Beyond PBL: The Value of Stacking High-Impact Practices

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1 Introduction

High-impact practices are widely accepted to improve student learning of professional skills necessary for addressing the world's major STEM challenges [1] Some have also been demonstrated to support retention [2-3]. Experiencing high-impact practices can increase educational outcomes for all students while potentially leveling the STEM playing field for marginalized students [4-6]. For institutions of higher education, this can maximize institutional success and improve efficiency while benefitting society through broadening the talent pool tackling sustainable development goals.

There are two approaches to expanding access to high-impact practices for undergraduate STEM students. The first involves scaling up high-impact practices. The vast majority of studies examining HIPs have involved isolated courses and boutique programs with limited reach (see [7] for a notable exception). Increasing high-impact practices might involve creating new graduation requirements around mandatory participation in high-impact practice (e.g., [8-9]) or incentivizing adoption by more faculty (e.g., [10]). Strong cultural traditions allowing faculty autonomy over their teaching practices may limit the spread of high-impact practices within institutions, as has been the case with other teaching innovations [11-12].

The second possibility for expanding access offers depth over breadth. Stacking multiple high-impact practices has been demonstrated to hold potential as a multiplier effect [13,4,14-15]. Where experiencing a single high-impact practice is good, experiencing more than one can be even better. In this study we ask, To what extent does stacking additional high-impact practices on top of course-based PBL provide additional benefits for students? We examine this potential value in terms of the range of benefits previously associated with PBL: developing professional skills and mindsets, as well as building content mastery; improving self-efficacy and ownership over learning; and career preparedness. We then extend these well-established impacts of PBL by exploring two additional outcomes, long-term benefits to students' personal lives and achieving work/life balance after graduation, within the context of stacking multiple high-impact practices.

These analyses are made possible with the use of an alumni survey at Worcester Polytechnic Institute where all undergraduate students complete multiple projects in order to graduate. According to an externally conducted study in 2018, 70% of faculty reported using PBL in their courses. By 2021, 98% of surveyed alumni indicated that they had projects in at least 25% of their courses. In addition to course-based projects, all undergraduate students complete two major projects. One is a team-based project addressing a problem at the intersection of

technology and society. These projects are most often in collaboration with an industry, governmental body, or community-based organization. In the final year, all students complete a capstone in their major area of study that again can be done in collaboration with industry or other organizations. Eighty-five percent of our students complete one or both of these required projects by traveling to one of 45 global project centers for seven weeks, combining a global experience with a community-based learning experience. In addition to these required projects, students also have the option to participate in an interdisciplinary first year course designed to explore great problems in the world.

Together, these offerings allow for a unique opportunity to examine a range of outcomes associated with stacking high-impact practices on top of PBL that is facilitated within a classroom. The study contributes a new frame for thinking about expanding access to high-impact practices and scaling their implementation: considering the relative value of spreading a single high-impact practice, in this case, course-based projects, against the value of providing each student with the opportunity to experience multiple high-impact practices.

2 Literature Review

When implemented well, project-based learning (PBL) has been documented to have broad impact on undergraduate students and it has been widely embraced in undergraduate STEM programs [9]. PBL can be used to develop professional skills such as communication and project management [16-18] that are vital for engineers, yet not always taught in technical courses. While learning skills that are useful in completing projects - which are arguably what engineers do for much of their careers - students also develop stronger sociocognitive processes that aid in learning. PBL has been demonstrated to support growth in motivation [19], self-regulation [20], and self-efficacy [21]. High-impact practices in STEM, specifically, have been shown to have a significantly positive relationship to degree attainment for transfer students, adding another layer to our understanding on the potential equity and inclusion benefits of HIPs.

Skills and mindsets developed through PBL can then set students up for success in their careers [22-23]. Technical skill is only as useful as it can be communicated with colleagues and stakeholders while navigating the ambiguity of scoping and addressing open-ended problems. In fact, a recent study of employers conducted by the AAC&U found that the ability to work effectively in teams, to apply knowledge and skills in real-world settings, ethical judgment and reasoning, and the ability to communicate through writing - all skills developed through PBL - are among the top ten skills in demand by employers [9].

These benefits of PBL are often structured through scaffolded teamwork [24] with authentic challenges set by community-based or industry sponsors [25]. While there is a wealth of descriptive studies that illustrate instances of these projects to describe why and how such

features matter, there is far less analysis of their relative importance. The initial wave of PBL research was almost entirely theoretical and opinion-based; the second wave was comprised largely of case studies of individual courses and isolated programs with little methodological rigor. As traditional lecture-based teaching remains widespread in undergraduate STEM education [26], this study questions the premise that a single project experience might be sufficient for deeply countering the tide of passive learning provided elsewhere in the curriculum.

3 Methodology

The study is designed to address the overarching research question, "To what extent does stacking high-impact practices on top of project-based learning increase the benefits to students?" We replicated an experimental design using propensity score matching. Propensity scores were calculated using a combination of a set of variables including gender, race/ethnicity, graduating class year, whether or not they traveled off campus to complete the third year project, and the proportion of their courses that included project work.

Each alum who participated in GPS was then matched to an alum who did not participate in GPS using propensity scores. A random number generator was used to choose matches where more than one non-GPS participant with the same propensity score was available. In cases where there was no exact match available, a non-GPS participant with the next closest propensity score was matched to the GPS alum. This method imitates the results of random assignment of students to the two conditions (i.e., participating in a first year experience and not).

3.1 Participants

Sampling for the study involved a stratified approach. A random selection of alumni who had not been invited to participate in the most recent prior alumni study were invited to respond to the survey. The resulting pool of 2,336 respondents reflect a convenience sample from which we enrolled all 210 alumni who had participated in the first year experience, due to this being the most limited high-impact practice in this study's setting. These participants were then matched with participants who did not enroll in a GPS course using propensity score matching procedures that expanded the sample to 420 alumni.

The resulting total of 420 alumni were included as participants in the study. Within this sample, 59% reported identifying as a woman and 41% reported identifying as a man, which overrepresents a gender marginalized in STEM. The racial/ethnic representation is more typical, with 17% of the sample indicating they are BIPOC (Black, Indigenous, Person of Color) and 83% white. Students' major areas of study are in line with the institution's focus: 66% majored in an engineering program, 26% in a science program, and 4% in another field.

3.2 Measures

Data were collected through an alumni survey that was administered in March 2021. A Qualtrics survey was emailed to 15,528 alumni with a reminder sent only to those who had not submitted a response one week later. The following survey items were used to construct measures for these analyses.

3.2.1 Development of Professional Skills and Content Mastery

Gains in three types of professional skills were assessed using survey items. A composite measure for each of three types of skills was constructed using items that began with the prompt, "Indicate the extent to which your project experiences (through GPS, HUA capstone (inquiry seminar/practicum or sufficiency), your IQP, and/or your MQP) enhanced your ability to…" Response options were on a five-point Likert scale from not at all (1) to very much (5). Teamwork skills used responses to five items: interact effectively as a professional, effectively manage interpersonal dynamics, effectively function on a team, effectively manage a project, and be an effective leader. Communication skills were assessed using four items: write clearly and effectively, speak clearly and effectively, communicate effectively visually (by using images or graphics to convey information, data, or ideas), and deliver effective presentations. Cross-cultural skills were assessed using six items: view issues from several different perspectives, understand people of other racial identity and ethnic backgrounds, understand people of other cultures, respect for cultures outside your own, understand the connections between technology and society, and understand global issues. Skills using information included four items: integrate information from multiple sources; make connections across disciplines; identify, analyze, and solve problems creatively through sustained critical investigation; and develop ideas.

In addition to professional skills development, items from this section of the survey were also used to assess development of content mastery. This composite item averaged responses to two items: development of a solid base of knowledge and mastery of fundamental concepts and methods in your major.

3.2.2 Long-term Outcomes

Four long-term outcomes are examined in this study, also using survey data. Unlike professional skills and content mastery, each of these variables was constructed from a single survey item. Career preparedness was assessed by asking, "How well did your project experience at WPI prepare you for your current career?" Response options were on a five-point Likert scale from very poorly (1) to very well (5) with an additional option to indicate "not applicable." The second long-term outcome asked alumni to "Indicate the extent to which your WPI formal

project experience…contributed to helping you develop a stronger personal character." This was followed by a definition of strong personal character with several examples of relevant characteristics. Response options were on a five-point Likert scale from not at all (1) to very much (5). The third long-term outcome asked alumni the extent to which formal project experience "contributed to enriching your life in ways that were not necessarily academic or work-related." As with the item on personal character, this item also gave a formal definition and examples and used a similar five-point Likert scale. The final long-term outcome asked alumni the extent to which formal project experience "contributed to achieving work-life balance," which used the same five-point Likert scale.

3.2.3 Educational Activities

This study uses several variables describing participants' experiences with high-impact practices. The first high-impact practice assessed was project-based learning. The survey asked respondents, "What percentage of your courses included project work at WPI?" Response options were ordinal: none, about 25%, about 50%, about 75%, and nearly all.

Second, the survey asked respondents to indicate whether they participated in the Great Problems Seminar, as this is an optional learning experience. The survey prompted respondents, "For each of the following aspects of your time as an undergraduate at WPI, indicate how and to what extent it affected you after having completed your undergraduate studies at WPI." Response options included a five-point bi-directional Likert scale from very negatively (1) to very positively (5), with an additional option to indicate "not applicable" for activities in which the respondent did not participate. One of the learning activities listed was the Great Problems Seminar, which was included only for those who enrolled in one of these seminars while at WPI.

Next, the survey asked respondents to indicate whether they completed each formal project on campus or off campus; the number of off campus projects was tallied and converted to a variable on the number of global experiences. Another item asked respondents, "How much did you learn about working with members of a local community during your IQP experience?" Response options included: nothing, a little, a moderate amount, a lot. A third variable was constructed from the item described above asking how much the IQP affected them after WPI. Finally, we used another item responding to that same question stem to assess the impact of the MQP, which is a design project in the student's major area of study that meets the ABET capstone requirement.

3.2.4 Control Variables

Three control variables were measured also using survey responses. The first is an indicator variable for respondents who reported being a woman. The second is an indicator variable for

those who reported being BIPOC (Black, Indigenous, Person Of Color), which included those who indicated their race or ethnicity included being Black, Hispanic/Latino, Indigenous/Native American/Native Alaskan, Native Hawaiian or other Pacific Islander, or Middle Eastern or Northern African. Finally, we include a measure of response bias to account for any respondents providing a more positive or more negative reflection of their undergraduate experiences because of their current life. This variable uses a survey item that asked "Overall, how satisfied are you with your career thus far?" Response options were on a five-point bi-directional Likert scale from very dissatisfied (1) to very satisfied (5), with an additional option to indicate "not applicable." The logic for using this item as a measure of response bias is that the extent to which someone is satisfied with their career might likely color their estimation of how useful their undergraduate education was to them.

3.3 Data Collection

Data were collected using a survey of alumni to report their experiences with each high-impact practice and their self-assessment of how much their formal project experience influenced the development of skills and mindsets and impacted various aspects of their lives after graduating. All alumni who graduated from WPI between 1970 and 2019 who had emails available in the institution's extensive alumni database were invited to respond to the survey between March 2021 and April 2021. The survey was administered virtually through Qualtrics and managed by the institution's Office of Institutional Research and Strategic Decision Support.

3.4 Analysis

Hierarchical multiple regression was used to model the extent to which various educational experiences predicts student outcomes. This analytical strategy allows us to not only assess which predictors are significant effects for each outcome; it also allows us to compare the relative explanatory power of each block of variables. Stacking high-impact practices in the order students experience them provides an assessment of their individual, relative, and cumulative value.

For each outcome, five models were constructed and assessed. The first is a control model, which included three variables: whether the student identifies as a woman, whether the student holds a BIPOC racial/ethnic identity, and an indicator of response bias via career satisfaction.

The second model adds a measure of how widespread PBL was in the students' coursework.

The remaining three models assess the additional predictive power of stacking other high-impact practices on top of the course-based PBL included in the second model. The third model adds a description of students' engagement in first year experiences through two variables: whether or

not the student participated in a first year seminar and a bidirectional measure of first year seminar quality (see measures for how this variable was constructed for those who did not participate in a first year seminar).

The fourth model then adds three variables describing the global learning and community-based learning experiences: the number of global experiences the participant had, the extent to which they learned from the local community, and the quality of the technology and society project experience.

The final model describes the capstone experience with a single indicator of capstone quality.

4. Findings

The findings in this study are presented in three stages. The first stage explores whether any of the control variables influences the set of outcomes examined in this study. The second stage then establishes the extent to which course-based projects effects the development of various skills, content mastery, career preparedness, and long-term personal outcomes after controlling for demographics and response bias. The third stage assesses the value of stacking the additional four HIPs together on top of course-based PBL for the same series of short- and long-term outcomes.

4.1 Demographics and Response Bias

In the first stage of findings, we examine a set of hierarchical linear regression models that were constructed with only the control variables as predictors. These included participant demographics (indicators of marginalized gender and marginalized race/ethnicity) and an indicator of response bias. The control model explained a significant portion of the variance for each outcome variable (see Tables 1 & 2). Women reported greater outcomes than men for developing each type of skill, but not for content mastery (see Tables 1 & 2). Women also reported greater outcomes than men for enrichment of their lives long-term. This confirms findings from an earlier alumni study at this university that demonstrated greater impact of PBL experiences for women [8].

Response bias was also significant predictor of each outcome with the single exception of enriching their life in non-academic ways (see Tables 1 & 2). This pattern of findings validates the need to include this measure in the control model before assessing the explanatory power of variables describing participation in high-impact practices.

Table 1. Hierarchical Linear Regression Modeling of Skills Development & Content Mastery with Stacking High-Impact Practices

Independent Variables	Teamwork Skills	Communica-tions Skills	Cross-Cultural Skills	Information Use Skills	Content Mastery
Model 1: Controls					
Woman	.13*	.11*	.08*	.11*	.06
BIPOC	.01	<.01	.02	<.01	-.01
Career Satisfaction	.19*	.15*	.11*	.24*	.17*
R^2	.12*	.09*	.08*	.15*	.07*
F	20.14	15.07	13.79	25.77	12.09
Model 2: PBL					
PBL in Courses	.18*	.17*	.14*	.18*	.15*
R^2	.17	.14	.13	.20	.11
ΔR^2	.05*	.05*	.05*	.05*	.04
Δ F	26.58	23.02	21.42	28.44	17.95*
Model 3: FYE					
GPS Participation	-.03	-.06	<.01	-.05	-.03
GPS Quality	.16*	.13*	.15*	.12*	.06
R^2	.21	.17	.17	.23	.11
ΔR^2	.05*	.03*	.05*	.03*	.01
Δ F	12.06	8.24	12.74	8.06	1.46
Model 4: Global & Community-based Learning					
# Global Experiences	.04	.06	.13*	-.02	-.06
Community Learning	.18*	.19*	.33*	.22*	.16*
IQP Quality	.16*	.13*	.21*	.15*	.02
R^2	.29	.24	.40	.31	.13
ΔR^2	.08*	.08*	.23*	.09*	.03*
Δ F	15.81	14.83	52.51	17.48*	4.27
Model 5: Capstone					
Capstone Quality	.12*	.19*	.13*	.23*	.33*
R^2	.30	.27	.41	.36	.23
ΔR^2	.01*	.03*	.02*	.05*	.10*
Δ F	7.68	19.03	11.22	30.05	53.48

Note. *denotes statistical significance, set at p<.05

Table 2. Hierarchical Linear Regression Modeling of Skills Development & Content Mastery with Stacking High-Impact Practices

Independent Variables	Preparing for Your Career	Developing a Stronger Character	Enriching Your Life	Achieving Work/Life Balance
Model 1: Controls				
Woman	.03	.08	.10*	.04
BIPOC	.01	.04	<.01	.03
Career Satisfaction	.33*	.22*	.07	.13*
R^2	.17*	.12*	.05*	.05*
F	29.17	20.68	8.37	6.50
Model 2: PBL				
PBL in Courses	.14*	.14*	.08	.09*
R^2	.20	.16	.06	.06
ΔR^2	.03*	.04*	.02*	.02*
Δ F	14.95	18.22	6.88	7.07
Model 3: FYE				
GPS Participation	<.01	<.01	-.06	-.10*
GPS Quality	.14*	.14*	.07	.11*
R^2	.22	.19	.08	.09
ΔR^2	.03*	.04*	.02*	.03*
Δ F	7.59	9.63	3.51*	6.83
Model 4: Global & Community-based Learning				
# Global Experiences	<.01	.05	.25*	.07
Community Learning	.18*	.18*	.23	.09*
IQP Quality	.04	.15*	.13*	.15*
R^2	.25	.27	.24	.15
ΔR^2	.04*	.09*	.17*	.05*
Δ F	6.82	16.58	31.38	8.71
Model 5: Capstone				
Capstone Quality	.14*	.19*	.09*	.13*
R^2	.27	.31	.27	.16
ΔR^2	.02*	.03*	.01*	.02*
Δ F	9.45	20.11	4.10	7.23*

Note. *denotes statistical significance, set at p<.05

4.2 The Effects of Course-Based PBL Dosage

The second stage added the proportion of courses that included project work as a second set of models. The course-based projects model explains an additional two to five percent of the

variance in the outcome variables (see Tables 1 & 2). This represents significant increases in explanatory power over that of the control models. The second set of models establishes that course-based projects confer widespread benefits within the context of this case.

4.3 The Effects of Stacking HIPs

In the final stage, we added each of the four other high-impact practices in turn to construct a series of third, fourth, and fifth models. These demonstrate whether each of these HIPs provides additional benefits to students within the context of course-based PBL. First we modeled outcomes related to teamwork skills development, followed by long-term career-related and personal outcomes.

4.4 Skills Development

After controlling for demographics and response bias, and after taking into account the influence of course-based PBL, three types of skills that alumni attributed to project work were significantly and positively influenced by all four additional high-impact practices (see Table 1). Teamwork skills, communications skills, and information use skills were all positively influenced by stacking first year experiences, global experiences, community-based learning, and capstones on top of course-based projects. Participating in a first year experience regardless of its quality was not a significant factor for developing these skills; nor was participation in a global experience. Each of these sets of high-impact practices explains an additional 1% to 9% of skills development attributable to project work, above and beyond prior learning experiences. A total of 27% to 36% of the variance in these outcomes was explained by the significant predictors in these models.

The development of cross-cultural skills was also significantly strengthened with the addition of stacked high-impact practices. In addition to being significantly increased by the quality of a first year experience, the extent learned from the local community, the quality of the community-based project experience, and the quality of the capstone experience, the development of cross-cultural skills is also increased through the number of global experiences (see Table 1). The final full model explains 41% of the variance in this outcome.

4.5 Content Mastery

After accounting for the influence of response bias and the dosage of course-based projects, content mastery was also significantly increased through two additional high-impact practices: the extent learned from the local community and the quality of the capstone experience (see Table 1). The final full model explains 38% of the variance in this outcome.

4.6 Career Preparedness

Three of the four high-impact practices had a unique influence on preparing students for their careers after controlling for the influence of course-based PBL, student demographics, and response bias (see Table 2). There were a few particularly noteworthy trends within these findings. First, while first year experiences contributed a significant addition to the explanatory power of the model, participation alone was not a significant predictor. The quality of the first year seminar determined its influence on career preparation. Second, the impact from global and community-based learning depended entirely on how much alumni reported learning from the local community during the experience. Together, these point to the critical need to attend to the quality of implementation when relying on high-impact practices as a differentiator for a program or institution. Altogether, the full model accounted for 27% of the variance in this outcome.

4.7 Long-term Personal Outcomes

All four high-impact practices provided additional explanatory power after controlling for the influence of course-based PBL, student demographics, and response bias (see Table 2). Similar to career preparation, quality of implementation was significant when participation was not for the influence of first year experiences on developing a stronger personal character; a similar pattern emerged for stacking global learning on top of course-based PBL and first year experiences. It is also worth noting that global and community-based learning had twice to three times the explanatory power of any other high-impact practice when it comes to developing a stronger personal character. The full model accounted for 31% of the variance in developing a stronger personal character.

Three high-impact practices - first year experiences, community-based learning, and capstone experiences - demonstrated a significant additional contribution to the explanatory power after controlling for the influence of course-based PBL, student demographics, and response bias. Both course-based PBL and first year experiences explained a significant portion of the variance in personal enrichment without any of the variables describing these experiences significant effects. The number of global experiences had a moderate, significant effect, as did the quality of the technology and society project. In fact, the majority of the explanatory power of the full model is derived from adding global and community-based learning variables at this stage. The full model explains 27% of the variance in personal enrichment, with 24% added by these variables. This suggests that these experiences are quite influential in providing students with transformative experiences for their personal lives.

5 Discussion

A key learning from our study is that it is dangerous to hyperfocus only on individual aspects of high-impact practices. Oftentimes in the literature, high-impact practices are highlighted as singular experiences that are assumed to be acutely transformative. However, when enmeshed in the different practices of a whole-system ecology of transformative learning, the realization of student effects is greater and deeper. Thus, HIPs in concert and across the curriculum are necessarily better together than separate. This learning: the importance of systemic engagement of HIPs, the potential for scaffolding HIPs towards greater student agency, meaning-making, and academic and personal development. In addition, we must also appreciate and study the additive value of the HIPs with regard to career-related and personal outcomes. The following sections will outline recommendations and implications for educators, researchers, students, and stakeholders within the larger higher education landscape.

5.1 For Educators

There are two ways in which we see high-impact practices' impact in higher education for educators: on the delivery of educational experiences for the students and on their development and self-concept as an educator. In terms of how HIPs are realized in the course or classroom experience, our research has found a few key learnings for educators. First, there is a myth of "readiness" for students to participate in high-impact practices. As our curriculum is imbued with HIPs from the first year, we have found that students thrive in experiences where they have the support of a near peer. In our first year high-impact, PBL courses, we employ peer learning assistants who have taken the course in the past and serve as an educator and navigator for our students. The idea that our students must have attained a certain level before they can engage in HIPs is a myth that we have seen repeatedly dispelled. In addition, we have seen the importance of HIPs as a pathway for full participation and diversification of participation in the classroom. Our courses that incorporate practices such as project-based learning, student-created open educational resources, and global learning have emphasized critical reflection and appreciated the assets of student teams in ways that have created learning communities of support. Such communities are essential for student development and retention.

High impact practices can be impactful not only for the students, but also for faculty and staff educators, as well. They can be transformative in helping educators find new ways to innovate their pedagogy, deepen connections with the students, and explore new intellectual pathways in integrative and interdisciplinary ways. For those who are responsible for program direction, advising, and/or major recruitment, HIPs can provide students with related but diverse experiences to develop their individual relationship with the major, and in some cases, the profession for which they are training. Finally, HIPs that incorporate team teaching, interdisciplinarity, and project-based learning can also provide more pathways for a broader

array of faculty to participate and lend their talents to these experiences and partner across disciplines. Such partnership can lead to future research partnerships, course innovations, and even securing external funding for convergence research.

Reflection questions for educators:

- How do you utilize HIPs in your classroom, course, or experience? If you have not used HIPs, what are your concerns or barriers to entry?
- Who participates in these experiences?
- What are the essential components of the HIPs and the resources needed to support all students engaging?
- How might you talk about HIPs and how they have shaped your pedagogy? How would you talk about your experience in something like a tenure portfolio or annual review?

5.2 For Researchers

While our survey data has yielded important contextual understanding, there is more to be explored. Researchers have spent much of their time and focus to understand isolated experiences of high-impact practices or specialized programs. We see that there is an opportunity to do more widespread, empirical data collection on organizations that have a series or sequence of high impact practices to understand the stacked effects. Further, there is more nuanced exploration to be done on connections across experience types, as well as variation like delivery modes/modalities, student and educator identity, interdisciplinarity, and individual- vs. team-based engagements. Finally, there is much to be understood about the structure of experiences and the roles of educators from undergraduate assistants through instructors. The work of facilitation and design of such experiences is influenced by a multitude of factors, and those nuances have yet to be fully understood.

Reflection questions for researchers:

- How have you looked at HIPs in the past - as singular phenomena or as part of a whole?
- What ways do identity and past experience influence the way in which students experience the effects of HIPs?
- What role does peer learning (on teams, mentors/more knowledgeable others) have on students in a high-impact practice?
- What types of critical reflection help students process their experiences for maximal impact or transformation?

5.3 For Students

While we know that oftentimes scholarship of teaching and learning is not primarily on the radar of undergraduate students, we want to share the following reflections in hopes it can support the

meaning-making of the students who do read this and the advisors/mentors who support them. In addition, High Impact Practices are not limited to the classroom or curricula, as deep experiential HIPs can be found in co-curricular activities (e.g. travel and project-based learning through Engineers Without Borders). Students who are motivated in the classroom and out are often finding leadership and service experiences to supplement their learning and align with their values and vision for their future. As such, we focus our recommendations here on student agency and personal development.

For students, we recommend seeking out opportunities throughout your college career to engage in high-impact practices. Being given the choice to take a course outside of one's comfort zone or take a new look at your major courses through an interdisciplinary lens adds to one's skillsets and mindsets. Students who endeavor to take a non-mandated first year seminar could find that the experience shapes their interests and major course choices. As an example, one student, for instance, undertook a high-impact first year seminar on housing scarcity and precarity then completed a sociocultural junior-year project on community housing solutions and then pursued a fire protection engineering graduate degree to bring together their interests in addressing housing vulnerability for populations at risk for fire disaster in underrepresented communities.

Reflection questions for students:

- What have been the most impactful experiences of your education? What made it so?
- If you looked at all of the courses you have taken at your school, what commonalities do you see? How would you explain your experiences to a prospective employer?
- When have you felt like your academic work served a higher purpose?
- Can you think of a time that an educational experience changed your mind or your behavior? Do you know how to seek out similar experiences and do you?

5.4 For Higher Education

Beyond our individual contexts, there are lessons to be extrapolated for higher education. In our current political landscape, there are many questions and critiques about the purpose of higher education. High-impact practices, as discussed above, have provided ample evidence of the transformative learning capacity of higher education. When critics paint higher education as without merit or utility, high impact practices provide the examples of students developing confidence, self-concept and agency, technical skills, and career preparedness. Further, high-impact practices support students' critical thinking skills and civic identity. The public purpose of higher education is to develop an informed, engaged society and high-impact practices such as community-based learning and project-based learning.

The high-impact practices stacked at this study's focal institution are used in their ABET accreditation process with success (e.g., [27]). For example, our institution regularly uses the

capstone project required for graduation to satisfy Criterion 5d, which is “a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints, and 2) is based on the knowledge and skills acquired in earlier course work.”

Several of the outcomes examined in this study provide evidence of meeting several student outcomes articulated in Criterion 3. Communication skills (Outcome 2) and teamwork skills (Outcome 5) were found to be improved through each high-impact practice assessed. Both Outcome 2 (“an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors”) and Outcome 4 (“an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts”) include the ability to consider global and cultural factors and contexts, which map onto the cross-cultural skills examined in this study. Finally, our measure of information use skills maps onto Outcome 7, “an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.” Each high-impact practice examined in this study contributes to these student learning outcomes individually; however, they have a much larger impact when stacked over time.

In addition to the learning outcomes identified as necessary for accreditation, all institutions across higher education are struggling with mental health and adjustment in a post-pandemic world. High-impact practices, as we have found, help students to find larger purpose, as well as confidence and faith in themselves. For administrators and decision-makers in higher education, we recommend investment in high-impact practices as a critical strategy for whole student development and support.

Finally, inclusion is a key concern - and oftentimes identified as a weakness of institutions - who have statements and beliefs, but not action. High-impact practices are a strategy of inclusion in the development and support of students across identities and abilities, the creation of a culture of collaboration, and the innovation of pedagogy for more equity, inclusion, and justice.

Reflection questions for the field/ administrators:

- How do HIPs factor into the mission and vision of the university?
- How might high-impact practices help create a culture of collaboration and innovation within your organization?
- How might HIPs help to advance justice, equity, diversity, and inclusion within post-secondary education within institutions or at-large?

- What ethical, social, and resource considerations impact how HIPs are supported at your institution?
- What evidence do student and educator outcomes provide to underscore the importance of higher education? What can we do to better share the story of the transformative capacity of higher education and HIPs?

6 Conclusion

The finding that different types of HIPs have additive effects is welcome news. Different faculty may feel more able to adopt one over another; different programs or courses may be a better fit for one over another. Faculty, like students, thrive and develop better when allowed voice and choice. Allowing and even encouraging a diversity of these practices will more likely include a broader range of faculty, and therefore reach a broader population of students. Based on a review of meta-analyses and literature reviews related to PBL, [28] called for research into the conditions required to achieve the full potential of PBL. This study extends the existing literature on PBL in two ways that answer this call. First, this study provides additional assessment of dosage effects in understanding the value of student-centered, experiential pedagogies. Second, the study involves an examination of how experiencing multiple types of student-centered, experiential pedagogies might amplify the benefits of PBL.

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