Introduction

While frequently studied in the context of undergraduate studies, the suitability of PBL for the discipline-based training of graduate education has also been examined. This emerging literature extends two key benefits of PBL seen in undergraduate education: learning 21st century skills needed in the evolving workforce and engaging students to address gaps in retention. In 2018, the National Academies of Sciences, Engineering, and Medicine released a joint report about the future of graduate STEM education recommending that graduate students ideally should be taught using team-based projects “as a means of developing transferable professional skills such as communication, collaboration, management, and entrepreneurship” (p. 3). The rise of student-centered pedagogies like PBL in graduate school might be valuable beyond STEM programs. Discussions on how to improve humanities instruction has also suggested student-centered, inquiry-based teaching as a solution.

PBL and similar experiential high-impact practices have become increasingly common because of the impact not only on 21st century skills, but on student engagement. As has been demonstrated in undergraduate education (Ahern, Dominguez, McNally, O’Sullivan, & Pedrosa, 2019; Hart, 2019; Stolk & Martello, 2015), graduate students who experience PBL learn an array of professional skills (Brundiers & Wiek, 2013; Wurding & Qureshi, 2015).

Graduate students engage in more advanced levels of knowledge construction in online courses that use PBL than in online discussions during non-PBL competency building assignments (Koh, Herring, & Hew, 2010).

While PBL and similar student-centered experiential pedagogies may be widely used in graduate programs, there is little high-quality research examining the quality of implementation or best practices for bringing PBL to scale in graduate programs.

While PBL and similar experiential high-impact practices have become increasingly common because of the impact not only on 21st century skills, but on student engagement.2 Nationwide, 50% to 60% of students who begin a PhD program do not obtain their doctoral degree.3 Given the evidence base with undergraduates, the possibilities of using PBL to engage graduate students and increase retention hold promise.

This research brief begins with literature describing how PBL can enhance the learning that graduate students traditionally do through research experiences. The ways PBL has been found to support the development of professional skills expected of graduate level training are then explored. Finally, we summarize some critical gaps in the available empirical literature on PBL in graduate education to suggest further study.
Using PBL to Enhance Learning from Research Experiences

Graduate education is designed to train students to become experts in particular fields. For many degrees, this requires students to engage in demonstrations of professional quality scholarship. Learning how to engage in scholarship is naturally experiential and ideally achieved with authentic opportunities to practice. The research on how PBL might be used to scaffold that learning is largely case study in design, conducted with small samples of graduate students as faculty examine the impact of their curricular and pedagogical decisions.4

Perhaps the most direct relationships between PBL and graduate student learning is how it can be leveraged to strengthen students’ mastery of the research process. Sleeter, Schrum, Swan, and Broubalow (2019) documented the benefits of having students in a graduate history program use their own scholarship to create virtual PBL lesson modules. Mallinson (2018) demonstrates how PBL can structure doctoral coursework to help students connect their academic expertise to tangible products of value to industry, nonprofits, and government. This ability to translate scholarly expertise and communicate with multiple audiences—regardless of discipline or subfield—can provide graduate students with skills demanded by employers.

A few studies have more broadly assessed the state of PBL implementation in graduate programs. Brundiers and Wiek (2013) analyzed six problem- and project-based learning courses in sustainability and found wide variety in PBL format (e.g., workshops, hybrid courses combining lectures with student-centered projects), amount of structure, scope of work, and number of projects per course. Using a framework for transformational sustainability research,5 Brundiers and Wiek found that several key principles of PBL are not reliably implemented in graduate studies, including self-directed learning and advanced teamwork. These emergent findings suggest that, while a promising practice, PBL is not yet widely embraced with reliable fidelity in graduate classrooms.

Using PBL to Teach Graduate Students Professional Skills

One of the more compelling benefits of using PBL with students in colleges and universities is its effectiveness at developing a variety of professional skills while students master content.6 Learning professional skills is often part of the hidden curriculum of graduate school, which can be supported through explicit attention.7 Wurdinger and Qureshi (2015) used pre- and post-course surveys to assess changes in graduate students’ life skills in a course using PBL and found statistically significant increases in responsibility, problem solving, self-direction, communication, and creativity. However, there were no measurable changes in students’ time management, collaboration, or work ethic. Further research is needed to validate these findings and expand upon which professional skills are developed indirectly through PBL experiences and which require more direct scaffolding in graduate student populations.

Brownell and Jameson (2004) presented a model that integrates the cognitive, affective, and behavioral learning objectives of problem-based learning, akin to PBL in its experiential pedagogy. Using a historical case study of a graduate management program, Brownell and Jameson demonstrated how such integration leads to professional skills often touted by proponents of PBL. Their analyses of their PBL-based management program indicated that graduate students engage in both analytical learning processes as well as interpretive learning processes to learn how to implement plans, lead teams, resolve conflict, persuade others, and communicate with multiple constituencies during projects.

Graduate education positions students differently than undergraduate education; this calls into question how the existing rich body of research on PBL with undergraduate students might be extended to fully understand the potential of PBL. For example, graduate students are often positioned as instructors, in addition to contributing to original research. In their exploration of sustainability courses, Brundiers and Wiek (2013) point out that positioning doctoral students as PBL coaches with undergraduate students provides them with experience using PBL teaching techniques, as well as practicing principal investigator roles. Further research in understanding whether and how such positioning benefits graduate students in their professionalization would provide a more compelling argument of this contribution to graduate student experiences.

Using PBL in Online Graduate Courses

Much of the attention in the literature on PBL in graduate school has focused on how to use instructional technology to leverage its benefits with adult learners. Some of these
studies have revealed that issues that sometimes plague online learning more generally, such as the risk of low-quality discussion and uneven student participation, can still occur when using PBL online. The majority of these studies are also limited to single case studies with varying degrees of attention to transferability to new contexts and constructing or validating theoretical frameworks. Even so, some trends have emerged across cases.

There is moderate evidence that students learn more online when participating in PBL, compared to other pedagogies. Koh, Herring, and Hew (2010) compared the depth of knowledge construction among 17 graduate students during non-PBL and PBL components of an elective course in a school of education. In the first part of the course, students were asked to demonstrate competency in a series of e-learning courseware technical skills while participating in online discussions of how to apply theoretical principles to these tasks. Students then completed individual projects to develop e-learning courseware to address the learning needs of a self-selected target audience. Using qualitative content analysis of students’ posts, Koh and colleagues found that during PBL, students were significantly more likely to engage in advanced levels of knowledge construction instead of more superficial exchanges, compared to their exchanges during the non-PBL competency building assignments.

Based on these findings, Ching and Hsu (2013) studied the role of peer feedback in providing learning supports that boost knowledge construction among graduate students. Twenty-one students enrolled in an instructional design course engaged in peer feedback exchanges while completing group instructional design projects. An evaluation of the course found that students used the opportunity to provide and receive feedback to “validate ideas, identify issues, and revise drafts into a well thought-out project,” improving students’ learning beyond their own initial independent work. When prompted mid-course to focus more on assessment of their peers’ demonstration of content knowledge, peer feedback increasingly involved problem identification and suggestions, which points to the importance of instructor guidance in the quality of peer feedback among graduate students. The study was limited by an exploratory, descriptive design, however; there is much to be further studied related to how peer feedback works and how to best leverage its power.

Another mechanism for structuring online communication that has been investigated is mob programming, which comes from professional problem-solving practices in industry. In this tactic, a group of programmers with varying types of expertise and perspectives works on a problem simultaneously to maximize synergy and creativity. Each “programmer” in the “mob” is assigned a particular role: most members of a team are “navigators” discussing the idea to be coded, while one person serves as the “driver” who translates the discussion into code and types it into the group’s computer. Programmers take turns cycling through the different responsibilities. Hilton and Sankaranarayanan (2019) assessed the efficacy of mob programming with undergraduate and graduate students and found that the clear definition of roles and rotation across them affords graduate students opportunities to understand the value of multiple perspectives while building multiple competencies.

As the research in online PBL continues to mature, we might anticipate evidence of additional mechanisms to emerge.

Case Studies of Project-Based Learning in Graduate Education

There are several case studies describing PBL implementation in graduate-level courses and programs (see Table 1). PBL at the graduate level is frequently employed as a pedagogical bridge to research and service-learning experiences, often in the context of studies that defy traditional disciplinary boundaries. We suggest these case studies as further reading. These articles provide details on how PBL has been deployed in particular graduate level courses and programs, which may be both inspiring and informative.
Table 1. Case Studies of Project-Based Learning in Graduation Education

<table>
<thead>
<tr>
<th>Citation</th>
<th>Institutional Context</th>
<th>PBL Practices Studied</th>
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<tbody>
<tr>
<td>Ge, X., Huang, K., &amp; Dong, Y. (2010). An investigation of an open-source software development environment in a software engineering graduate course. <em>Interdisciplinary Journal of Problem-Based Learning</em>, 4(2).</td>
<td>A major southwestern university</td>
<td>PBL in a graduate software engineering course, with authentic projects, a learning community, cognitive apprenticeships, and technology affordances</td>
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<tr>
<td>Saleh, A., Cox, D., Fowler, T., &amp; Duncan-Shemwell, B. (2010). Student and facilitator engagement to develop leadership competencies in a project-based learning environment. <em>Academic Leadership: The Online Journal</em>, 8(2), Article 38.</td>
<td>Data on the institutional context was not given</td>
<td>Redesign of a capstone portfolio to bring PBL to scale in an educational leadership program; focused on process evaluation with some assessment of impact for one cohort of doctoral students.</td>
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</table>

Conclusions & Future Research

There are several effects of PBL that hold promise for graduate programs, yet have been under-examined in the existing empirical literature. Student-centered experiential learning experiences have been demonstrated to increase student retention as students transition from high school to community college, persist through developmental coursework, earn an associate’s degree, and/or transfer to a 4-year institution. However, there are no existing studies of whether this benefit extends through graduate degree attainment. Given that an estimated half of all doctoral students do not persist to degree and findings that PBL can engage students early in degree pathways, such examination of persistence to graduate degrees may be warranted.

At the undergraduate level, PBL has been found to be an effective pedagogy for facilitating interdisciplinary learning. Graduate programs are increasingly focused on emerging areas of expertise that require multi- and interdisciplinary training, such as understanding the food, energy, water nexus, and developing effective human health systems. PBL may be particularly useful in such programs with its focus on authentic learning objectives and adaptability for multi-disciplinary teamwork.

Finally, there is scant research examining how to bring PBL to scale in graduate programs. The majority of research at the graduate school level involves descriptive case studies of PBL in single courses. This makes it difficult to assess the cumulative benefits for graduate students who engage in PBL across multiple learning experiences. Without systematic examination, it is difficult to understand the best practices for transforming departments and academic fields in ways that balance pragmatic realities of higher education against the intended outcomes for the next generation of scholars.
Notes


8 See Akarasriworn, C., & Ku, H. Y. (2013). Graduate students’ knowledge construction and attitudes toward online synchronous videoconferencing collaborative learning environments. Quarterly Review of Distance Education, 14(1).


Works Cited


