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WIP: Framing for the Engineering Major Journey: An Orientation Course for First Semester Students to Deepen Motivation and Sociocultural Connection

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Abstract

Work in Progress: This paper reports the redesign of a one-credit, first-semester introductory engineering course at a regional campus. The redesign responds to student evaluations indicating the legacy course felt minimally useful, local retention concerns, and new faculty interest in student-centered, action-oriented pedagogy. The new course shifts from information-heavy lectures and tours to a model centered on motivation, belonging, identity development, and human-centered problem solving. The curriculum blends socially relevant engineering challenges with student-success skills such as digital literacy, time and project management, collaboration, and communication. We analyzed end-of-semester reflections from two redesigned using reflexive thematic analysis to develop themes about students' evolving 'why,' collaboration practices, and understanding of engineering as a people-focused, iterative problem-solving process [8],[9]. To complement reflection data and address limitations, future iterations will incorporate pre and post survey measures of expectancy-value, belonging, and engineering identity, and will link findings to institutional outcomes [1],[5],[11]. This WIP presents the course structure, theoretical grounding, weekly activities, early findings, and planned revisions.

Introduction

First-year engineering students enter their programs while navigating new academic expectations, forming emerging identities, and building peer communities. Research suggests early persistence is supported when students experience engineering as personally meaningful and socially relevant [1],[5]. These considerations are especially important on this campus, where 139 first-year engineering students were eligible to take the course, 78 are first-generation, and 75 are Pell-eligible. Such proportions motivate equity-centered and friction-reducing design choices that foreground belonging and confidence.

In response to these needs, the engineering faculty redesigned an introductory engineering course that students had previously described as minimally useful. Instructor observations, advising feedback, and local retention data indicated the legacy version relied heavily on informational presentations by faculty and campus units, facility tours, and exposure to majors, with limited opportunities for active learning, reflection, collaboration, or human-centered practice. The redesign introduces weekly activities that connect engineering to lived experiences and community needs, support students in revisiting their personal motivations, and incorporate reflective and collaborative assignments.

The redesign is guided by complementary frameworks. Expectancy-Value emphasizes value and competence beliefs; Identity-Based Motivation links future selves to present actions; Self-Authorship centers internal meaning making; and Situated Learning

highlights participation in authentic communities of practice [1],[2],[3],[4]. These perspectives inform human-centered problem contexts, alongside skills instruction in digital literacy, time management, teamwork, and communication. Together, these elements aim to help students build confidence, develop engineering identity, and envision ways their emerging skills can contribute to their communities.

Across engineering programs, introductory courses are consistently linked to improved preparedness, persistence, and early identity development. Studies show that first-year design courses can raise self-efficacy in design, communication, and teamwork, with effects sustained a year later [14], and that active, project-based introductory courses can increase multi-year retention and satisfaction [15]. Large programmatic evaluations also connect introductory engineering enrollment with higher GPAs, better performance in math and science, and higher first-year retention [13]. At the same time, national scans emphasize that introductory engineering courses vary widely in scope and emphasis while shaping students' first image of the field [18]. These trends motivate our focus on a common introductory experience that explicitly attends to motivation, belonging, and identity while maintaining early design engagement.

Evidence also suggests that introductory contexts are promising sites for belonging and identity supports. Identity-focused interventions embedded in common intro courses have been tied to improved retention [17], and ecological belonging approaches within first-year courses have improved continued enrollment and narrowed performance gaps by normalizing struggle and help-seeking [19],[20].

Course Context and Design: Legacy to Redesigned Course

Legacy Course

The legacy course centered on faculty presentations, facility tours, and overview talks from many departments and campus units, including professionalism and ethics sessions, Out-of-Class Presentations, and a Reverse Engineering Project. Opportunities for active learning, collaboration, reflective practice, or human-centered contexts were limited.

Redesigned Course

The redesigned course structures the course around student-centered, reflective, and action-oriented learning. Weekly modules include Week 1 'why' reflections, file naming and cloud versioning, time and project management, makerspace visits, a digital twins module, three Engineering Solutions for Society sessions, a human-centered design session, an interview with an older adult, senior-design exposure and presentations, and a final revision of Week 1 reflections. Assignments include explainer videos, a 168-hour inventory, photo journals, collaborative solution proposals, interview transcripts, and a brief group presentation.

The redesign emphasizes collaborative learning, community-connected problem contexts, transparent assignment design, and frequent formative feedback. These choices are intended to function as high-impact practices within a one-credit structure and to reduce hidden-curriculum barriers for first-generation and Pell-eligible students [6],[7].

Table 1. Legacy versus Redesigned Course Elements

Legacy Course	Redesigned Course
Department talks, tours, expert presentations	Student-centered activities and collaborative problem solving
Focus on exposure to majors and facilities	Focus on motivation, identity, belonging, and human-centered design
Limited explicit student-success skills	Digital literacy, time and project management, teamwork, communication
Minimal structured reflection	Structured reflection cycle: Week 1, midterm, final
Projects: Reverse Engineering Project, Out-of-Class Presentations	Assignments: explainers, makerspace artifact, photo journal, design sprints, elder interview, team presentation

Table 2. Weekly Structure in the Redesigned Course

Week	Topic	Key Student Activity or Deliverable
1	Welcome, origins, why, learning together	Syllabus; "why" reflection; small-group discussion
2	Using technology as an engineering student	Peer review of explainers; file naming and cloud practices
3	Time as a resource	168-hour inventory; scheduling and prioritization
4	Understanding your major	Curriculum map; concentrations; problem brainstorming
5	Overview of majors; makerspace	Makerspace visit and artifact exploration
6	Digital twins	Discussion of CAD, VR, AR; ideation for 3D printed aids
7	Engineering Solutions for Society 1: flooding	Water-use photo journals; team think tank
8	Teamwork	Team dynamics and roles
9	Engineering Solutions for Society 2: phone use	Analyze usage trends; team synthesis
10	Human-centered design	Empathy and failure cases; HCD principles
11	Engineering Solutions for Society 3: aging	Interview elder; team design ideas

12	Senior design and professionalism	Link ESS modules to senior design directions
13	Senior design presentations	Half of groups present; feedback
15	Final presentations and reflection	Revisit Week 1; submit final reflection

Participants

Across the campus, 139 first-year engineering students were eligible to take the introductory engineering course. Three sections of the redesigned course ran in the term with 30 students enrolled in each (90 students total). Across the three sections, 44 students submitted the final reflection assignment. This WIP analyzes coded reflections from the first two sections (Figure 1 previously) and now presents a merged all-sections view (Figure 1) together with a Section 3-only view (Figure 1a). Students who did not enroll in the course did so because of scheduling conflict or course availability, rather than lack of interest in the course.

Methods

Students completed a final reflection that revisited their Week 1 responses about their 'why,' learning with others, and their understanding of engineering, and offered course suggestions. We analyzed the reflections from the two redesigned sections described above.

We used reflexive thematic analysis. The phases included familiarization with the data, inductive coding of meaningful features, development and review of candidate themes, naming and defining themes, and selection of anonymized excerpts to illustrate each theme. Two researchers iteratively reviewed codes and themes for coherence and credibility. Quotes are anonymized [8],[9].

For all three sections, we applied the same keyword-proxy pipeline to generate comparable theme frequencies before merging totals for Figure 1.

Reflection Prompts

Students responded to six prompts: (1) What is your 'why' as a student and how has it changed after this course? (2) How do you learn and learn together, and how has this changed? (3) How do you understand your engineering major now and in the future? (4) What concepts or skills from this course will be important to you? (5) Did this course change your thinking about pursuing engineering or succeeding in college? (6) Suggestions for course improvement.

Results

Students most often described growth in collaboration and teamwork, shifts in their personal 'why' toward community-connected meaning, and a broadened view of engineering as iterative, human-centered problem solving. Students also named concrete

skills, including time management, communication, presenting, and research or library use, and offered improvement suggestions such as earlier hands-on work, structured team rotation, micro-career scaffolds, and aligning deadlines to 11:59 p.m. [1],[4].

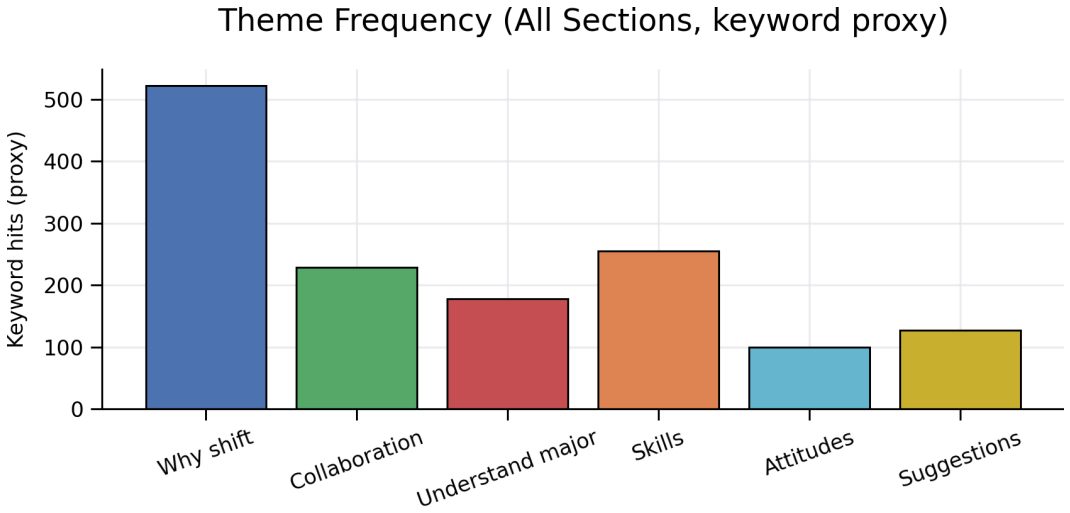

Figure 1. Theme frequency across reflections (All sections; keyword proxy)

Note: Bars display counts of coded segments assigned to each theme across all reflections. Counts are descriptive and do not indicate effect size. Depth and nuance are provided by exemplar excerpts.

Anonymized Exemplar Quotes

Student A: 'My why shifted from just getting through classes to wanting to build things that help people.'

Student B: 'Assignments like the flooding project helped me see how engineering starts with understanding the people who are affected.'

Student C: 'Engineering felt like math and machines; now I see a process, define, design, test, fail, fix, repeat.'

Student D: 'This course showed me how engineering affects things we use every day and how engineers solve problems for communities.'

Student E: 'Working in groups taught me how to coordinate with others, divide tasks fairly, and communicate effectively.'

Student F: 'This class made engineering feel real. Working through real challenges helped me picture myself as someone who can contribute to solutions that matter.'

Student G: 'Being a first-generation student made me question whether I belonged, and this class helped me see how my background adds value to problem solving.'

Discussion

Several course features intentionally align with widely recognized high-impact practices in undergraduate education while remaining feasible in a one-credit structure [6]. The Engineering Solutions for Society modules, makerspace visit, and senior design exposure create problem-centered, applied learning that connects classroom work to authentic contexts. This applied focus is reinforced by frequent short deliverables, such as concept pitches and brief presentations, which build communication fluency without adding substantial workload. Repeated low-stakes reflections scaffold metacognition and help students integrate experiences across weeks, a practice consistent with evidence-based guidance for learning and teaching [3]. Team-based deliverables create frequent opportunities for collaborative learning, peer accountability, and social integration. Together these choices are intended to cultivate habits of mind associated with persistence in demanding majors.

Equity-centered scaffolds for first-generation and Pell-eligible students

The redesign foregrounds transparent assignment design and explicit modeling of academic tools that are often part of the hidden curriculum [7]. Early sessions on file naming, version control, and calendar planning make academic logistics visible. The 168-hour inventory and planning activities help students align time use with goals, while office-hour invitations, peer feedback routines, and makerspace orientation normalize help-seeking. Deadline alignment to 11:59 p.m., options for brief extensions with proactive communication, and in-class time for planning function as friction-reducing practices for students who manage work or commute obligations. These structures are intended to improve students' sense of control and capability in engineering contexts, complementing approaches that bolster belonging and value [5],[10].

Community connection and identity formation

The elder interview, local flooding analysis, and technology well-being activities anchor engineering in lived experiences. Students' narratives suggest that such contexts help them move from abstract notions of engineering to concrete roles that serve people and communities. When students can name who benefits from a solution and why their perspective matters, they are more likely to articulate a personal 'why' that connects to community needs. This shift is consistent with an expectancy-value account of motivation in which task value increases as relevance becomes more salient, and with identity-based perspectives that emphasize future-oriented self-concepts [1],[2],[4].

Our qualitative findings of increased teamwork confidence and clearer conceptions of engineering as people-focused align with reports that first-year design courses build professional skills and self-efficacy [14],[15]. The emphasis on revisiting a personal 'why' and practicing collaboration is consistent with identity-oriented introductory course interventions that have reported gains in retention [17]. Moreover, the sense-making and norming of help-seeking we observed echoes ecological belonging studies in first-year engineering showing positive pathways from help-seeking and psychological safety to belonging and subsequent continued enrollment [19],[20].

Limitations

This Work in Progress relies on reflective self-reports from a subset of enrolled students (N = 38), which limits claims about magnitude and durability of change. Social-belonging style activities and messages may not yield uniform effects across contexts, cohorts, or subgroups; classic studies show promise, and large-scale reviews note mixed impacts on achievement and progression, underscoring the importance of alignment to context [10]. The planned pre and post measures and longitudinal comparisons are intended to provide converging evidence and clarify for whom and under what conditions the course is most effective.

Future Work

Study design. We will conduct a longitudinal, comparative study that follows students who enrolled in the introductory engineering course and a matched comparison group who did not enroll. Matching will use propensity scores on prior GPA, intended major, first-generation status, Pell eligibility, commuting distance, and baseline motivation and belonging scores. Outcomes will include pre and post survey measures aligned to expectancy-value, belonging, and engineering identity; course grades in first-year gateway STEM courses; one-year and two-year persistence in engineering; and time-to-major declaration [1],[5],[11].

Conclusion

The redesign of an introductory engineering course demonstrates that a first-year orientation experience can be re-imagined to support motivational, identity-based, and community-connected outcomes in a low-credit format. This Work in Progress reports early qualitative findings and describes the next cycle of evaluation, which will integrate pre and post surveys and institutional metrics. Low-cost structural changes such as earlier design sprints, team rotation, and micro-career supports are planned for the next offering.

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