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WIP: ”From Concept to Delivery”: Lessons Learned from Offering a New Interdisciplinary First-Year Experience

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Introduction

This Work in Progress paper presents lessons from the inaugural implementation of a redesigned first-year experience at University of the Pacific. This initiative addresses a compelling challenge that has been evolving in engineering education for over a decade: how to prepare students to solve the complex, interdisciplinary problems inherent to modern society while creating a sense of belonging to the engineering and computing profession, their university community, and their peer networks. This challenge is particularly acute during the first year, when students form foundational identities, establish peer relationships, and determine whether they will persist in engineering and computing majors. Recognizing that sense of belonging is not incidental to academic success but rather foundational to student retention and career persistence, many schools and colleges have fundamentally redesigned their first-year experiences to prioritize both rigorous technical preparation and intentional community building [1-3].

University of the Pacific, a medium-sized private student-centered university, joined this movement by developing the IDEA (Interdisciplinary Design and Entrepreneurship in Action) program – an interdisciplinary two-course sequence designed for all incoming engineering and computer science students. Developed through a faculty-led, iterative curriculum development process informed by evidence-based practices in the field, the courses integrate human-centered design, professional skills development, project-based learning, and explicit interdisciplinary peer collaboration. The initial implementations in academic years 2024-25 and 2025-26 yielded encouraging results with students reporting a greater sense of connection compared with the prior first-year program.

This paper reports on the evolution of the IDEA course series curriculum from initial concept to delivery, describes key instructional decisions and structural supports that were implemented, and presents initial quantitative evidence of impact on students' sense of belonging and community.

Prior Work

Importance of First-Year Belonging

Sense of belonging, a students' perception that they are valued members of an academic or professional community, able to meaningfully contribute, and likely to succeed, has emerged as one of the most important predictors of engineering and computer science student persistence [4-7]. The past decade of research demonstrates that first-year belonging is particularly consequential. Students who develop a strong sense of belonging during their first year are significantly more likely to persist through major transitions, remain in engineering or computer science, and graduate [8-10]. The connection between belonging and persistence is particularly pronounced for underrepresented populations, including women, students of color, and first-generation students [6], [11-13].

The importance of a student's sense of belonging extends beyond persistence metrics. A strong sense of belonging to the profession – the sense that "I am an engineer" or "I am a computer scientist" – influences major satisfaction, professional identity formation, and career success [14]. Similarly, peer belonging, connection to classmates, and the development of relationships within the cohort, creates the social infrastructure that supports students through academic challenges and reinforces commitment to engineering and computing careers [12], [15].

Interdisciplinary First-Year Courses and Computer Science Integration

Historically, most engineering programs have offered discipline-specific first-year experiences (e.g., separate introductory courses for mechanical, electrical, or civil engineering students). Over the past 8-10 years, a shift has occurred toward interdisciplinary first-year courses that serve engineering cohorts regardless of intended major. Some recent examples include implementing project-based learning in the University of Mary Hardin-Baylor Introduction to Engineering course [9], the Engineering+ program at Oregon State University [16], the integrated first-year experience program at Purdue University [17], and the two (2) semester Intro to Engineering program and Cornerstone course at LeTourneau University [18]. This shift reflects both pedagogical research supporting the benefits of disciplinary exposure and recognition that modern engineering increasingly requires cross-disciplinary and computational fluency and collaboration.

These programs share several common elements with University of the Pacific's IDEA program: (1) intentional interdisciplinary/cross-disciplinary design, (2) project-based learning with authentic contexts, (3) emphasis on design thinking and problem-solving, (4) integration of professional and communication skills, and (5) explicit measurement of learning outcomes. The IDEA program's innovations include the integration of makerspace engagement as a community-building mechanism, the deliberate use of semester-long thematic frameworks (resilience, empathy), and the integration of entrepreneurial mindset development through the Kern Entrepreneurial Engineering Network (KEEN) resources.

In the following, we describe the course context from the implementation in academic year 2024-25, as well as our experience teaching the courses, before reporting initial results on students' sense of community and belonging, as well as lessons learned.

Curricular Design

In summer 2023, a faculty working group developed the initial syllabi and the pedagogical and curricular framework for the two 2-unit interdisciplinary courses that would serve as the new introductory experience for all engineering and computer science students. While the previous 1-unit introductory engineering seminar was complemented by discipline-specific courses in several departments, the new course sequence integrates both aspects.

Following approval of the proposed curricular changes, a subsequent working group, convened in summer 2024, refined the course designs and implemented revisions prior to the launch of the new courses. Recognizing the value of project-based learning on improving connection and community building, the final course revisions shifted projects towards hands-on making while reducing and integrating the initial course design's focus on mathematical problem solving. Many of these changes were enabled by the opening of a new makerspace on campus. Core pedagogical elements across both iterations included project-based and active learning, design thinking, teamwork, engagement with real-world problems, and small class sizes. Additional details about the design process and the resulting initial curricular design are described in [19].

IDEA 10

The first course in the course sequence features resilience as a theme and includes two team projects related to the engineering design process, as well as several activities designed to introduce students to the makerspace.

To introduce students to fabrication techniques and makerspace equipment, an early in-class assignment required students to fabricate a custom LED-lit acrylic sign using laser cutting, etching, and assembly. This assignment set the tone for the course by emphasizing independent learning and making and led to a personalized artifact that students could take home as a tangible outcome of their work.

The first project in the course required students to work together in teams to design, build, and test a floating vessel, with the mission of transporting supplies in a changing environment.[1] Teams began by researching boat designs and brainstorming concepts. Each team selected two ideas, built cardboard prototypes, and tested them in a pool. Testing consisted of adding ballast to each boat until it sank. This phase created a competitive and fun learning experience, as new challenges (different types of ballast and simulated turbulence with a fan) were introduced. Based on their observations and performance, teams refined and iterated on their designs, ultimately creating the vessel in TinkerCAD and fabricating it with 3D printing.

The second project was a seven-week design challenge that asked students to envision a thriving, self-sustaining human settlement on Mars.[2] Grounded in Maslow's Hierarchy of Needs, each team selected a level of human need and designed an automated system to support it, responding to the extreme environmental constraints of Mars. Following an initial research phase, technical modules (e.g. on Arduino microcontrollers and sensors, such as for humidity and moisture, and MATLAB for data analysis) were introduced just-in-time to support the implementation. The project culminated in a final showcase where teams presented their interactive prototypes, pitched their design rationale, and displayed their research and data visualizations on posters.

IDEA 20

The second course in the sequence is intended to provide students with opportunities to gain a deeper understanding of the design process and emphasizes empathy as a theme. As with the previous course, it consists of two major projects.

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[1] This project was inspired by a KEEN card (https://engineeringunleashed.com/card/2327).
[2] This project was inspired by a KEEN card (https://engineeringunleashed.com/card/2838).

The topic for the first project was "sensing the campus" with the goal to refamiliarize students with data collection and visualization approaches.[3] Students were again provided with an Arduino microcontroller and a set of sensors (light, temperature, humidity, etc.) and were asked to collect data to inform ways of improving the campus experience. They then analyzed the data in MATLAB and produced initial visualizations, which were included in an app prototype built in Figma (a digital prototyping tool). Examples of student projects for this assignment included efforts to track noise levels and available rooms in the library, light levels in classrooms to conserve energy, and data collection in the community garden.

For the second project, we partnered with a local organization called Pacific Homecare Services that provides in-home care services to elderly adults and neurodiverse individuals. The goal of this project was for students to practice building empathy and to experience the design process in its entirety, whereas previous projects focused on parts of it. Students learned about different neurotypes (such as autism, ADHD, and down syndrome) in-class, were paired with a family of a neurodiverse individual, and conducted a home visit. Student teams were asked to develop a prototype to address a need of their assigned community partner, grounded in insights from their home visit. Approximately halfway through the project, we invited representatives from the partner organization, including the families' caregivers, to campus to provide feedback on students' initial prototypes. Student teams continued to refine and iterate on their projects and ultimately presented their prototypes at the end of the semester as part of a final showcase. Examples of student projects for this assignment included a personalized fidget board, customized puzzles, and several communication tools. Several of these prototypes were ultimately shared with the families participating in the project.

Team Formation & Peer Evaluation

Both of the IDEA courses involved team projects and we used the Comprehensive Assessment of Team Member Effectiveness (CATME) system to form teams more intentionally and to provide structured methods for peer evaluation [20-22].

In terms of team formation, the teams were primarily structured to be interdisciplinary, as we tried to group students from different majors whenever possible. Additional criteria included gender balance [23] and students' self-reported level of time commitment to coursework. The inclusion of students' anticipated time commitment was particularly valuable; teams were generally more balanced in terms of expected workload contribution. In addition, having two team projects during the semester proved beneficial, as it allowed us to reshuffle teams between projects and make targeted adjustments to improve collaboration.

In terms of peer evaluation, we administered CATME surveys after each project, which we primarily used to inform instructional decisions (rather than directly penalizing students). This helped us to identify instances of uneven workload distribution, lack of clarity around team roles, and challenges with conflict resolution. We also found that the use of intermediary deliverables, which enhanced teams' task delegation, and allocating in-class time for teamwork supported collaboration.

[3] This project was inspired by a KEEN card (https://engineeringunleashed.com/card/3972).

Assessment & Data Collection

Throughout both courses, we regularly collected student reflections (at the end of each project) and data on students' sense of community (at the end of each semester). We obtained approval from the university's IRB. The reflection prompts focused on the connection between the project and CS / engineering, students' perceptions of skill development, and team / leadership development. For this paper, we focus on the initial results from the sense of community surveys.

We used the Classroom and School Community Inventory (CSCI), a quantitative measure of sense of community that is commonly used in first-year engineering research on sense of community and belonging [24]. It is a validated self-report instrument that consists of 10 classroom community (CCI) and 10 school community (SCI) items. The items are included in Figures 1 and 2 below. Each item is scored numerically from 0 to 4 to represent the range of agreement with the item (from strongly disagree to strongly agree) and summed for the total score. The CCI and SCI scores ranging from 0 to 40 with higher scores reflecting a stronger sense of community. They can also be separated into social community and learning community subscales with scores ranging from 0 to 20.

The survey was administered at the end of the introductory engineering seminar prior to the curricular change (ENGR 10), as well as the two new courses (IDEA 10 and 20). As students from the biological and mechanical engineering departments have the option (but are not required) to take IDEA 20, the number of participants is lower than for the first semester course. The means and standard deviations of the CCI and SCI and the subscales for the offerings are summarized in Table 1. Standard deviations are enclosed in parentheses.

Table 1. Sizes, means, and standard deviations for each course measured using the CSCI.

	n	Total (out of 40)	Social Community (out of 20)	Learning Community (out of 20)
Classroom Community Inventory				
ENGR 10, Fall 2023	89	24.3 (5.8)	12.8 (4.2)	11.6 (3.3)
IDEA 10, Fall 2024	102	27.5 (5.1)	14.3 (3.0)	13.2 (2.9)
IDEA 10, Fall 2025	85	27.8 (4.5)	15.0 (3.2)	12.8 (2.7)
IDEA 20, Spring 2025	47	26.7 (5.2)	14.1 (3.7)	12.6 (3.2)
School Community Inventory				
ENGR 10, Fall 2023	89	28.3 (6.4)	13.2 (4.6)	15.1 (2.8)
IDEA 10, Fall 2024	102	28.4 (5.7)	13.2 (3.9)	15.2 (2.6)
IDEA 10, Fall 2025	85	29.2 (5.9)	13.7 (4.1)	15.5 (2.5)
IDEA 20, Spring 2025	47	28.3 (6.0)	13.7 (4.3)	14.6 (2.7)

The percentage of ENGR 10 and the IDEA 10 students that strongly agreed or agreed with each of the statements in the CCI survey and SCI survey are presented in Figures 1 and 2, respectively.

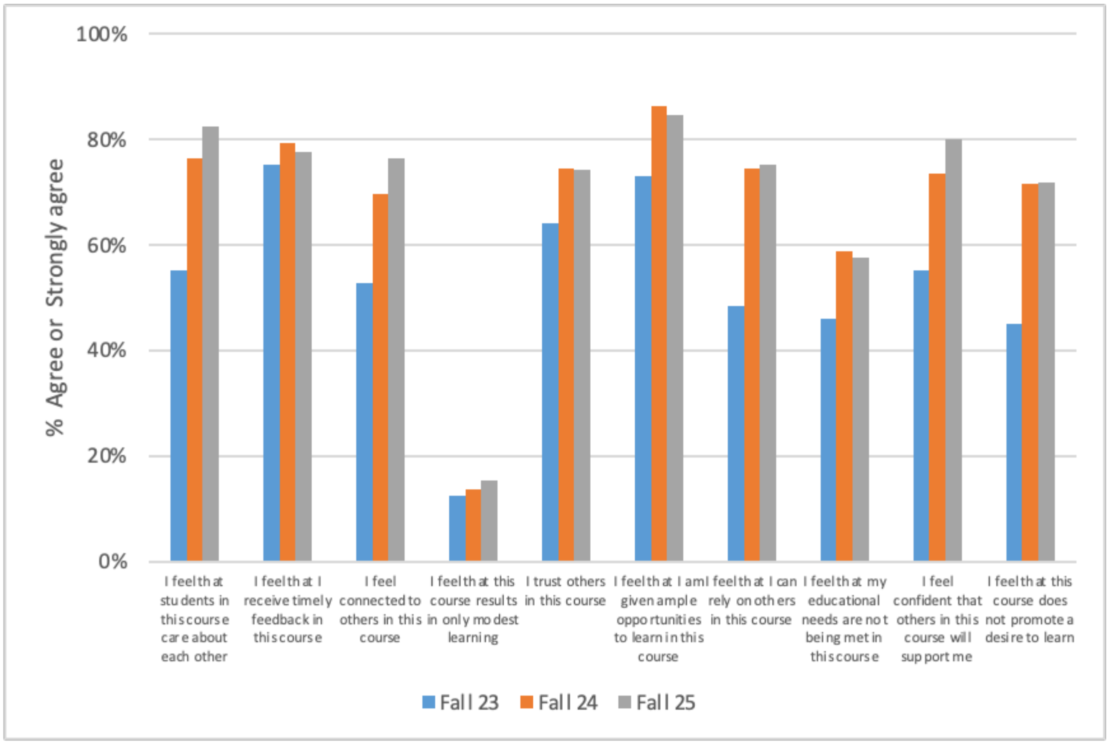

Figure 1. Percentage of students that agreed or strongly agreed to CCI questions in sequential years. Negatively worded items were reverse scored.

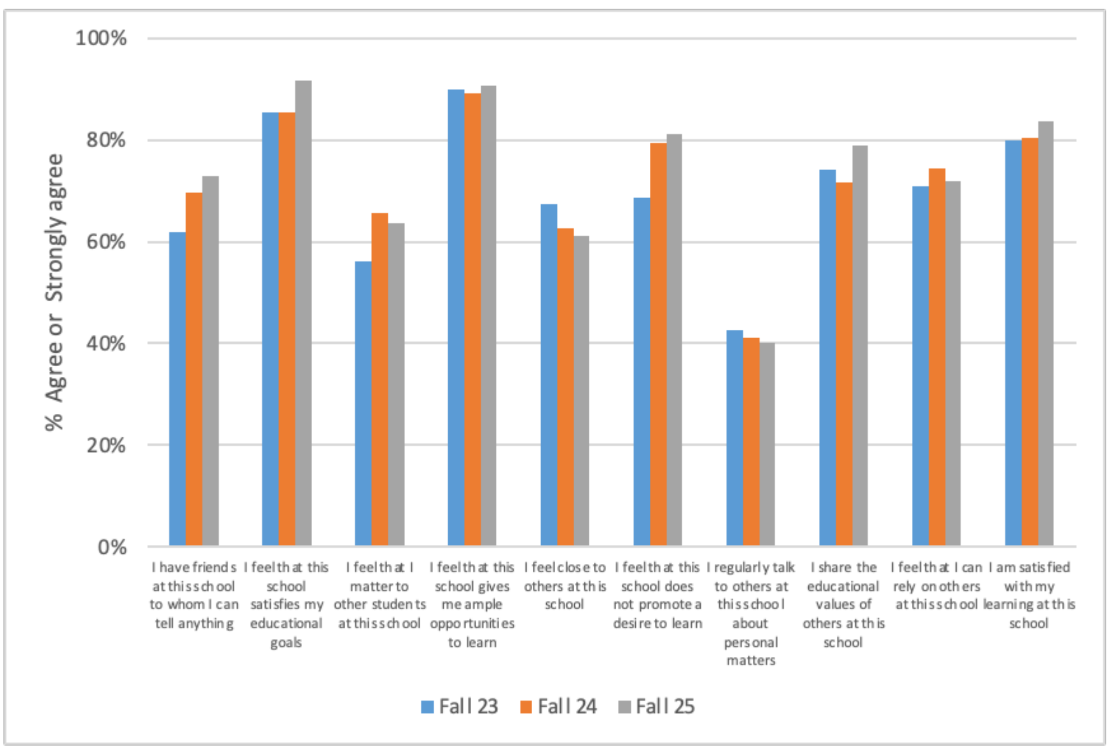

Figure 2. Percentage of students that agreed or strongly agreed to SCI questions in sequential years. Negatively worded items were reverse scored.

Independent samples t-tests were conducted to compare the mean CCI and SCI scores for the IDEA 10 classes and the ENGR 10 class as shown in Table 2. CCI scores were significantly higher for IDEA 10 in Fall 2024 and for IDEA 10 in Fall 2025 than ENGR 10. CCI scores for IDEA 10 in Fall 2024 and Fall 2025 were not significantly different. T-tests comparing SCI scores were not significantly higher for IDEA 10 in Fall 2024 and for IDEA 10 in Fall 2025 than ENGR 10. Additionally, SCI scores for IDEA 10 in Fall 2024 and Fall 2025 were not significantly different. This is not necessarily surprising, as most of the interventions were course-specific and less directly related to the university community as a whole.

Table 2. Comparison of CCI and SCI statistical metrics for prior seminar and new first-year experience courses.

Comparison Group	Metric	t-statistic	df	p-value	Significance
IDEA 10 (F24) vs. ENGR 10	CCI	4.08	189	< .001	**Significant**
	SCI	0.08	189	0.47	Not Significant
IDEA 10 (F25) vs. ENGR 10	CCI	4.41	172	< .001	**Significant**
	SCI	0.94	172	0.18	Not Significant
IDEA 10: F24 vs. F25	CCI	0.4	185	0.69	Not Significant
	SCI	0.95	185	0.35	Not Significant
Sequential: IDEA 10 vs. 20	CCI	0.51	114	0.61	Not Significant
	SCI	0.66	114	0.51	Not Significant

CCI and SCI scores for the students that completed both IDEA 10 and IDEA 20 classes were also compared using t-tests. Neither the CCI scores nor the SCI scores were significantly different for the sequential classes.

Conclusions & Future Work

This paper documents the design, implementation, and early outcomes of the IDEA two-course interdisciplinary first-year experience. The initial implementation demonstrated a significant increase in students' sense of classroom community compared to the prior introductory seminar, with CCI scores increasing from 24.3 in Fall 2023 to 27.5 and 27.8 in the two subsequent years ($p < .001$). The sustained gains across two consecutive cohorts suggest that the improvements were attributable to the curricular redesign. These results add to the significant body of evidence toward the value of intentionally designed project-based learning and community building, which is especially beneficial in the first year.

We believe that our pedagogical and structural design choices contributed to reinforcing students' development of social connections and professional identity. Importantly, the use of smaller class sizes of 20-24 and interdisciplinary teams, helped students make school-wide connections. Authentic projects that incorporated the full design thinking process emphasized the human-centered nature of engineering. The semester-long themes of resilience and empathy created narrative coherence across projects, helping students see engineering not as a collection of unrelated technical tasks but as a purposeful response to human needs and constraints. Additionally, the makerspace served not only as a fabrication facility, but as a vibrant space for creativity and allowed first-year students to observe upper-level peers engaging in projects and capstone experiences.

As a work in progress, the study has its limitations. Since the participation in the second semester course was optional for some majors, it resulted in a smaller sample size. Going forward, we are planning to continue the analysis of the quantitative sense of community data in the future semester to better understand how specific course elements contribute to strengthening students' sense of class belonging. In addition, we aim to extend qualitative analysis of students' reflections regarding students' perceptions of engineering and computer science as a discipline to inform the ongoing evolution of the program and the broader conversations about designing interdisciplinary first-year experience in engineering and computer science education.

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