Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48132

BOARD # 305: The Engineering in Context Learning Community at Whatcom Community College (NSF IUSE ITYC Program)

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The Engineering in Context Learning Community at Whatcom Community College (NSF IUSE ITYC Program)

Introduction

Community colleges play an important role in providing access to engineering careers, particularly for students from historically marginalized backgrounds. However, many incoming students place below calculus-level mathematics [1] [2], creating a challenging pathway through multiple prerequisite courses before they can begin core engineering coursework. The extended sequence of abstract mathematical concepts, often taught without clear connection to engineering applications, can discourage capable students from pursuing or persisting in engineering majors.

To address this challenge, a multidisciplinary team of faculty at Whatcom Community College (WCC) developed The PEEC^3 (Preparing Early Engineers through Context, Community and Connections) project, currently in the third year of a five-year grant from the NSF IUSE: Innovation in Two-Year College STEM Education (ITYC) Program. The main activity of this grant concerns the development, pilot offerings, and impact assessment of the Engineering in Context (EiC) Learning Community, an innovative two-quarter integrated curriculum designed for precalculus-level students entering our engineering transfer program. This project features collaborative curriculum development involving engineering, mathematics, history, English, and physics disciplines. The resulting program combines contextualized precalculus instruction with English composition, Pacific Northwest history, engineering orientation, and introductory problem-solving and computing skills within a cohort-based learning environment [3].

The curriculum design incorporates multiple evidence-based practices for supporting student success including place-based learning that connects course content to local contexts, community-engaged projects that demonstrate engineering's societal impacts, and course-based undergraduate research experiences that develop technical and collaborative skills. This integrated approach aims to support student learning and success by improving students' sense of belonging, increasing their intrinsic motivation, and supporting development of their engineering/STEM identity. Building a sense of belonging, connection and community is important to persistence and student success in college, particularly in STEM fields [4] [5]. Increasing engineering students' intrinsic motivation may lead to a desire for deeper learning as opposed to a surface approach focused primarily on grades [6] and can be promoted by giving students opportunities to engage in independent, self-directed learning [7]. Development of a professional engineering identity has been tied to retention in the engineering field [8] and can be weaker for engineering students compared to other science majors [9]. Cultivating students' development of engineering identity is important to increasing participation rates in engineering by women and underrepresented minorities [10].

The Engineering in Context (EiC) Learning Community spans two academic quarters and integrates six different courses: a new two-quarter precalculus for engineering sequence, contextualized English composition, Pacific Northwest history, and our existing first-year engineering sequence (Introduction to Engineering and Introductory Design and Computing). The curriculum is designed to fill the entire academic course load for participating students for

their first two quarters working toward an engineering transfer degree and is open to students with math placement in intermediate algebra or higher. The program features community-engaged project-based learning in the first quarter and a course-based undergraduate research experience in the second quarter, both with an overarching theme of energy and water resources.

The 2023-24 academic year marked our first pilot offering of the learning community courses. This paper presents early data informing our investigation into the following research question:

RQ1: Does participation in the EiC Learning Community contribute to improved learning outcomes in follow-on math, engineering, and physics courses?

Pursuant to this question, we compare persistence rates between learning community participants and our broader engineering student population, with particular focus on progression into calculus and physics sequences. Going forward we will also examine how the program might influence students' socioemotional development through analysis of survey results measuring engineering identity, motivation, and sense of belonging constructs pursuant to a second research question:

RQ2: Do students who complete the EiC Learning Community make larger gains along social-emotional measures such as sense of belonging and engineering identity compared to their peers who complete prerequisites through the current a la carte model?

Methods

Student persistence and outcomes data was supplied by the college's Office of Assessment and Institutional Research. This data allows us to track student enrollment and success in key gateway courses like Calculus and Engineering Physics across multiple quarters after participation in either the learning community or traditional Introduction to Engineering courses taken á la carte with other concurrent courses in math, sciences, or other subjects. In general, students take our Introduction to Engineering course (ENGR 101) concurrent with a variety of math courses ranging from Precalculus 1 (the prerequisite for ENGR 101 is Precalculus 1 or concurrent enrollment) to Calculus 2. The control sample for the persistence study consists of only students who enrolled in ENGR 101 concurrent with Precalculus 1, because this represents a math level comparable to that of the learning community cohort.

To assess the program's impact on students' socioemotional factors, the SUCCESS (Studying Underlying Characteristics for Computing and Engineering Student Success) survey will be administered to all engineering program students during the middle of winter quarter 2025, with repeat deployment in 2026 and 2027. This validated instrument measures various factors including engineering identity, motivation, and sense of belonging [11] [12]. Results from EiC students (both those who participated in 2023-24, those currently participating in 2024-25, and future cohorts) will be compared with results from the larger engineering student population. All students are offered a $10 cash incentive for completing the survey. We anticipate presenting this survey data at a future conference.

Results

Student Progression and Retention

Table 1 presents the results of the student persistence study using data supplied by the institutional research office. This initial data is promising! The 95% pass rate for the learning community ENGR 101 is significantly higher than the 77% pass rate for students enrolled in standard ENGR 101 sections concurrent with precalculus. And a much higher fraction of these students pass Calculus 1 (74% vs 37%) and Engineering Physics 1 (32% vs 13%) in a timely manner indicating no interruption to their progression through the curriculum. Based on historical institutional data that passing Engineering Physics 1 is a milestone that indicates strong likelihood of graduation with an engineering associate degree, these retention improvements should correlate to higher rates of successful transfer for the learning community participants.

There are a couple important caveats that temper the excitement about these seemingly high retention gains. First, the low numbers of students progressing to physics in both samples is not necessarily representative of attrition from the engineering program or the college more generally. ENGR 101 attracts enrollment from throughout the college of students considering engineering as a major. Some reach a conclusion that engineering is not for them and decide to pursue something else. Furthermore, a significant fraction of our ENGR 101 enrollment consists of high school students in a dual-enrollment program. Many of them are also not fully committed to pursuing an engineering major, but rather are using the course to meet a high school graduation requirement. Furthermore, even those dual-enrollment students who are committed to engineering (or become committed during their ENGR 101 experience) may graduate high school and transition to a university before progressing deeper into the WCC engineering curriculum (i.e. Engineering Physics 1). Students who enroll in the EiC program are likely more committed to engineering as a major at that time, some of these apparently impressive retention gains are likely simply due to an increased average commitment level of the participants.

Table 1. Student persistence data comparing Engineering in Context participants with a control sample selected based on math placement at time of ENGR 101 enrollment.

	Control Non-linked ENGR 101*	**Intervention EiC ENGR 101**
Total Students in Sample (N)	30	19
Number passing ENGR 101 (C or better)	23	18
Enrollment in Calculus 1 within 2 terms	13	14
Number passing Calculus 1 (C or better first attempt)	11	14
Mean grade in Calculus 1	3.39	3.71
Enrolled in Engr Physics 1 within 4 terms	4	7
Number passing Physics 1 (C or better)	4	6
Mean grade in Engr Physics 1	3.33	3.78
Mean cumulative WCC credits at time of Engr Physics 1 enrollment	72.3	60.0
Mean college-level credits at time of Engr Physics 1 enrollment	66.0	59.7

*Control population is students enrolled in standard ENGR 101 sections concurrent with MATH& 141 F22-F24

We anticipate being able to parse out some of these effects as we collect more data with future cohorts. Increased sample size should allow a more refined approach to demographic matching the control sample. Furthermore, increased sample size with future cohorts will allow us to examine whether the apparent retention gains vary at all across any demographic subgroups such as first-generation, female-identifying, and/or historically underrepresented students of color.

Discussion & Future Work

The early results from the Engineering in Context pilot implementation suggest that the integrated learning community approach likely contributes to improved student progression through critical mathematics and physics prerequisites. The progression rates to Calculus 1 and Engineering Physics 1 for learning community participants represents a substantial improvement over historical rates. This acceleration through prerequisites is particularly important given that students who start in precalculus or lower mathematics are typically less likely to succeed in engineering and take considerably more college credits along the way to degree completion. The forthcoming SUCCESS survey analysis may help provide context for these improved progression rates. Our theoretical framework suggests that strengthened engineering identity, increased motivation, and enhanced sense of belonging should contribute to academic persistence.

Looking ahead, we will continue to track these students' progression through the engineering transfer curriculum while gathering additional data from three more cohorts. The SUCCESS survey results will provide insight into how participation influences students' socioemotional development. This understanding could help identify specific program elements that most effectively support students' academic progression and professional identity development.

Acknowledgment

This material is based upon work supported by the National Science Foundation under grant number DUE #2147320. Any opinions, findings, and conclusions or recommendations expressed are those of the authors and do not necessarily reflect the views of the NSF.

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