Cultivating Preservice Secondary Teachers for Project-Based Learning: A Four-Step Model

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Abstract

This article describes four different mechanisms for preparing teacher candidates from a liberal arts institution to teach in project based learning (PBL) classrooms: Observe it, Experience it, Create it, and Become it. For each of the four mechanisms, the authors also provide concrete examples of candidates' PBL experiences and candidates' feedback about the process. From observation to mini-teaches in schools to field placements, the authors suggest a variety of methods for engaging both undergraduate and graduate students in learning about PBL instruction. The four-step mechanism could also provide suggestions for how to implement PBL in similar liberal arts institutions.

Keywords: **teacher education, project-based learning**

Students, teachers, and parents gather in an open field between the school and the fire station. Chatter resonates throughout the crowd and there is noticeable excitement in the air. The firefighters next door have been notified and are "on call" and the nearby international airport a couple of miles away has been notified. Is this an emergency situation? No! It's launch day for the miniature hot air balloons students have developed as part of their project-based learning (PBL) unit exploring gas laws. Students have been anxiously looking forward to this day since the launch of their PBL unit that included a visit from a professional hot air balloon pilot. Student engagement has been at an all-time high for the past two weeks as students explored gas laws in their science class and then designed and built miniature hot air balloons that they think will fly based on their understanding of those gas laws. Finally, it is time to test their creations!

Nestled on the south side of a large, metropolitan area, it has been our university's experience that schools are aggressively seeking candidates who can actively engage students in their own learning. PBL is unquestionably one way to do this.

Our four-year liberal arts university, the University of Indianapolis, has the fortunate circumstance of choosing from a number of school configurations in which to place our preservice teacher candidates. An existing partnership in a local, urban-fringe school district provided us the setting to launch initial conversations and experiences with and for our teacher candidates about new ways to prepare future teachers. From these conversations came our university's strong desire to integrate PBL approaches in the preparation of secondary teachers at all levels, in all programs.

Our integration of PBL has spanned immersive clinical experiences for undergraduate sophomores to graduate students' preparation of PBL experiences and interactions with our city's Mayor's Office. In this article we will discuss the systematic way in which we prepare preservice teachers to incorporate PBL into their professional practice using a four-step approach: Observe it, Experience it, Create it, Become it. Each of these steps will be discussed in detail in the remainder of this article.

Contextual Background

PBL was not a foreign concept to the School of Education and College of Arts and Sciences Faculty at the University of Indianapolis. Through a PBL Institute that has been jointly offered by our university, another local university and a K-12 partner district, many college faculty have engaged in the process of using PBL to not only teach content knowledge, but also to prepare future teachers. Thus, content area experts in the College of Arts and Sciences are able to provide subject-specific expertise for teacher education candidates as they develop PBL units.

While there is no single definition of PBL, there are criteria that are recognized as commonalities for defining PBL. The Buck Institute for Education (BIE), a leader in the development and implementation of using PBL as a framework for teaching, identifies the following eight elements as being essential to PBL: significant content; 21st century competencies; in-depth inquiry; a driving question; a need to know; student voice and choice; critique and revision; and student presentations of work to a public audience (Buck Institute for Education). In a review of research about project-based learning, Thomas (2000) uses the following five criteria to determine what a project must have in order to be considered as project-based learning: (a) PBL projects are the curriculum, not an add on or end; (b) PBL projects drive students to pursue learning related to the desired concepts and principles of the content; (c) PBL projects require students to construct knowledge as a result of participating in inquiries; (d) rather than being teacher-led and scripted, PBL projects are driven by students; and, (e) PBL projects are authentic and incorporate real-life challenges. As can be seen, there is significant overlap in the two sets of criteria provided here and these criteria meet the majority of descriptors used by Daniels and Bizar (2005) to describe best practice teaching.

Preparing preservice candidates to teach using PBL is critical for several reasons. Research has shown that PBL has positive effects on student content knowledge and their ability to apply knowledge to solve real world problems. In a meta-analysis of the effectiveness of PBL in teaching content knowledge, Strobel and van

Barneveld (2009) concluded that students in PBL learning environments outperformed their counterparts in traditional instructional settings on knowledge and real-world skills. "PBL is significantly more effective than traditional instruction to train competent and skilled practitioners and to promote long-term retention of knowledge and skills" (Strobel & van Barneveld, 2009, p. 55). Boaler (1997) found that students with immersive PBL learning experiences emerge with more content knowledge that can be applied to a variety of real-world tasks. In an experimental study of 76 PBL classroom teachers, Finkelstein, Hanson, Huang, Hirschman, & Huang (2010) reported that PBL learning led to higher scores on not only standardized exams, but also ability tests that focused on problem-solving skills and application to real-world problems.

PBL learning experiences are also found to lead to improved critical-thinking and problem-solving skills (Shepherd, 1998; Treten & Zachariou, 1995). Research suggests that PBL is a successful approach for 21st-century skills and that students with immersive PBL learning experiences show more initiative by utilizing resources and revising work (Barron et al., 1998).

Higher levels of student motivation and engagement are also found to be associated with PBL learning experiences. For example, secondary students were more excited about marine engineering and physical science when they participated in an applied shipbuilding project (Verma, Dickerson, & McKinney, 2011). Similarly, in a study of an economics class, both the lowest- and highest-performing students were engaged in a PBL unit, including students who showed no or minimal interest in economics at the start of the unit (Ravitz & Mergendoller, 2005). One explanation of higher levels of engagement and motivation is that PBL places students in a real-world problem context and helps students to see the value of the learning experiences (Blumenfeld et al., 1991).

In summary, PBL offers many advantages, including: increasing student engagement; providing authentic, real-world learning experiences for students; and teaching students the skills they will need to continue to be life-long learners and contributors to their communities. There are specific pedagogical strategies that teachers

must know in order to be successful using the PBL approach. In addition, because this approach is often new for not only secondary teachers but also for their students, teachers need to know how to structure time, space and resources in order to promote a classroom culture that will lead to student success when using PBL. Thus, we have implemented the four-step approach described below to enable our candidates and the teachers and students with whom they are working to successfully employ PBL in their teaching and learning.

Observe It

The first step is to observe PBL. Field observation has been widely adopted in teacher education programs and is esteemed as an essential component in teacher preparation (Guyton & McIntyre, 1990). In a typical early field observation experience, prospective teachers are exposed to cooperating teachers' application of theory and instructional approaches, which are usually connected to the university's educational courses. The goal is for preservice teachers to develop their theoretical understanding and pedagogical knowledge, in part through close, guided observation of the cooperating teacher.

Besides the traditional value of an early field observation experience in teacher education programs, field observation of PBL carries additional meaning and plays an even more critical role. Research shows that teachers tend to teach the way they were taught (Ball, 1990; Vrasidas & McIsaac, 2001). Since PBL is still relatively new in schools, many teacher candidates have little to no prior experience or knowledge about it. For many of them, observing PBL is a culture shock. Many components of PBL classrooms are different and sometimes even opposite to the traditional model that pre- and in-service teachers have been through in their own learning experiences. Therefore, PBL field experience needs to provide in-depth opportunities for teacher candidates to develop their understanding of PBL.

With the partnership between a local secondary school in the New Tech Network, teacher candidates in the Secondary Education program from this four-year liberal arts university are introduced to

PBL and start their field experience in their sophomore year. This PBL experience is embedded in a required educational psychology course. The course is offered in the PBL middle school twice weekly. As part of the course requirement, every week each teacher candidate spends two hours (over two visits) in the PBL school. This semester-long field experience provides a variety of opportunities for teacher candidates to observe, participate in, and reflect on PBL. Here are some examples of these opportunities.

Observing PBL Learning in all Content Areas

In this field experience, teacher candidates work with 7th graders in all content areas (e.g., English language, math, science, and social studies). Since many projects are designed to promote students' knowledge in multiple content areas, teachers of these content areas collaborate with each other in planning, teaching, and evaluating projects. An example of collaboration between social studies and English teachers is for students to write a fictional story, at the request of a classroom teacher of younger students, to introduce a selected Asian culture to the students. Another example of social studies and English collaboration is for students to explore different countries and cultures and discern which country they may want to live in if they are forced to leave the United States due to some natural disaster. An example of collaboration between math and science is to design and create math and science games. The games are eventually played and reviewed by peers on a Game Day.

Immersive field experience also allows teacher candidates to observe a variety of PBL activities. For instance, teacher candidates are able to observe PBL teachers co-teaching cross-curricular projects, which is another key component of PBL but is not usually present in traditional classrooms and may be new to teacher candidates.

Tutoring and Workshops

In addition to observation, teacher candidates are also part of the students' PBL learning experiences. Teacher candidates are asked to interact with a small group of students, such as tutoring within

their projects, being an audience for and judges of student presentations, and giving workshops on the topics that are identified from the "what needs to know" analysis conducted by students when they started a project.

Candidates generally felt that immersive observation experiences in a PBL school significantly improved their understanding of PBL. When asked about their understanding of PBL, candidates emphasized its connection to the real world. One candidate said, "Through research and creating projects, students are not only doing work according to standards, but are learning real-world application skills through them." Another candidate commented that PBL "allowed students to see how school subjects relate to the real world" and that PBL is "more about problem-solution." Candidates also commented on the potential of PBL learning in improving non-cognitive skills, such as helping students "gain confidence" and "collaboration skills." Overall, candidates expressed positive feelings about the impact of PBL for students. As one candidate put it, "PBL better prepares middle school students for higher education, future careers, and even the workforce." However, many candidates also mentioned that PBL is a new instructional model and prompts their need for more pedagogical knowledge, skills and clinical experiences to be prepared to teach in PBL settings.

The course instructor of the educational psychology course designed the PBL experiences not only to improve teacher candidates' understanding of PBL, but also to develop their understanding of major educational theories and concepts. First, many field observation forms were modified to address candidates' unique field experiences in this PBL setting (e.g., co-teaching across different content areas, integrating technology in small group research projects, etc.). Second, during class-time conversations, the instructor used specific prompt questions about the connections to PBL and educational theories. For instance, when teacher candidates were learning Piaget's cognitive development theory, they talked about the stage of cognitive development of those 7th grade PBL learners they had been observing. Teacher candidates also discussed the advantages (as well as challenges) of incorporating

inquiry-based PBL research projects with young teens, given where they are in terms of cognitive development. Third, students were given opportunities to share their thoughts and ideas about PBL in a variety of learning activities. In such learning activities, the instructor tended to use general guidelines and did not ask, specifically, about connections to candidates' PBL experience. However, when teacher candidates made connections to PBL experiences, they were asked to elaborate on their thoughts and ideas. For example, all teacher candidates were asked to draw a concept map of memory. Two out of three groups included "PBL" in their concept map. They were asked to explain why they believed that PBL plays a positive role in helping students remember information. Additionally, during class discussion about meta-cognition, a teacher candidate made a comment, "That's why they were doing need-to-know analysis in PBL!" Her "aha moment" soon inspired others to look at metacognition from a PBL perspective.

Experience It

There are multiple means in which we have our teacher candidates experience PBL lessons from the introductory phase of observation to being the learners in a course that is designed entirely around the PBL model. In our multi-step approach we affirm Kolmos' (2002) notion that PBL enables students to draw upon prior skills and knowledge while partaking in real-world problem-solving situations, arguing that this approach allows students to transfer knowledge into unknown and new situations.

Our undergraduate educational psychology students have the fortunate opportunity to have their college course and articulated field experience set in a New Tech Middle School in a local school township. The experience actually begins with a flipped model wherein the middle school students instruct the teacher candidates in the essentials of PBL. As both the course and the clinical experience progress, teacher candidates learn via observation and through the creation of mini-lessons, which they eventually create to support PBL projects at this clinical site.

In a more in-depth way, all secondary candidates in our teacher

education programs have a course or a major portion of a course that is taught in a PBL format. For example, in one of our graduate programs, candidates take a class about designing PBL units that is taught using PBL as the delivery mechanism. The advantage of this approach is that candidates are experiencing the same thing their own students will experience as they each progress through a PBL unit. This gives them a greater understanding of the PBL process and of both the scaffolding and the freedom for student choice that are necessary for the design of a successful PBL unit. Graduate students commented, "PBL allows for student choice within the project. It gives the teacher the ability to find ways to allow students to pick their topic within the concept." In addition, a graduate student added, "Instructors (in PBL environments) must allow students to complete their work in ways that appeal to the students, but checkpoints are essential."

Undergraduate Secondary and Master of Arts in Teaching candidates learn content in their Social and Political Contexts of Education courses via the delivery of a PBL portion of the course wherein they create a charter school prospectus that aims to serve a certain K-12 student population. This prospectus is presented to an authentic audience, our Mayor's Office, which is one of the two State charter agencies. The entirety of this experience affirms educational research that the acquisition of knowledge is embedded in experiential, active engagement that challenges students to assess situations from analytical and critical perspectives in order to reach a proposed outcome (Savin-Baden & Wilkie, 2004).

Create It

Once our candidates observe and experience PBL, it is time for them to move on to the third step of our model: creating their own PBL units for use with secondary students. The PBL units designed by our candidates include the standards and 21st-century skills that will be addressed in the unit: a driving question; scenario and entry documents; assessment plans including a description of products and artifacts along with rubrics for assessing products; artifacts and 21st-century skills; and a map of the project including daily

student activities, ideas for how the teacher will scaffold the project both academically and procedurally including possible resources, potential workshops, task lists, group supports and progress checks (Buck Institute for Education).

The creation of PBL units varies from program to program with some candidates designing and delivering a portion of a PBL unit and others designing and delivering an entire unit. In our undergraduate secondary program, upperclassmen are asked to design a PBL unit while in their intense middle school field practicum. During this time, candidates design a PBL unit that has a focus on promoting literacy in the content area they will prepare to teach. At the graduate level, candidates consult with their cooperating teacher during their full-time student teaching to come up with a topic for their unit. They are then tasked with designing an entire PBL unit to address the agreed upon content. Once they have designed the entire PBL unit, the candidates have the opportunity to present their PBL unit design at a public exhibition where they receive feedback about the unit from both content area professors and education professors as well as from community members with real-life expertise in the content area of the candidate's PBL unit. They then have a chance to make revisions to the unit before implementing it with students during student teaching. Following the implementation of their PBL unit, candidates are required to do another revision of the unit based on what they learned from implementing it in an actual classroom. The revised PBL units are shared with other teacher candidates who, in turn, can revise these units for use in their own classrooms once they have teaching positions. Ideas for the development of PBL units are as varied as the content areas secondary students' experience. Some examples of units that candidates have designed include students exploring polynomials by considering the cost, type and amount of flooring materials it would take to install floors in a new home, creating and launching miniature hot air balloons to explore gas laws, teaching exponents and logarithms in the context of buying a car, and exploring parabolas by designing an efficient solar powered cooker.

While creating and implementing their PBL units, candidates

collaborated with a variety of community partners. Such partners included local professionals from the business, medical, and nonprofit sectors. These community members added real-world application and community involvement components to the PBL unit which promoted intrinsic motivation in our candidates' students. One candidate commented that PBL "challenges the students to seek more knowledge outside the walls of the classroom. It provides room for them to interact professionally with the community." Another candidate stated, "Creating my first PBL unit without having seen it play out in the classroom first was challenging. Once I was able to implement my PBL unit, I realized that PBL brought even more purpose and direction to my teaching."

Become It

Whether it is via observation or an entire program based almost entirely on PBL, our candidates are entering the teaching profession armed with knowledge of PBL as a creative and authentic methodology for engaging secondary learners. In addition, they are better prepared to solve the multi-faceted problems that are encountered by today's secondary teachers. According to researchers (e.g., Spiro, Feltovich, Jacobson, & Coulsen, 1992), this approach helps prospective teachers form networks of ideas and see patterns across problems and issues so they extend and transfer their thinking from what they encounter in the university to their work as teachers.

The majority of secondary candidates from the university have the chance to not only experience PBL, but also to design PBL experiences. In addition, by having such close ties to grassroots movements in our state, such as #PBLChat (i.e., a social media platform for PBL), the State Collaborative for PBL that is housed in the University of Indianapolis and a local summer PBL Institute (see more details at http://magnifylearningin.org/), our graduates have the means to always be on the journey toward becoming better PBL educators. Because of their PBL experiences, our candidates are actively recruited by districts who have shown an interest in PBL and other formats of instruction that are especially engaging.

Conclusion

In short, throughout our teacher education programs, in collaboration with the College of Arts and Sciences, our teacher candidates are provided with numerous opportunities to develop their knowledge and understanding of PBL and integrate that into their teaching practice. The four-step approach—Observe it, Experience it, Create it, and Become it—is embedded in clinical experiences based on the university's collaboration with local agents, including PBL schools, programs, and nonprofit organizations. The collaboration also benefits students and residents in the community as many of the PBL projects are designed to serve their various needs.

The preliminary findings of this approach are promising. The university is increasingly recognized as a hub for developing PBL teachers. The unique PBL component in both undergraduate and graduate programs answers the call for more PBL teachers in the metropolitan area and the state. Partnership schools and programs express interest in maintaining and in some cases expanding their collaboration with the university.

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