PBL BRIEF #5

WPI

Project-Based Learning in the First Year

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Briefer Brief

- First Year Experiences (either dedicated programs or courses) have become increasingly popular, offered at three out of every four colleges and universities (Young, 2018).
- Studies of FYEs that use PBL have established the ability of such courses to advance students' communication skills (Degenhardt, & Woodard, 2019), critical thinking (Brown, Calkins, & Davidson, 2020; Hutchingson, 2016), leadership (Hennessey & Primeau, 2016), information literacy (Johnson, Prucha, & Roter, 2008; Hutchinson, 2016), and other skills and dispositions critical to thriving in college-level coursework.
- Much of the scholarship about PBL in the first year is limited to examination of individual courses or a set of related courses within a single program.

Introduction

First year experiences (FYE), which can include courses, extracurricular programming, and dedicated housing to support the transition to college, have been demarcated as a high-impact practice at the college level.[1] There is great variation in how FYE courses and programs are structured to fit into particular institutional contexts and priorities. Some FYE courses are designed to recruit and support BIPOC and/or first-gen students[2]; other FYE programs are open to all students within a major or even institution-wide. The curricula of FYEs range from directly teaching students how to navigate college and improving study skills to introducing students to particular fields of study and exploring grand challenges through multiple disciplinary lenses.[3] What is common across FYEs—regardless of structure, student populations, and student learning objectives—is the desire to intentionally intervene during the first year to assist students in transitioning to college. The goal is always to improve student experiences and achievements.

Student-centered, experiential pedagogies such as project-based learning (PBL) have become widely adopted within FYEs across the variety of course structures and curricula. PBL's demonstrated effectiveness at advancing students' pre-professional skills and dispositions makes it a compelling choice for FYE courses.[4] Several studies have determined that first year students are more capable of engaging with advanced concepts and problems than previous curricular sequences have assumed.[5] First year students can benefit from PBL to accelerate scientific literacy and other foundational mastery in preparation for college-level coursework.[6] Using PBL to engage in challenging, yet appropriately scaffolded, early learning experiences can increase first year students' academic self-efficacy[7]—a key component to continued success.

This research brief focuses on the scholarship examining PBL implementation and impact in FYE courses and programs. Student learning outcomes related to skills and dispositions advanced through PBL in FYEs are reviewed, followed by a deeper examination of PBL in STEM-based FYEs, where the majority of existing publications are focused. The challenges and lessons for implementation are summarized across a sample of lessons shared by FYE faculty using PBL. The brief then summarizes exemplar case studies on the use of PBL in a variety of FYE courses and programs as a guide to further reading and concludes with recommendations for future study.

Advancing Skills and Dispositions in the First Year

Faculty charged with designing FYEs are often tasked with developing student skills and dispositions that will support their success in subsequent years. Early successes in FYEs are intended to influence short-term outcomes,

such as retention, as well as long-term outcomes, including completion to degree and professional success after graduation. Studies of FYEs that use PBL have established the ability of such courses to advance students' communication skills,[8] critical thinking,[9] leadership,[10] information literacy,[11] and other skills critical to thriving in college-level coursework. These academic abilities are distinct from content knowledge; the possibility of developing these skills and dispositions *in addition* to content knowledge makes PBL appealing to many FYE instructors. They are also in high demand by industry leaders.[12]

In addition to specific skills, PBL is often chosen to develop student dispositions, which are arguably harder to impart yet even more important.[13] Engineering-focused FYEs have implemented PBL to encourage an entrepreneurial mindset,[14] creativity,[15] and human-centered design.[16] In the liberal arts, PBL can assist first year students learn how to construct personal meaning[17] and to value a well-lived life beyond career productivity.[18] Comfort with interdisciplinarity has also been found to increase when PBL is used.[19]

FYE leaders argue that establishing these dispositions early through opportunities for student choice, collaboration with peers, and connection to authentic problems positively influences students' subsequent pathways through their college experiences. Embedding PBL in the first year, rather than waiting for capstone projects and undergraduate research experiences available to upperclassmen, better prepares students to take ownership over their own learning.[20]

Providing Authentic Early Stem Experiences

The vast majority of recently published studies about PBL in FYEs have been in STEM courses. This follows a broader trend of PBL adoption in STEM disciplines, due in part to the pre-existing preponderance of experiential learning in engineering and science labs. The value of using a PBL approach in these courses lies in several features: authentic problems connect students to the pressing social issues engineering and science address;[21] collaborating on teams reflects the social realities of STEM careers;[22] and the open-ended nature of PBL prepares students for the ambiguity they must learn to manage while tackling grand challenges and wicked problems.[23]

Each of these facets of PBL defies common first year student assumptions about engineering.[24] Using PBL in first year engineering courses can help students become familiar with the realities of professions before making decisions about whether to continue or leave engineering pathways through subsequent coursework.[25] FYEs with this objective often span multiple engineering programs to allow students to examine their assumptions about potential majors and to explore similarities and differences across fields.[26]

The student choice and authentic connection to community involved in PBL can be particularly engaging for underrepresented minority students in STEM, including BIPOC students and women students.[27] FYEs designed to recruit and retain underrepresented minority students in STEM pathways can leverage these benefits by using PBL.[28] The ownership that students have over their learning in PBL can build students' self-efficacy[29] and reward intrinsic motivation[30] when students' ideas and problem solutions prove successful. For underrepresented minority students, this experience may counterbalance messages that they are not welcome in STEM fields, conveyed through lack of inclusivity within faculty and mentoring experiences.[31] However, there has been little systematic investigation into whether and how these mechanisms provide particularly benefits for underrepresented minority students in FYEs using PBL.[32]

Implementation Challenges and Lessons for FYEs

There are a plethora of conference papers describing implementation of PBL in FYEs, primarily in engineering and other STEM fields with a strong history of discipline-based education research. Descriptions of PBL curricula in FYEs often provide details on assignments (see the case studies in Table 1). A subset of faculty have shared how they structure their PBL assignments and manage logistics in response to widespread beliefs that PBL requires a level of planning and preparation that can be prohibitive.[33] Although the majority of these conference papers and articles do not articulate an appropriate research methodology for studying implementation, the pedagogical details shared have value as examples for those in similar contexts.

Facilitating effective collaboration and the logistics of teamwork is a particular trend in implementation narratives.[34] For example, Clavijo and Pochiraju (2019) focused on strategies to maximize student satisfaction with

team dynamics using the CATME team maker (https://info.catme.org/) and gradually scaffolding additional team and topic choices as first year students mature. Gender roles and tactics for ensuring inclusive, equitable teamwork during first year project work have also been explored, given the need to explicitly attend to these dynamics.[35] Developed while co-teaching an interdisciplinary first year seminar, Stoddard and Pfeifer have created an open educational resource for fellow faculty hoping to reduce stereotype threat and task assignment bias on student teams (https://digital.wpi.edu/concern/generic_works/v692t890f).

Translating PBL for large enrollment courses is another area of implementation frequently highlighted, largely in response to faculty skepticism. Embedding PBL into large introductory courses can be an effective means of engaging students in an otherwise didactic, passive learning environment.[36] Several faculty, particularly in STEM, have suggested injecting active learning assignments that are hands-on and increase experiential learning, yet do not involve a full PBL curriculum (e.g., no open-ended problem examined over the course term).[37] These steps toward a more PBL-like curriculum may provide a stepping-stone for curious faculty, particularly in large enrollment courses where yielding control to students may seem too overwhelming. These studies have great merit in describing implementation possibilities beyond early adopters of PBL in FYEs.

Together, the body of scholarship on PBL implementation in FYEs confirms: a single project experience cannot achieve all potential objectives. As Stolk and Martello (2018) suggest, we must ask "What are we trying to support or achieve with this project?" in order to draw our attention to the factors that matter most for any particular assignment. The objectives of each FYE within its institutional context—the students to be served, the professional development available for faculty—must be taken into account to determine whether and how PBL might be of service.

Case Studies of Project-Based Learning in FYEs

For those interested in how PBL has been implemented in FYEs and the resulting impacts, reviewing what others have done can provide inspiring examples and persuasive motivation. We have organized a set of case studies of PBL by type of FYE (see Table 1). These articles provide examples of PBL curricula, assessments, and other teaching practices which may be useful in envisioning what PBL might look like in your own FYE course or program.

Table 1. Case Studies of PBL in First Year Seminars

Seminar Type	Focus and Description	Case Studies Using PBL
Extended orientation seminars	Helping students transition to college by introducing the purpose of higher education and teaching students how to navigate college success. Includes learning about campus resources, study skills, academic and career planning, and strategies for health and wellness.	Veach, C. C. (2019). Breaking out to break through: re-imagining first-year orientations. *Reference Services Review, 47*(4), 556-569. Boss, K., Angell, K., & Tewell, E. (2015). The Amazing Library Race: tracking student engagement and learning comprehension in library orientations. *Journal of Information Literacy, 9*(1), 4-14.
Academic seminars with uniform content across courses	The academic transition from norms in high school to the expectations in college. Includes skill-building in writing and critical thinking, often within the context of themes designed to be engaging for first-year students. All first year students receive the same course content.	Bleicher, E. (2020). Teaching Critical University Studies: A First-Year Seminar to Cultivate Intentional Learners. *Honors in Practice – Online Archive,* University of Nebraska – Lincoln.
Academic seminars with variable content across courses	The academic transition from norms in high school to the expectations in college. Includes skill-building in writing and critical thinking; themes are likely to be related to a particular discipline or profession. First year students have a choice over different course topics.	Wobbe, K. K., & Stoddard, E. A. (2019). *Project-based learning in the first year: Beyond all expectations.* Stylus Publishing.
Pre-professional or discipline-linked seminars	Preparing students with foundations for particular professions or disciplines. May be required for a degree program even if first year seminars are not required of all students university-wide.	Sundaram, R. (2016, October). Engage and educate: Engineering laboratory activities for first-year engineering students. In *2016 IEEE Frontiers in Education Conference* (pp. 1-5). Vernaza, K. M. (2017). Developing team-work skills in a first-year seminar. Paper presented at ASEE Zone II Conference.
Basic study skills seminars	Explicitly focused on college-level skill development. Typically target underprepared students, sometimes as a condition for admission.	Hottell, D. L., Martinez-Aleman, A. M., & Rowan-Kenyon, H. T. (2014). Summer bridge program 2.0: Using social media to develop students' campus capital. *Change: The Magazine of Higher Learning, 46*(5), 34-38.

Note: The typology of seminar types and descriptions in this table are modified from "Helping first-year college students climb the academic ladder: Report of a national survey of freshman seminar programming in American higher education" by B. O. Barefoot (1992), dissertation, College of William and Mary; as used by the National Resource Center for the First-Year Experience and Students in Transition at the University of South Carolina

Conclusions & Future Research

PBL is a promising pedagogical choice for heightening the impacts of FYEs. However, the potential has been less rigorously examined in the context of FYEs—particularly those outside of STEM—than other aspects of this widespread, high-impact practice. Much of what has been published on PBL in FYEs has involved faculty members' scholarship of teaching and learning in their own courses and programs, with findings primarily presented in conference papers and journals dedicated to first year programming or experiential education. These curricular descriptions may serve as descriptive resources for colleagues in planning FYEs. However, in terms of systematic knowledge development, there are widespread methodological limitations.

One major limitation is how small the sample sizes are, typically within single courses, in studies using quantitative assessment data; this makes it difficult to accurately detect relationships and limits generalizability of findings. Some studies draw on larger samples by combining courses within a college or university's program (e.g., Krsmanovic, 2021; Nguyen, Wu, Fischer, Washington, & Warschauer, 2020). These studies have corroborated many of the micro-trends found in individual case studies of PBL in FYEs with stronger methodological designs. However, small sample case studies are, by far, the predominant design in published studies.

There are several benefits of PBL that hold promise for FYEs—and indeed may motivate its adoption—that have been under-examined in FYEs. PBL boosts student motivation and self-efficacy,[38] provides opportunities to practice self-regulated learning,[39] connects content to applications for various stakeholders,[40] and can teach students how to manage team dynamics.[41] These are skills that provide long-term outcomes for students. However, much of the scholarship on PBL within FYEs has been limited to analyses of short-term outcomes within the FYE course studied. The potential for more distal outcomes has yet to be widely assessed.

There is little research regarding how to bring PBL to scale in FYE programs, which reflects research trends in higher education more broadly. Many FYEs are born of strategic plans and institutional priorities, with their intended impacts discussed broadly in terms of recruitment, retention, and students' postbaccalaureate success. Yet there seems to be little evidence that bringing PBL to scale within FYEs across a college or university increases the beneficial impact for students, faculty, and the institution as a whole. As a result, the attention is drawn to singular course contexts, rather than addressing institutional-level needs, supports, changes, and benefits. Moving beyond individual case studies and analyses of assessments in single settings would advance our knowledge of PBL's value to FYEs, clarifying which aspects of PBL are most beneficial, for whom, and under which conditions.

Notes

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