone (2009);
Training Program Design	1. Need assessment 2. Coherence with job requirements 3. Content focus 4. Active learning 5. Collective participation 6. Model the practice 7. Opportunity for practice 8. Opportunity for feedback and reflection 9. Sustained duration	Darling-Hammond et al. (2017) Desimone (2009); Goldstein and Ford (2002); Shoobridge (2002)
Trainees' Work Environment	1. Organizational support 2. Expert coaching and support 3. Peer support	Darling-Hammond et al. (2017); Fullan (2007); Shoobridge (2002)

TABLE 2. The framework to design an effective teacher training program.

Drawing inspiration from Shoobridge's (2002) work, Ni planned to approach the training program from three critical perspectives to ensure its effectiveness: the trainee, the training program design, and the trainee's working environment.

For the trainee, Ni would consider four training elements based on the work of Bandura, Desimone, Clarke, and Hollingsworth: (1) teacher knowledge, (2) beliefs, (3) job attitude, and (4) changes in practice.

For the training program design, Ni would incorporate nine elements drawn from the research of Darling-Hammond et al. (2017), Desimone (2009), Goldstein and Ford (2002), and Shoobridge (2002).

To address the trainee's working environment, Ni planned to focus on the element of expert coaching and support as being the mentor herself, considering the three critical design elements, informed by the work of Darling-Hammond et al., Fullan, and Shoobridge: (1) organizational support, (2) expert coaching and support, and (3) peer support. Table 2 summarizes these teacher training design elements across the three areas.

In considering the effectiveness of the training program design, Ni embraced the design elements proposed by Darling-Hammond and colleagues (2017). The first element, **content focus**, emphasized the importance of centering the training on specific subjects. Ni planned on using the forthcoming teaching content of the two teachers as the basis for designing PBL lessons. The second element, **active learning**, highlights the need for teachers to engage actively through various interactive learning modes. Ni planned for diverse activities, including video analysis and teacher discussions in Phase 1, periodic reflections during each phase, and daily reflections in Phase 3. The third element, **collective participation**, underscores the value of peer collaboration in professional development. To facilitate more effective and relevant collaboration, Ni planned to recruit participants teaching at the same grade level. The fourth element, **modeling the practice**, requires mentors to demonstrate curriculum and instruction. Recognizing the importance of modeling for teachers during her pilot study, Ni planned to model PBL lesson design in Phase 1 and PBL implementation in Phase 3, providing teachers with concrete examples to guide their practice. The fifth element, **expert coaching and support**, encourages mentors to offer various types of support, including individual and group coaching. Ni desired to adopt this principle by providing personalized assistance to the teachers throughout the program. The sixth element, **offering opportunities for feedback and reflection**, informed Ni's mentoring approach. She planned to provide regular opportunities for teachers to receive feedback and reflect on their learning and practice. The final element, **sustained duration**, emphasizes that meaningful intellectual and pedagogical changes in teachers require sufficient training time.

In reviewing the literature on teacher professional development, Ni found that Desimone (2009) recommends at least 20 contact hours over a semester for effective professional development. To meet and exceed this minimum requirement, Ni planned to provide ample time for deep learning and practical application. Ni also planned to incorporate Desimone's (2009) **coherence** element into her design, ensuring the training content aligned with these mandatory

requirements to address teachers' concerns about meeting state, district, and school guidelines. In addition, Ni planned to draw on the work of Goldstein and Ford (2002) and Shoobridge (2002) to utilize a **needs assessment** with the two teachers before the training, collecting vital information about contextual relevance, trainee readiness, and motivation to learn.

4. Review the Training Components and Materials

After finalizing the training content design, delivery mode, and framework to ensure the training effectiveness, we carefully reviewed each component of the training process, including all materials and evaluation instruments, for any necessary revisions. Once the design was completed, Ni scheduled the start date of the training with the two teachers.

IMPLEMENTATION PROCESS

The training implementation lasted about ten weeks, including a week-long Thanksgiving break from late October 2020 to early January 2021. Phase 1 took 37 hours to complete over two weeks, Phase 2 took nearly four weeks, and Phase 3 took over two weeks. The timeline for the design implementation is presented in Figure 4 below.

The first training phase took place either in Ni's classroom or via Zoom. The second phase was conducted in teachers' classrooms, while the final phase occurred outside the school during the winter holidays. The three-phase implementation of the PBL training (Figure 3) is described below.

Phase 1 (37 hours)—Teacher as Learner

In this phase, the teacher's role was that of a learner, focusing on two components: (1) foundational knowledge of PBL in Sessions 1 and 2, and (2) the design process in Sessions 3 and 4. The first part was conducted in Ni's classroom for two hours on the afternoon of the third Friday in October 2020. The second part spanned 35 hours over the following two weeks.

The first part covered foundational knowledge about PBL and included video case analysis. Ni selected three videos from different grade levels and asked the teachers to analyze how the PBL design elements were applied in each case.

Session 1 (45 minutes) focused on building teachers' foundational knowledge. The two teachers and Ni met in her classroom after school. Ni began by showing the teachers a YouTube video from PBLWorks to explain PBL. She then reviewed two handouts, one covering foundational knowledge, including PBL's history, characteristics, misconceptions, benefits, and challenges, and the other introducing the seven essential design elements of PBL.

Session 2 (45 minutes) provided a comprehensive perspective on how teachers might implement PBL. Ni presented three case videos from PBLWorks:

1. An environment project for kindergarten (10 minutes),
2. A virtual library project for seventh graders learning social studies (7 minutes), and
3. A financial path project for high school students (7 minutes).

These videos demonstrated how each project was implemented, with clips providing background information.

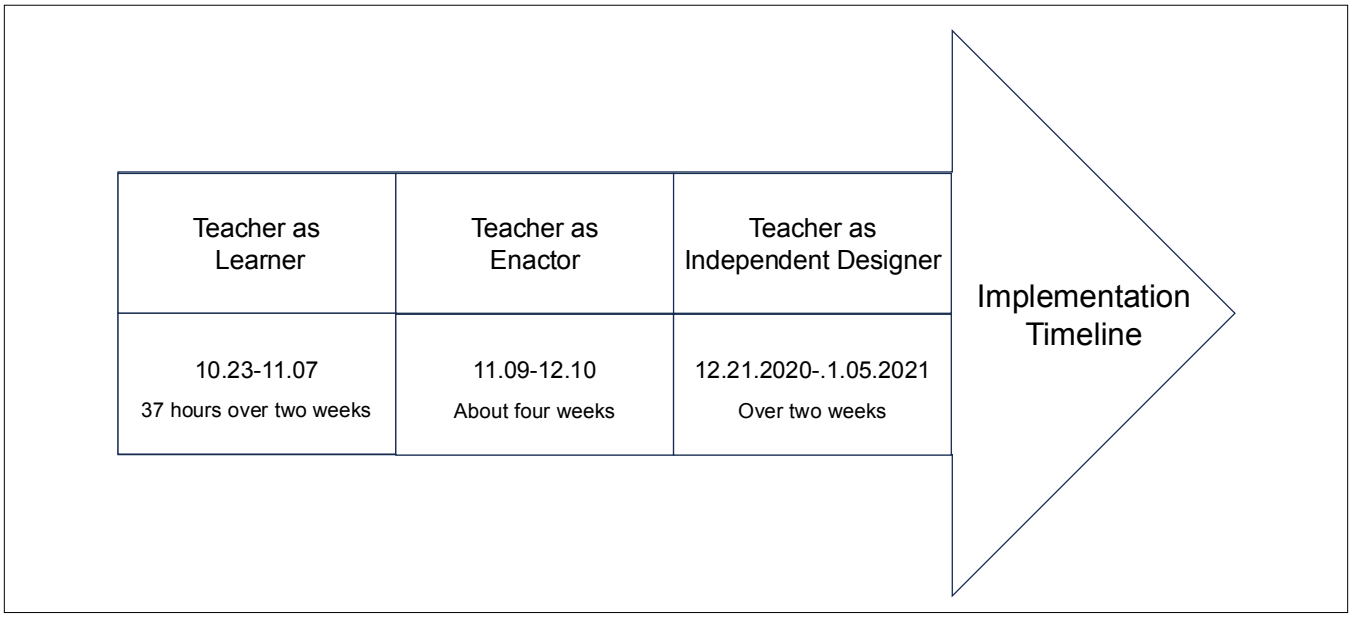

FIGURE 4. The timeline for design implementation.

Ni asked the teachers to discuss how the seven design elements were applied in each case and then complete a worksheet for each video to identify these design elements. We compared our answers, discussing the differences and similarities.

The second part focused on developing teachers' design knowledge and skills for PBL.

Session 3 (30 minutes) aimed to foster a design mindset through Ni's modeling with an example based on a video case. The two teachers chose one of the three video cases from Session 2 for Ni to demonstrate how the teacher in the video planned the PBL lessons using the project planner provided by Ni.

Session 4 was dedicated to training teachers to acquire PBL design skills. While Ni wanted the teachers to observe her design process and involve them directly, it was impractical due to her full-time teaching schedule. Ni spent 35 hours over two weeks designing the projects for them. Before starting the PBL design, Ni met individually with each teacher for a total of four hours to achieve the following goals:

1. Identify the scope of content and align it with TEKS (Texas Essential Knowledge and Skills. https://tea.texas.gov/)
2. Brainstorm ways to enhance the project's authenticity
3. Plan teaching strategies using a management document
4. Add Ni as a co-teacher to their course management platform

Ni demonstrated and explained her design process to the two teachers at various stages as the design progressed.

Ni recommended that Jen design an integrated PBL project for her two teaching subjects: English Language Arts (ELA) and social studies. The primary goal of the English unit was to familiarize students with informational texts, while the social studies unit aimed to explore the political, economic, religious, map, and social aspects (PERMS) of different regions, which could be enhanced through informational texts. Designing an interdisciplinary project allowed the same student groups to work on their project across the two class periods. After brainstorming, Jen and Ni decided the final product for this project would be an online museum displaying PERMS for three regions: (1) the U.S. and Canada, (2) Latin America, and (3) Europe.

Greg's engineering class was more accessible to design using PBL methods than Jen's, as the original engineering lessons were designed with PBL in mind and required delivery through PBL methods. Before the program, Greg had discussed the challenges of delivering lessons using PBL due to its ill-structured nature. The new unit involved designing toys as the final project for six physically challenged children. Ni suggested strategies for grouping and organizing students using Google Docs, with each student group tasked with addressing the needs of one child through their final product. Upon seeing the student groups and organized content, Greg expressed his relief and excitement multiple times during the design process.

Ni continued to work on management documents for both teachers in her own time. These documents included a group organizer and a workspace for each student to showcase their work. Ni dedicated over 12 hours to Jen's project, using the backward design model to map content from state standards to the instructional design. She also built a Google

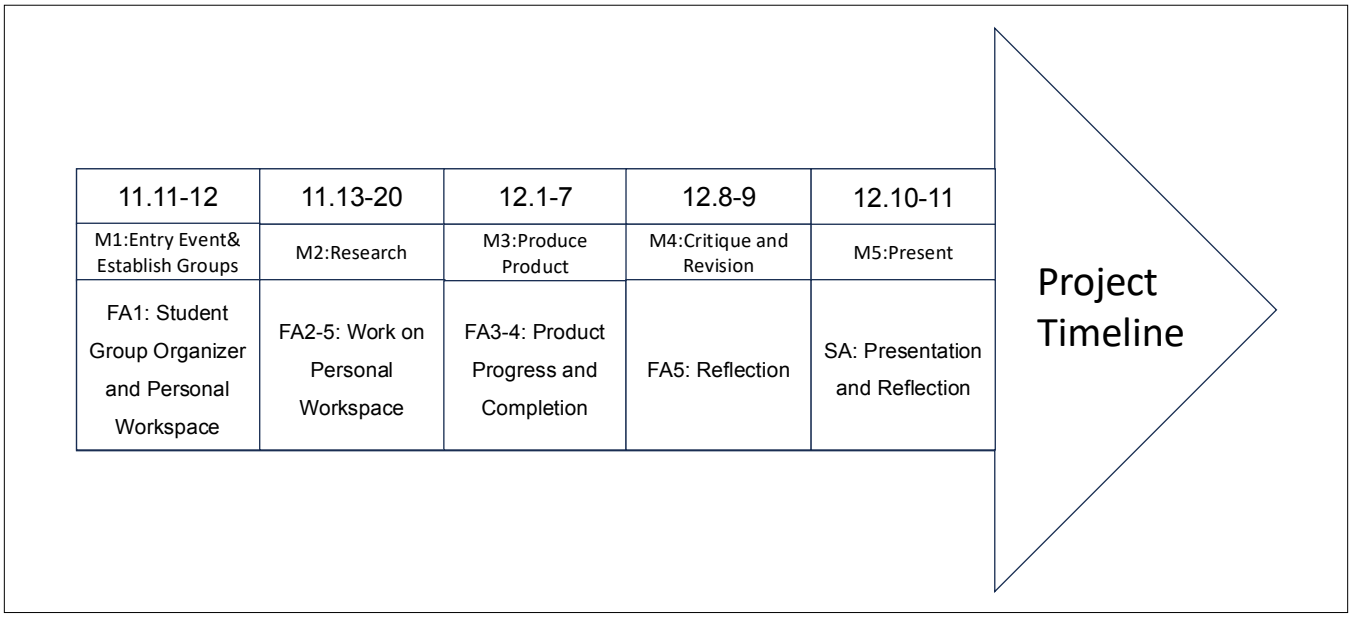

FIGURE 5. Jen's project timeline.

Site to organize and synthesize information about each region, allowing students to easily access key content from the textbook within the limited instructional time. Additionally, Ni created a project timeline (see Figure 5 for an example) with assessments laid out horizontally, designed templates for student workspace, developed rubrics, and set up school learning platform pages for both teachers.

Phase 2 (15 days) — Teacher as Enactor

In this phase, the teacher's role was an enactor, implementing PBL lessons in their classrooms over 15 days, spanning nearly four weeks. Ni observed each teacher daily and occasionally intervened as needed.

Ni visited the teachers' classrooms or joined Zoom meetings to observe their teaching. At the end of each day, she asked each teacher to reflect verbally on two questions: (1) Which parts of the lesson went well, and (2) Which parts did not go well? She then provided feedback to address areas for improvement or help resolve any problems as they arose.

Overall, Jen's project implementation was smoother than Greg's, as Greg struggled with classroom management and repeatedly reported difficulties. He felt that younger students were not ready for PBL. However, Greg noted that he would continue using the management documents because they provided valuable structure.

Phase 3 — Teacher as Independent Designer

In this phase, the teacher's role was that of an independent designer, creating a future project independently by applying knowledge gained from the previous phases. This phase began two weeks after the PBL implementation.

The two teachers had two weeks to review the required teaching content and design 7-10 days of PBL lessons for another project. During the two weeks, Jen contacted Ni to brainstorm ideas and get feedback while Greg worked alone.

Once the teachers submitted their lesson plans, Ni used a PBLWorks rubric to evaluate how well they applied the seven design elements, scoring from the lowest 1 to the highest 5 points. She provided feedback on their designs when the teachers returned from the winter holiday.

Summary of the Design Implementation

Table 3 presents the complete design implementation, consisting of three phases.

PROCEDURES	PHASE OF TRAINING	DESIGNER'S ROLE	TEACHER'S ROLE	TRAINING LENGTH
1. Learn foundational knowledge on PBL and PBL design processes	**Phase 1** 1. Session 1: Provide foundational knowledge and explain seven essential design elements 2. Session 2: Video case analysis	Training provider	Learner	1.5 hours (Friday afternoon)
	3. Session 3: Modeling PBL planning procedures based on a video case	Model	Learner	0.5 hour (Friday afternoon)
	4. Session 4: Modeling PBL planning procedures for teachers' projects	Model	Learner	6 hours with Jen plus Ni's own 12 hours for Jen; 9 hours with Greg plus Ni's 8 hours for Greg.
2. Put a PBL lesson plan into practice	**Phase 2** PBL Implementation	Observer/ Mentor	Classroom teacher	3.5 weeks
3. Design another PBL lesson plan independently	**Phase 3** Independent PBL design	Evaluator	Designer	Within two weeks after the PBL implementation

TABLE 3. Procedures for teacher training in project-based learning.

SUCCESSES AND CHALLENGES

Overall, the PBL training program spanned one semester, providing valuable opportunities to reflect on its successes and challenges. Ni frequently engaged in self-reflection using her reflection diary and periodically discussed her implementation experiences with Sungwon. These discussions allowed her to reflect carefully on the successes and challenges during each program phase.

Ni considered Jen's experience the most successful. Jen reported that she had been burnt out and attempted to resign until the interdisciplinary PBL design saved her time in planning and grading. Although Greg consistently doubted the maturity of young students in handling PBL, he valued the management documents and stated that he would continue using them to organize future projects.

Design Elements for Successes

In reflecting on the project's successes, we identified three key design elements that contributed to our successes:

1. The three-area design framework guided the overall training design and ensured its effectiveness;
2. The phase-based training design scaffolded teacher learning progressively and clarified teacher roles in each phase, especially with the enactor phase particularly boosting teachers' confidence and
3. The management documents transformed PBL's "messy" (i.e., ill-structured) nature into a concrete structure, making learning evidence visible.

Element 1: Three-Area Design Framework

We believe that the design framework, constructed based on multiple scholarly works, is one of the most critical design elements of this training, ensuring its success. The framework guided Ni's design to focus on three areas (i.e., trainee, training program, and training environment) and provided her with a sound structure to start her design.

First, Ni's focus on increasing the teachers' knowledge in Phase 1, as part of addressing the trainee area in the framework, resulted in positive training outcomes. For example, she provided PBL's history, research findings about PBL benefits, essential design principles, and video case analysis. The two teachers expressed that they understood better why they needed to teach with PBL because of the history and benefits of using PBL presented, and the video cases aided their quick understanding of the graphic and immediate context. When asked what was beneficial in Phase 1, the two teachers commented, "Everything, especially the videos." They also commented that the knowledge acquired from Phase 1 was constructive in building their foundational knowledge of PBL and establishing their confidence to use PBL.

Second, we consider applying the nine design elements in training program design as another key to the design success and mainly based on the two teachers' feedback from the post-questionnaire (Likert scale from 1—strongly disagree to 5—strongly agree) that measured their perceptions of the training program design's effectiveness. They rated "strongly agree" for all items except Jen, who rated "agree" for the last item, which stated, "This training program had a sustained duration." She explained that she needed more time in every aspect and a more extended mentoring period with fading support in the following years. In this training project, both teachers exceeded 40 training hours (see Table 4).

Finally, regarding the training environment, we perceived that the mentors' support and coaching were significant factors in their success. The two teachers highlighted Ni's support during the implementation phase, noting that Ni's daily feedback was constructive and that they needed a mentor to "bounce ideas off" to clarify them. In addition, both teachers appreciated Ni's moral support. Jen commented:

> *You were always available when I had a question or a concern. Not just for PBL, but also for me as a teacher and peer; you were just available. That really, really, [emphasized] helped. It helped me build confidence and want to understand.*

Greg also attributed the success of his PBL implementation to Ni's support. He felt reassured by Ni's daily visits and appreciated having someone to step in and help when needed. For example, when Greg struggled on the first day, Ni modeled how to launch the project. Later, Ni also demonstrated how to give students feedback and address their progress as a whole class, as she noted that Greg rarely provided feedback on student work. Greg reported that Ni's modeling was beneficial and guided his practice. Both teachers expressed a desire for this mentorship to be longer, "at least one year."

Element 2: Phase-Based Design

We believe the phase-based design scaffolded teacher growth and clarified teacher roles, effectively directing teacher learning. The two teachers felt that the training phases were essential for preparing to understand PBL and found the content in each phase beneficial.

As learners in Phase 1, both teachers reported that the three video cases helped them understand PBL's seven essential design elements and how to apply them to different subjects at various grade levels. They also commented that modeling the design process was necessary and helpful but regretted their limited involvement in the design process. Ni shared this sentiment and wished the teachers could have been present when she designed the lessons alone.

ROLES	PHASES	GREG	JEN
Teacher as learner	**Phase 1 (Session 1-4)** Learning foundational knowledge on PBL (Session 1-2) and the PBL design process (Session 3-4)	2 hours on PBL knowledge 9 hours on PBL design	2 hours on PBL knowledge 6 hours on PBL design
Teacher as enactor	**Phase 2** Put PBL lesson plans into practice	10 hours on-job-training 3 hours of reflection time in total	10 hours on-job-training 3 hours of reflection time in total
Teacher as independent designer	**Phase 3** Independently design a PBL lesson plan	16 hours	40 hours
TOTAL TRAINING TIME		**40 hours (2+9+10+3+16)**	**61 hours (2+6+10+3+40)**

TABLE 4. Training hours of each teacher participant over three phases.

However, adding more hours to the teachers' already packed schedules was impossible. Greg participated in the design process for nine hours, and Jen participated for six hours, while Ni spent an additional eight hours on Greg's project design and twelve hours on Jen's (see Table 4).

As an enactor in Phase 2, both teachers emphasized the necessity of the implementation phase. Greg stated, "By experiencing the process, I can say this is working for me; this is where I can improve." Jen added, "Experiencing the knowledge is different from knowing the knowledge... I know these elements now and understand what they mean by implementing them. To implement what it means." Literature supports Jen's comments of "experiencing the knowledge" that it captures the essence of PBL, encouraging students to fully engage in the learning process and practice it to develop a final product. Simply, the two teachers learned how to teach PBL by teaching PBL. They expressed that their confidence was significantly boosted because of this enactor phase. We believe that embedding the enactor phase was critical to the success of this teacher training.

As independent designers in Phase 3, both teachers recognized the importance of designing PBL independently. They believed it allowed them to think critically and explain instructions clearly. Greg reported that he better understood the backward design process after this phase. During Jen's independent design, she asked Ni about the target audience for the students' final product, which led to a shift in Jen's perception of the public product. Previously, Jen had given little credit to the public product until Ni pointed it out, helping her realize the value of presenting to an audience beyond the classroom. This independent design practice resulted in a final product of 7-10 days of PBL lessons, which is the ultimate goal of PBL: asking students to produce artifacts or engage in complex activities as the ultimate learning outcome. Both teachers developed their PBL design skills by observing the mentor in Phase 1 and designing independently with the mentor's feedback in Phase 3.

Overall, each phase effectively prepared the teachers for the subsequent phase. The progressive phases scaffolded their growth from learners to enactors and finally to independent designers.

Element 3: Management Documents

Due to the ill-structured nature of PBL, we believe that providing tools such as collaborative management documents to assist teachers and students was crucial. Throughout the three phases, both teachers recognized the value of these management documents, including the project planner, the student group organizer, and the project timeline. Greg repeatedly commented on how well the PBL lesson was organized and presented, expressing his excitement:

> *This way helps me think from the student side, not my side. I love the way you structured everything and developed a system. It is a good system, very intuitive, very efficient, and very helpful.*

Greg said he would continue using the management documents and adjust them to fit his future teaching needs. He also introduced these documents to a colleague.

Jen found the timeline particularly beneficial for students and teachers, aiding in time management and keeping track of assessments. Also, she recognized the importance of PBL planner and commented:

> *To get the big idea, [you] need to develop it before you start it. I think it will be the most beneficial because it is more of a rock-solid plan; that way, you only do a little tweaking throughout and can enjoy PBL more later on.*

Challenges

While Ni and the teachers achieved some successes, three significant challenges frequently hindered the training process:

1. Lack of Classroom Management Skills: Teachers' inadequate classroom management skills led to ineffective PBL implementation.
2. Heavy Workload: Teachers' workload reduced available training time and negatively impacted their emotional well-being.
3. Impact of COVID-19: The pandemic affected student engagement, attendance, and punctuality.

Lack of Classroom Management Skills

The most outstanding problem regarding the PBL implementation was Greg's classroom management, which was unexpected in this design case. Greg's shortcomings in classroom management led to low student engagement, with nearly half of the students being off-task. While Greg occasionally corrected misbehavior, he often ignored it. Thus, the classroom noise level exceeded that of a typical project. Ni suggested establishing classroom rules to help Greg manage students consistently, but Greg felt it was too late to reinforce them effectively. The sight of disengaged students might have also impacted Greg's self-efficacy in using PBL and contributed to his pessimism about students' maturity in handling PBL.

In contrast, Jen faced fewer challenges with classroom management. She consistently enforced the rules posted on the wall and referred to them when students violated them. Additionally, Jen implemented a reward system using stamps for significant achievements, displayed daily objectives and tasks on the board, and tracked students' missing work. Based on Ni's observations, overall student performance in Jen's classroom appeared to be better than in Greg's despite having the same groups of students.

Heavy Workload

Both teachers faced heavy workloads that hindered their full participation in the training. Greg was responsible for teaching three subjects in the first year and an additional three new subjects in his second year. Jen, a first-year teacher, taught two subjects. Greg's preparation for these subjects and the PBL training left him with no time for student feedback, which he admitted in a reflection session. On the other hand, Jen found that the interdisciplinary PBL, which integrated two subjects, reduced her planning and grading time. In the post-interview, she mentioned that she worked fewer late nights than before the training. Despite this, both teachers reported working overtime daily during the training weeks. The modeling session (Session 3) in Phase 1 was not executed as planned due to the teachers' limited availability. They occasionally had to leave the meetings to address family needs, which suggested that insufficient time for participation impacted their understanding of PBL.

Impact of COVID-19

COVID-19 presented another significant challenge to the training. The teachers struggled with engaging students online, especially when about 15% were absent due to COVID-19. Greg frequently noted that engineering classes require students to be physically present to engage in hands-on projects effectively. To address this, he used a 3D design tool called Tinkercad to enable students to design products online. Likewise, Jen experienced difficulties managing student learning as she had to teach online after being quarantined for six days after the PBL was launched.

Both teachers reported several issues with online teaching. Some online students did not answer the teacher's questions; others experienced lagging audio or technology problems. Despite repeated instructions, students often remained confused. Both teachers also found it challenging to facilitate collaboration between online and on-campus students during the same class period. Jen noted that online students were often marginalized by their on-campus peers.

Furthermore, student absences and tardiness were significant issues due to the impact of COVID-19. Both teachers reported that several students failed to attend video conferences regularly, and some students appeared intermittently, complicating teaching and group collaboration. Additionally, students' inconsistent return to campus and frequent switching between learning modes made it challenging for teachers to address missed instruction.

REFLECTIONS

Overall, the design and implementation of the teacher training were considered successful by both the teachers and the authors, as well as through various evaluation instruments. However, we also discussed three areas for improvement for future iterations:

1. Incorporate classroom management training into PBL training.
2. Aim to reduce teachers' workload by integrating multidisciplinary design and possibly shifting Phase 1 to before the school year begins.
3. Extend the duration of mentorship to provide more sustained support.

The most significant and unexpected problem in this PBL training was the lack of effective classroom management. It is crucial to include training in classroom management before introducing advanced teaching methods such as PBL. Classroom management is often cited as one of the top challenges for novice teachers (Voss et al., 2017), impeding their ability to teach effectively and maintain authority in

the classroom (Hirsch et al., 2019; Westling, 2010). Without proper classroom management skills, novice teachers may experience emotional exhaustion and a negative emotional state (Voss et al., 2017), which deteriorates their management abilities (Klusmann et al., 2008b). Poor classroom management not only hampers student learning but also exacerbates the difficulties of implementing "ill-structured" PBL projects, potentially leading to decreased student outcomes and diminished teacher confidence in using PBL.

Even though Greg expressed his frustration and acknowledged his shortcomings in classroom management, it was too late to address these issues during PBL implementation. Ideally, teachers should be proficient in classroom management before they undergo PBL training, which is assessed during annual evaluations. If teachers are not yet skilled in classroom management but are required to receive PBL training, the PBL training must include classroom management instruction. As training designers, we could use the pre-questionnaire to evaluate trainees' abilities, confidence levels, and attitudes toward classroom management. Even if the results are satisfactory, Ni could have still emphasized the importance of classroom management during Phase 1 and provided relevant strategies. We could assist novice teachers by helping them establish consistent expectations and classroom rules and offer examples of rewards and consequences. In Phase 2, the mentor could provide feedback on classroom management and PBL implementation.

The heavy workload of teachers was the second major issue during this training. Voss et al. (2017) found that higher teacher workloads lead to increased emotional exhaustion and burnout, which are top reasons for teacher resignations. Designing an interdisciplinary PBL project for Jen effectively reduced her workload. Although both teachers initially worried that PBL would require more time, Jen appreciated the interdisciplinary approach, which helped her save time and manage her workload more efficiently. Unlike Greg, who had different groups of students for each subject, Jen taught the same group for both English and Social Studies. Having the same group of students allowed Ni to create an interdisciplinary project for Jen's combined class. Jen noted that the interdisciplinary design reduced her workload in planning and grading, viewing this training as a turning point that rekindled her "a kind of drive and passion back" and not "burn out every day." Most importantly, the training prevented resignation. Jen's positive feedback and enthusiasm encourage us to incorporate interdisciplinary or multidisciplinary designs in future training programs whenever possible.

Another strategy to reduce teachers' workload during the school year is to shift Phase 1 to before the school year begins. To implement this, the designer should obtain permission from the school administrator and schedule the training time after the mandatory training. In three to four hours, the trainer could cover the foundational knowledge of PBL and engage trainees in a case study.

Despite Greg and Jen's desire to reduce their workload, they both expressed a need for more extensive and prolonged guidance and mentorship. Scholars such as Desimone (2009) and Darling-Hammond et al. (2017) have highlighted the importance of sustained training length, though they do not specify the exact duration that constitutes "sustained." Ni found only one study by Van Veen et al. (2011), which suggested that teachers might change their behavior with anywhere from 14 to 80 hours of training. We define effective training length as the duration of meaningful interaction with the trainer or mentor. In this training program, both teachers exceeded 40 hours of interaction. However, the interaction time with Ni appeared insufficient for achieving optimal training effects, as both teachers indicated they still needed ongoing guidance and support for subsequent projects. Ideally, Ni could have followed up with the teachers to help initiate a second PBL project, providing scaffolding based on their levels of independence and confidence. One potential solution is to hire specialist mentor teachers or instructional coaches to work with novice teachers full-time and schedule one or two free class periods for mentees to meet with their mentors to develop their skills further.

In addressing the mentee teacher's skepticism about using PBL in Ni's dissertation pilot study, Ni discussed several factors that could influence novice teachers' beliefs. First, extended mentorship could significantly boost teachers' confidence in using PBL. The two teachers consistently emphasized the importance of mentor support, repeatedly recognizing its role in shaping their success throughout the training. Second, mentors should be mindful of helping novice teachers observe positive student learning outcomes whenever possible. Teachers' perceptions of student learning outcomes—whether positive or negative—strongly influence their optimism or skepticism about the pedagogy (Clark & Hollingsworth, 2002; Zambak et al., 2017). For instance, Greg initially hesitated to use PBL with younger students due to his pessimism about its effectiveness, which stemmed partly from his struggles with classroom management. However, believing in the value of nontraditional pedagogies like PBL can enhance teachers' willingness to implement such methods (Anderson, 2002; Lotter et al., 2007). Despite his initial doubts, Greg's content-oriented skepticism toward PBL gradually shifted as he observed beneficial outcomes in his students' learning, making him more receptive to the approach. Third, scaffolding novice teachers' growth through various strategies proved essential to boost novice teachers' beliefs. Effective strategies included using a three-phased training delivery mode, video case studies, modeling instructional practices, utilizing management documents, and providing timely and frequent feedback. Fourth, mentor teachers should provide opportunities for novice teachers to gain hands-on experience with PBL by designing

and implementing their lessons. These experiences can help build teachers' competence and reinforce the value of PBL through practical application.

FINAL WORDS

Given the overall success of the structured training framework, Ni plans to continue using it to examine the effectiveness of additional training programs. The framework, which addresses three components —the trainee, the training program's design, and the trainee's work environment — can serve as a baseline guide and valuable tool for other designers and researchers of teacher training effectiveness. Moreover, the three-phase training delivery model can be used as the implementation structure for PBL training. The scaffolding design, which transitions from a preliminary design mindset through video case analysis to observing a mentor's project design and then to independent design, proved effective in developing both teachers' PBL design skills.

A carefully structured training design is essential for helping novice teachers master advanced teaching methods such as PBL. This case recommends that teachers be open to using PBL, even with younger students, and that schools support novice teachers by assigning them long-term mentors to build classroom management skills and receive constructive feedback.

Regardless of the specifics of the training program, it seems crucial for mentors to help mentees recognize positive evidence of student learning and provide encouragement within the PBL environment to reinforce their belief in using PBL. Most importantly, mentors might mentor mentees by implementing at least one project and offering on-site assistance until the mentees feel confident enough to teach independently using PBL. Effective mentoring can significantly enhance teacher retention and improve competence and effectiveness, as novice teachers benefit more from guided practice than trial-and-error alone (Confait, 2015; Jones et al., 2016).

While the program's successes underscored the value of modeling, feedback, and hands-on practice, the challenges revealed opportunities for refinement. Moving forward, we plan to tailor the program further to address specific needs, such as more robust classroom management strategies within the PBL framework and deeper integration of real-time student feedback. This reflection process has reinforced our belief in the transformative potential of thoughtfully designed professional development to empower teachers and elevate their practice.

REFERENCES

Aldabbus, S. (2018). Project-based learning: Implementation & challenges. *International Journal of Education, Learning, and Development*, *6*(3), 71–79.

Anderson, R. D. (2002). Reforming science teaching: What research says about inquiry. *Journal of Science Teacher Education*, *13*, 1–12. http://dx.doi.org/10.1023/A:1015171124982

Bandura, A. (1997). *Self-efficacy*: T*he exercise of control*. Freeman.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, *83* (2), 39–43. https://doi.org/10.1080/00098650903505415

Clark, N. (2020). Why do we have such dilemmas? A reflection on shadowing a PBL mentor teacher. *Journal of Education*, pp. 1–6. https://doi.org/10.1177/0022057420979601

Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. *Teaching and Teacher Education*,*18*(8), 947–967. https://doi.org/10.1016/S0742-051X(02)00053-7

Confait, S. (2015). Beginning teachers' challenges in their pursuit of effective teaching practices. *Cogent Education*, *2*(1): 991179. https://doi.org/10.1080/2331186X.2014.991179

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute. https://learningpolicyinstitute.org/product/effective-teacher-professional-development-report

Desimone, L. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181–199. https://doi.org/10.3102/0013189X08331140

Dewey, J. (1938a). Experience and education. New York: Macmillan.

Dillion, J. (2008). *A review of the research on practical work in school science. Retrieved from* https://www.academia.edu/35007091/A_Review_of_the_Research_on_Practical_Work_in_School_Science

Ertmer, P. A., & Simons, K. D. (2006). Jumping the PBL implementation hurdle: Supporting the efforts of K–12 Teachers. *Interdisciplinary Journal of Problem-Based Learning, 1*(1). https://doi.org/10.7771/1541-5015.1005

Fullan, M. (2007). *Leading in a culture of change*. Jossey-Bass.

Georgellis, Y., & Lange, T. (2007). Participation in continuous, on-the-job training and the impact on job satisfaction: Longitudinal evidence from the German labor market. *The International Journal of Human Resource Management*, *18*(6), 969–985. https://doi.org/10.1080/09585190701321112

Goldstein, I. L., & Ford, K. J. (2002). *Training in organizations*: *Needs assessment*, *development*, *and evaluation*. Wadsworth Thomson Learning.

Han, S., Yalvac, B., Capraro, M. M., & Capraro, R. M. (2015). In-service teachers' implementation and understanding of STEM project-based learning. *Eurasia Journal of Mathematics, Science and Technology Education, 11*(1), 63–76. https://doi.org/10.12973/eurasia.2015.1306a

Havice, W., Havice, P., Waugaman, C., & Walker, K. (2018). Evaluating the effectiveness of integrative STEM education: Teacher and administrator professional development. *Journal of Technology Education*, *29*(2), 73–90. http://dx.doi.org/10.21061/jte.v29i2.a.5

Hirsch, S. E., Lloyd, J. W., & Kennedy, M. J. (2019). Professional development in practice. *The Elementary School Journal*, *120*(1), 61–87. https://www.jstor.org/stable/26854160

Jones, G., Dana, T., LaFramenta, J., Adams, T. L., & Arnold, J. D. (2016). STEM TIPS: Supporting the beginning secondary STEM teacher. *TechTrends, 60*(3), 272–288. https://doi.org/10.1007/s11528-016-0052-5

Kali, Y., Levy, K. S., Levin-Peled, R., & Tal, T. (2018). Supporting outdoor inquiry learning (SOIL): Teachers as designers of mobile-assisted seamless learning. *British Journal of Educational Technology*, *49*(6), 1145–1161. https://doi.org/10.1111/bjet.12698

Karimi, M. N., & Norouzi, M. (2017). Scaffolding teacher cognition: Changes in novice L2 teachers' pedagogical knowledge base through expert mentoring initiatives. *System, 65*, 38-48. https://doi.org/10.1016/j.system.2016.12.015

Klusmann, U., Kunter, M., Trautwein, U., Lüdtke, O., & Baumert, J. (2008b). Teachers' occupational well-being and quality of instruction: The important role of self-regulatory patterns. *Journal of Educational Psychology*, *100*, 702–715. https://psycnet.apa.org/doi/10.1037/0022-0663.100.3.702

Korthagen, F., Loughran, J., & Russell, T. (2006). Developing fundamental principles for teacher education programs and practices. *Teaching and Teacher Education*, *22*(8), 1020–1041. https://doi.org/10.1016/j.tate.2006.04.022

Larmer, J., Mergendoller, J., & Boss, S. (2015). *Setting the standard for project-based learning*. ASCD.

Lesseig, K., Nelson, T. H., & Slavit, D. (2016). Supporting middle school teachers' implementation of STEM design challenges. *School Science and Mathematics*, *116*(4), 177–188. https://doi.org/10.1111/ssm.12172

Lotter, C., Harwood, W. S., & Bonner, J. J. (2007). The influence of core teaching conceptions on teachers' uses of inquiry teaching practices. *Journal of Research in Science Teaching*, *44*, 1318–1347. https://doi.org/10.1002/tea.20191

Mohammed, S. M. (2022). Teachers' Beliefs: Positive or Negative Indicators of Inquiry-Based Science Teaching? *World Journal of Education*, *12*(1), 17–33.

Muijs, D., & Reynolds, D. (2015). Teachers' beliefs and behaviors: what really matters? *Journal of Classroom Interaction*, 25–40. https://www.jstor.org/stable/23870407

Nariman, N., & Chrispeels, J. (2016). PBL in the era of reform standards: Challenges and benefits perceived by teachers in one elementary school. *Interdisciplinary Journal of Problem-Based learning*, *10*(1). https://psycnet.apa.org/doi/10.7771/1541-5015.1521

Oh, H., Yoon, S. K., & Lim, G. G. (2021). Exploring blended ic-pbl model & strategy for course based pbls in university: Using a case study in engineering education. *PBL, Sustainability and Digitalisation 2021*, 13.

Penuel, W. R., & Gallagher, L. P. (2009). Comparing three approaches to preparing teachers to teach for deep understanding in earth science: Short-term impacts on teachers and teaching practice. *Journal of the Learning Sciences*, *18*(4), 461–508.

Sherin, M. G. (2002). When teaching becomes learning. *Cognition and Instruction*, *20*(2), 119–150. https://doi.org/10.1207/S1532690XCI2002_1

Shih, W. L., & Tsai, C. Y. (2017). Students' perception of a flipped classroom approach to facilitating online project-based learning in marketing research courses. *Australasian Journal of Educational Technology*, *33*(5). https://doi.org/10.14742/ajet.2884

Shoobridge, J. (2002). *Training transfer: The what, how, and wherefore art thou? National Centre for Education and Training on Addiction*. http://nceta.flinders.edu.au/files/7212/5548/1894/EN109.pdf

Smolleck, L., & Mongan, A. (2011). Changes in preservice teachers' self-efficacy: From science methods to student teaching. *Journal of Educational and Developmental Psychology*, *1*(1), 133–145. https://doi.org/10.5539/jedp.v1n1p133

Thomas, J. W. (2000). *A review of research on Project-based learning.* Autodesk Foundation.

Van Veen, K., Zwart, R., & Meirink, J. (2011). *What makes teacher professional development effective? A literature review*.

Voss, T, Wagner, W., Klusmann, U., Trautwein, U, & Kunter, M. (2017). Changes in beginning teachers' classroom management knowledge and emotional exhaustion during the induction phase. *Contemporary Educational Psychology*, *51,* 170–184. https://doi.org/10.1016/j.cedpsych.2017.08.002

Westling, D. L. (2010). Teachers and challenging behavior: Knowledge, views, and practices. *Remedial and Special Education*, *31*(1), 48–63. https://doi.org/10.1177/0741932508327466

Zambak, V. S., Alston, D. M., & Marshall, J. (2017). Convincing Science Teachers for Inquiry-Based Instruction: Guskey's Staff Development Model Revisited. *Science Educator, 25*(2), 108–116.