Creating Belonging in Engineering Education: The Framework

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At the heart of my work is ENGR 101: Engineering, Design & Society—a course designed to develop sociotechnical mindsets, foster belonging, increase retention, diversify the profession, and inspire students who might not fit traditional engineering stereotypes to pursue careers in the field. My approach integrates three interconnected strategies into ENGR 101 that work together to create an inclusive and supportive learning environment as shown in Figure 1.

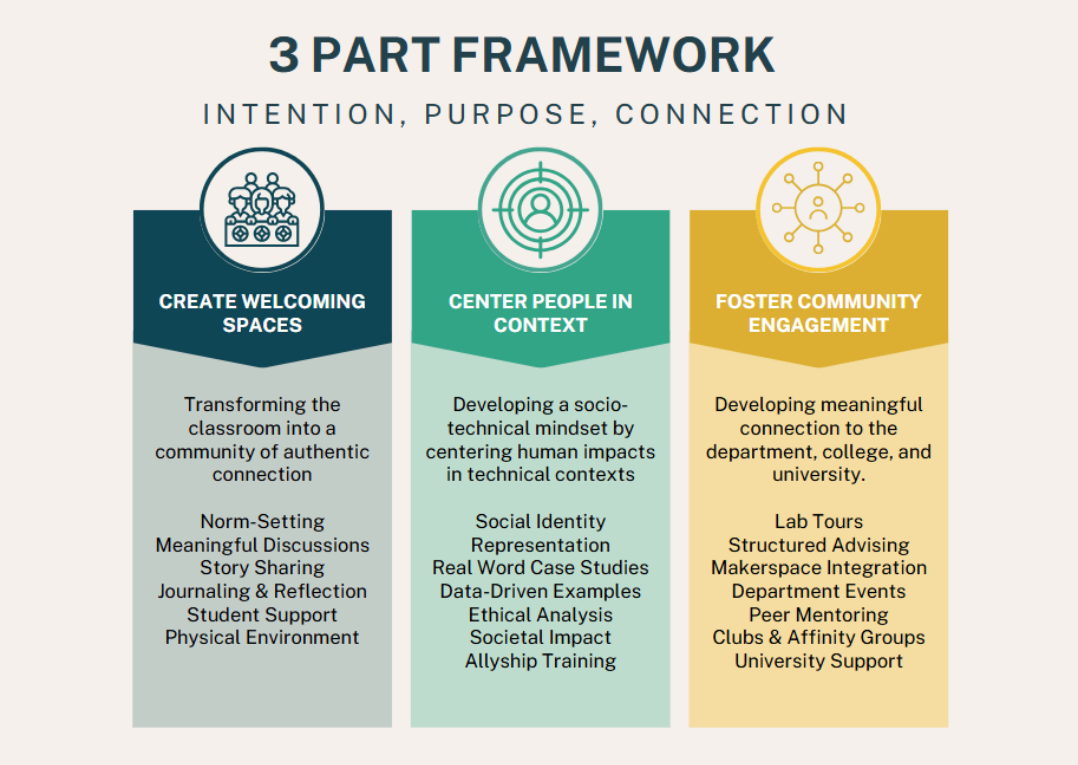

Figure 1: The Framework used in ENGR 101. J.Davishahl, 2025

1. Creating Welcoming Spaces Through Classroom Structure

Creating welcoming spaces requires authenticity, flexibility, and constant reflection. While established inclusive teaching methods such as collaborative norm-setting, equitable discussion formats, and identity awareness inform my approach, I've learned to adapt these practices to fit my teaching style and my students' needs.

At the heart of my approach is the belief that engineering education should be a dialogue, not a monologue. I integrate meaningful discussions into nearly every class session—a departure from the traditional lecture-based approach in engineering courses. Students don't just passively receive technical information; they actively question, explore, and challenge the status quo.

These discussions transform abstract concepts into lived experiences, helping students see how social and technical factors intertwine in real engineering contexts.

My **story sharing activity** in week two has proven particularly transformative. Students share personal experiences in their chosen format—written narratives, audio recordings, illustrations, or videos. The vulnerability students demonstrate often surprises me; they discuss challenges with belonging, identity development, and their hopes for using engineering to address issues they deeply care about. These stories create unexpected connections between students who might otherwise never discover their commonalities. As one student reflected, *"I have never attended a class that made students feel so seen, safe and heard."*

I design **class activities that matter to students**. There's no busywork or endless lectures—instead, students engage in purposeful exploration that connects directly to their personal and professional development. This approach not only improves attendance but transforms the classroom into a space students want to be. When engineering courses often feel like obstacle courses designed to "weed out" certain students, I create an environment where everyone has the opportunity to thrive. One student noted, *"School has stressed the importance of diversity for years upon years. But, where it often falls short, I believe, is in teaching students why diversity is important. I feel that this class did a better job of demonstrating the importance of diversity than any of my past classes have."*

The physical environment matters too. I play quiet music as students enter the classroom to ease those initial awkward moments. My teaching assistant hosts coffee hours, provides lab tours, and shares department events—creating multiple touchpoints for connection beyond formal class time. I intentionally learn and use students' names, answer emails promptly, and maintain availability before and after class.

Through personal reflection assignments three times per quarter and daily journaling, students connect course content to their own experiences. Nearly every class begins with a journal prompt that students respond to in personal journals—these aren't collected but serve as starting points for discussion and inform their formal reflections. This practice acknowledges the emotional dimensions of learning and communicates that I value their personal growth alongside their technical development. A student shared, *"I enjoyed having to reflect on what I was learning. It helped me understand my strengths and weaknesses better."*

These practices together create a classroom environment where students feel seen, heard, and valued—not just as future engineers, but as whole people bringing their unique perspectives to our shared learning community.

2. Centering People in Engineering Content

Traditional engineering education often presents technical content as divorced from human context—formulas, processes, and designs existing in a world of pure objectivity. My approach deliberately disrupts this false separation by centering people and social impact in every aspect of engineering content.

I begin with activities and experiences that help students recognize their own identities and how these shape their perspectives. The **social identity wheel activity** invites students to reflect on aspects of themselves they consider most salient versus those society might notice first. This creates awareness of the varied lenses through which we all experience the world—crucial context before diving into technical content. The **privilege beads exercise**, specifically focused

on engineering and university contexts, makes abstract concepts like privilege and barriers tangible for students.

With this foundation established, we examine how identity and social dynamics impact engineering itself. We analyze **engineering stereotypes and representation**, using hard data on demographics within the field to illuminate patterns of exclusion. Students often express surprise at the persistence of these disparities, spurring deeper conversations about why diverse perspectives matter in technical work. As one student reflected, *"Before this class, I definitely had internalized a lot of common stereotypes about engineers... After taking this class, I feel like I have moved past many of those stereotypes and feel more confident that I could belong in an engineering career."*

The course then moves to concrete examples of social-technical interconnections through **bias in design case studies**. Students examine real products where design choices had unintended consequences: facial recognition systems that struggle with darker skin tones, crash test dummies based solely on male bodies, and speech recognition technology that performs poorly with non-Western accents. These examples demonstrate how seemingly "neutral" technical decisions can embed exclusionary assumptions. One student remarked, *"I was expecting the social and ethics view in this class to be a waste of time, but now, I realize that both of those factors play a great part and role in the engineering and design world."*

Later assignments like the **societal impact case studies** ask students to evaluate emerging technologies through multiple perspectives, analyzing both benefits and harms across different population groups. The **Moral Machine exercise** presents ethical dilemmas in autonomous vehicle programming, revealing how engineering decisions inevitably embody values and priorities.

Hands-on projects integrate these concepts into practice. The **adaptive utensil design challenge** tasks students with creating eating utensils for people with limited dexterity, requiring them to consider diverse user needs while working within technical constraints. The tower activity intentionally creates unequal access to resources, prompting reflections on fairness and opportunity in engineering environments.

We conclude by exploring **allyship in professional contexts**, equipping students with concrete strategies to advocate for inclusive practices in their future workplaces. This frames engineering not just as technical problem-solving, but as a profession with responsibilities to address inequity. A student shared, *"The concept of allyship inspired me the most, specifically in the workplace. I've never really dealt with the idea of allyship in the workplace and I've come to understand that it could be really difficult to support someone when your livelihood could be at stake."*

By consistently integrating social and technical content, students learn that considering human impact isn't an add-on to "real engineering"—it's essential to ethical and effective practice. The data-driven approach helps skeptical students recognize these aren't merely subjective concerns but measurable factors that affect engineering outcomes. As one student reflected, *"Before this class, I viewed engineering and design as primarily technical fields focused on problem-solving and efficiency. Now, I see these fields as deeply connected to human values, ethics, and the broader societal context."*

3. Fostering Community Engagement Beyond the Classroom

Engineering education happens as much outside the classroom as within it. Students who develop genuine connections to the broader engineering community are more likely to persist through challenging coursework and develop professional identities as engineers. I deliberately extend learning beyond the classroom walls through structured projects and incentivized engagement with the broader engineering community.

The **Discipline Deep Dive project** transforms the often intimidating process of major exploration into an organized, community-based experience. Rather than assuming students will independently seek out information about different engineering programs, I create structured pathways for them to connect with faculty, peer mentors, and advisors. Students work in interest-based teams to investigate career options, develop academic plans, and articulate their professional goals. By arranging these connections early—before students might think to seek them out—I help them establish relationships that can sustain them through challenging courses and academic transitions. One student noted, *"I found working with our groups by specific major was most helpful because we were able to engage with students of our future major."*

The **Make-Do-Build project** introduces students to the makerspace—the physical heart of our engineering community. Through a team-based design challenge and individual CAD projects, students learn technical skills while becoming comfortable in a space that might otherwise feel intimidating to newcomers. Student clubs often host specialized workshops for ENGR 101 students, creating peer-to-peer learning opportunities that extend beyond the course itself. As one student noted in their evaluation, *"I found the hands-on projects most useful; getting to create and use CAD was overall the best part of the course. Getting involved with the Makerspace has best prepared me for the actual major."* Another shared, *"Our Make-Do-Build Project, it allowed us to actually learn and then make something."*

The **Engineering for Equity** project connects classroom discussions of ethics and social justice to real-world engineering practice. Students examine case studies of ethical dilemmas, interview professionals about responsibility in the field, and develop frameworks for ethical decision-making that they can carry into future roles. This project helps students see themselves as agents of change within the profession rather than passive recipients of established practices. One student reflected, *"This class has shown me that engineering is as much about asking the right questions as it is about finding the right answers."*

Beyond formal projects, the course incentivizes participation in department activities, student clubs, and university events by integrating them into the grading structure. Students can earn credit for attending lectures, joining club meetings, or participating in makerspace workshops. These experiences not only deepen learning but create multiple entry points into the engineering community for students with diverse interests and backgrounds. A student remarked, *"I found that having projects where you need to meet outside of class really helped me get to know people and become more comfortable in class."*

The makerspace serves as a particular hub for community building—a place where students from different courses and years can collaborate, teach one another, and develop confidence in their technical abilities. By requiring ENGR 101 students to earn a makerspace badge, I ensure they become familiar with this resource early in their academic careers, increasing the likelihood they'll return for future projects and connect with the diverse community that gathers there.

These community connections transform engineering education from an individual achievement to a collective endeavor, helping students develop the professional relationships and sense of belonging that support persistence and success in the field.