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BOARD # 463: Transitioning from a Project-Based Learning to a Work-Integrated Learning Program: Insights from Year 2

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Transitioning from a Project-Based Learning to a Work-Integrated Learning Program: Insights from Year 2

Introduction

"*If we teach today's students as we taught yesterday's, we rob them of tomorrow*" [1]. The quote by John Dewey describes the crossroads the project team was at in the transition Year 1 to Year 2 of the National Science Foundation (NSF) grant "Greenway Institute of Elizabethtown College Center for Sustainability and Equity in Engineering" (Grant No. 2219807). The project was funded by the NSF Division of Engineering Education and Centers (EEC) and Directorate for Engineering (ENG) through the Engineering Diversity Activities (EDA) program. During Year 0 and Year 1, the team planned and piloted an innovative, project-based learning program. The student feedback and short-term outcomes from the initial pilot were positive. However, as the team reflected on what is needed to educate today's engineering students to address the engineering problems of tomorrow it became clear that there was more work to be done.

The goal of the overarching project was to reimagine engineering education through a hands-on, project-based curriculum. Specifically, the team set out to design its programs centering four evidence-based practices: (1) A sense of mission explicitly centered on sustainability and equity, (2) hands-on teamwork on real engineering challenges, (3) mastery-based learning and assessment, (4) and focused mentoring [1]. In Year 2, the project transitioned from a project-based learning to work-integrated learning model. In the second pilot semester, students will experience a 3-week pre-internship preparation session and spend 12 weeks in a paid internship while taking engineering coursework. With this transition, the team designed a new curriculum and created a new research plan to learn from the work-integrated learning pilot.

The purpose of this poster paper is to describe the transition of an engineering program from a project-based to a work-integrated learning model. Based on this transition from Year 1 to Year 2 of the NSF grant, we discuss lessons learned and future research directions. This work has useful insights and implications for both engineering education practitioners and researchers, particularly those who engage in project-based or work-integrated learning initiatives. Based on the ongoing pilot, we have found work-integrated learning to be a promising practice for the advancement of engineering education.

Reflections from Year 1: Project-Based Learning Pilot

In Fall 2023, the team successfully developed the infrastructure, processes, and academic program components to implement a pilot semester of engineering education at The Greenway Center in Vermont for Fall 2023. The pilot cohort was composed of 4 students, 3 directly enrolled at Elizabethtown College, one visiting student from another Northeast College (not included for student identifiability). Although small in number, the cohort had diverse

representation across multiple demographics and targeted underserved and underrepresented populations (gender, race, socio-economic status, first-generation status, rural).

During the project-based learning pilot, the team conducted research and evaluation to assess the program's effectiveness. The Year 1 research plan focused on an explorative qualitative study using thematic analysis of semi-structured interviews with both faculty and students. The findings suggest that the project-based learning curriculum reframed 'failure' as an opportunity to learn, fostered strong engineering identity, and developed agency and ownership of their learning amongst the student participants [2], [3]. Additionally, in terms of outcomes, students reported experiencing lower levels of stress in their learning environment and developing a stronger sense of purpose and connection to the field of engineering [2], [3]. In triangulating students' perspectives, we also found that faculty working with the students noted a positive reframing of failure which also enhanced student agency and reduced academic anxiety [4]. Lastly, the research team explored cross-institution findings related to social and equity-centered instruction in an upper-level Sustainable Energy Systems Design [5].

The pilot project-based learning semester was successful from the standpoint of curricular innovation, research outcomes, student performance, and multi-institution collaboration. Challenges revealed in the course of developing and implementing the pilot project-based learning semester included simultaneous program delivery and design of the following semester's pilot; and establishing a sustainable recruitment pathway for subsequent program models, a small cohort in regard to representative research sample. These challenges are a focus of continued program development. The project-based learning pilot laid the groundwork for pushing the boundaries of the traditional engineering curriculum and provided a solid foundation for future directions.

In reflecting on the success and challenges of Year 1, the team determined that it would be beneficial to push the program design even further. In pursuit of this goal, the team PIs and faculty conducted exploratory interviews with program leaders from Arizona State University, Olin College of Engineering, Rochester Institute of Technology, Bucknell University, and Minnesota State Mankato's Iron Range Engineering Program. The purpose of these interviews was to discuss innovative engineering curricular approaches and consider potential future partnership expansion. In considering a coop model, the team conducted a systematic literature of ASEE publications focused on cooperative education. From the exploratory interviews and literature review, the team shifted focus to the topic of work-based or work-integrated learning which would allow students to study and engage in relevant engineering work simultaneously. To learn more about work-based learning, two groups of members from the project team conducted separate site visits with the award-winning Iron Range Engineering (IRE) program, an upper-division engineering program supported by Minnesota State University, Mankato. During the site visit the team was able to meet with administrators, faculty, staff, and students to discuss the program's shift from project-based learning to an integrated model. The program adopts an

integrated approach [6], blending project-based learning (PBL), work-based experiences, and self-directed learning [7]. IRE earned the ABET Innovation Award in 2017 for its commitment to challenging the status quo in engineering education and was also recognized as a top 10 "emerging world leader" in engineering education in MIT's Global State of the Art in Engineering Education report in 2018 [8].

From the pilot project-based learning semester in Fall 2023 and exploratory research into work-based learning, the project team determined that work-integrated learning would be a useful model the second pilot semester.

Progress from Year 2: Transition to Work-Integrated Learning

The initial project-based learning pilot, research, and exploratory work with other engineering programs was crucial in setting the foundation for Year 2. The two major aspects of the transition to work-integrated learning were the program design and research plan.

In terms of the program design, a major change in transitioning to work-integrated learning was building partnerships and connecting with local employers who would be willing to hire engineering student interns. Since equity and sustainability goals are central to the mission of the project, it was important to build partnerships with companies that had shared values and would pay students. Scholars have previously discussed the importance of paid internships and the equity concerns that arise with unpaid positions, particularly for first-generation and low-income students [9]. In addition to the work placements, the team had to redesign the initial courses for students at a different stage in their plan of study and to adjust delivery for work-integrated learning. The first three weeks of the semester will be a pre-internship preparation session, similar to a bootcamp, to prepare students for work, mimic the work-integrated learning schedule, and begin the coursework. The final 12 weeks of the semester will be work-integrated learning where students are working 20-40 hours with their employer and engaging in approximately 10-15 hours a week of coursework. This model was inspired by Iron Range Engineering Program and their "40 + 15" approach where students are working on a coop for 40 hours and engaging in approximately 15 hours of coursework. In the pilot semester, students will take 14 credits of coursework including: Calculus III (4 credits), EGR470: Internship in Engineering (4 credits), EGR355: Sustainable Resource Engineering & Design (3 credits), EGR201: Community Based Engineering Project (2 credits), and EGR395: Industry Speakers Series (1 credit). It is worth noting that five credits (EGR470 & EGR 395) are directly related to students' internships and another technical course (EGR 355) will also rely on connections and applications with work. While this may appear to be a higher overall workload than the average college student, the program is designed with flexibility and during the curriculum design stage the team designed a concurrent research and assessment plan to frequently monitor student progress and wellbeing.

In terms of the research plan, we will be conducting an exploratory case study to develop an initial understanding of the program [10]. Data collection will include pre/post interviews, pre/post surveys, and focus groups. Validated survey instruments will be used to compare pre/post: engineering identity [11], sense of belonging [12], and engineering self-efficacy [13]. Periodic evaluation questionnaires will also be distributed to monitor student progress and well-being as well as provide real-time feedback for program design. The primary goal of the Year 2 research plan is to explore students' experiences in the work-integrated learning pilot and evaluate the effectiveness of work-integrated learning

Lessons Learned and Future Research Directions

The overarching theme of this project is the importance of reimaging engineering education and pushing the boundaries of our work. From the initial project-based learning pilot in Year 1 to the transition and planning of the work-integrated learning pilot in Year 2, the grant team realized the need to adapt. We were able to adapt with the insight and support from other engineering education leaders, like Iron Range Engineering. As engineering education continues to evolve we cannot be complacent with traditional methods of teaching and workforce development.

Based on the Spring 2025 pilot, we hope to deeper explore and understand students' experiences in work-integrated learning. Our research on the project-based learning pilot found positive outcomes in terms of students' perceptions of failure, fostering a strong engineering identity, and developing a stronger sense of the engineering field [2]-[5]. Future work will focus on exploring engineering identity, engineering self-efficacy, sense of belonging, and career outcomes from the work-integrated pilot program. Additionally, the team plans to compare the perceptions and outcomes of students who participated in the pilot programs with similar students who took the courses at the primary campus. It is our hope that this transition provides useful insight for other programs and educators who are currently engaging in project-based learning or who are considering shifting to work-integrated learning.

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