A New Facet: Building Multifaceted Engineering Identity

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Abstract: We redesigned a first-year course to support diverse students to develop a sense of belonging and professional identity in engineering. We collected student work (N=104) and interviewed a subset (n=8). Students cited altruism, family, camaraderie, work ethic, and enjoying science and mathematics. They positioned themselves as problem solvers capable of the hard work ahead. Students began to take up professional engineering identities without sacrificing prior identifies.

Major issues, significance, and theoretical framework

Without understanding students' perceptions and ways their past experiences might be relevant to engineering design, we remain limited in our ability to design learning experiences that entice them to take up engineering identities, *without sacrificing who they are.* This view of identity as multifaceted directs us to consider how we might jointly add new identities while preserving existing ones (Tracy & Trethewey, 2005). We argue that not explicitly supporting students to maintain their other identities risks homogenizing them. In line with arguments about culturally sustaining pedagogies (Paris & Alim, 2014), we argue that this diversity in identity is key to supporting students to become creative designers capable of tackling grand challenges. Building on students' funds of knowledge supports diverse student participation and development in engineering (Mejia, Drake, & Wilson-Lopez, 2015), positioning them as designers defining and solving problems in their communities. This positioning matters because identity and learning are intertwined, with changes in one altering opportunities in the other (Holland, Lachicotte, Skinner, & Cain, 1998).

Methods

We sought to investigate a research question: How might a first-year design course shape diverse students' perceptions of what it means to be an engineer and support such students to bridge or build new facets of their identities without sacrificing existing identities? The course was a first-year 1-credit chemical engineering course at a Hispanic-serving, very high research university. The students reflected the diversity of our state, with a majority of them from groups underrepresented in engineering. Many of them worked, supported families, and came from low-income communities. Across four design-based research iterations, we completely redesigned the course from its original format, which consisted primarily of faculty giving guest lectures. We developed design challenges that would build on students everyday experiences. For instance, the acid mine drainage challenge tasked students with developing a prevention or emergency response system and a community engagement strategy to aid a rural community whose water is contaminated by an abandoned mine, a topic made relevant by current events in our state. Students completed activities intended to engage them more deeply in the departmental culture and broader chemical engineering community. While this provided an experience many found interesting because they had so many choices, they did not connect this to their own past experiences. We therefore added a *professional engineering identity letter* to make this connection. Data included student work and interviews on students' perceptions of what an engineer does, how the first-year class was preparing them and how their groups functioned on design challenges. All questions were semi-structured and aimed to elicit information about their funds of knowledge, group dynamics and engineering design processes. We also collected student work in the form of *professional engineering identity letters*. We transcribed the interviews and used open coding.

Results and discussion

Broadly, students cited designing, problem solving, altruism, family, community, work ethic, and enjoying science and mathematics across both data sources. A majority of the students opted to address the letters to their future selves, at a time when they were considering leaving engineering. They reminded their future selves of their work ethic, and that "You are ok with making mistakes, fixing them, and trying again." Nearly 80% of students cited altruism, and approximately 70% cited a long-term passion for or ability in STEM.

Many students expressed a love of STEM and having STEM ability. They connected these to designing, problem solving, and being able to help people or the environment by creating "solutions for real world problems." Students reflected on their shift from pure science to engineering. Jill explained how a high

school job fostered a sense of altruism, which led her to a career pathway in medicine, which then because of her passion for STEM, led her to engineering. Similarly, Lamont explained that he loved science and math, and in our class he "found out that I could use [his] new love to help many people across the globe."

Students were aware that the path ahead would challenge them. Jill explained that the design challenges were "difficult, and it is much more of what an engineer actually does especially in the industry. […] I feel like this class—these design challenges are really representative of what you actually do in real life." Jill viewed the design challenges as providing an opportunity to not just learn about engineering, but to also experience it first hand. Some expressed surprise at finding such community within an engineering department. Easton explained that he initially expected engineering to be individualistic, and based on this, he wasn't sure that engineering would be a good fit; because he developed connections with other students, he came to see engineering as a good fit. By engaging students in the design challenges from the beginning, we were able to shift their perceptions of what it means to be an engineer.

While some students cited having family members who are engineers and how this shaped their motivation for pursuing engineering, many are the first in their families to attend college and have not had much interaction with engineers. Such students referenced family in complex ways. For instance, several students connected their experiences growing up in a community or family of limited means with their desire to help others as an engineer, a stance we reinforced in positioning students from rural communities as experts in the acid mine drainage challenge. Maya explained the acid mine challenge "impacted my life because our job not only creates new things but helps others. I was able to relate to the struggle of not having clean water since my parents would tell me stories that they too had to drink from dirty rivers. […] The aspiration of helping people and coming from a humble family will make you succeed." This helped Maya "realize that I do have a purpose in this career." We argue that students like Maya have great potential, particularly if they are supported to view their life experiences as not only permissible, but relevant in solving design problems.

Conclusions and implications

Students explained how their backgrounds, family and friends played an important role in choosing engineering as their degree program, but also the role it played in their desire to build camaraderie with engineering peers in the program. The students shared how these identities influenced their everyday learning. Our analysis revealed a pervasive reported belief that engineering would allow them to leverage their interests and abilities in STEM to solve problems. Unlike the stereotypical view of engineers motivated by money or pursuit of knowledge, our students commonly expressed a strong sense of altruism, and this was commonly connected to their experiences growing up in the face of struggles. By engaging diverse students in engineering design challenges and encouraging them to connect to the department, we are helping to correct misperceptions they bring about engineering. By also explicitly positioning them as having assets that are derived from their diverse experiences and that matter in solving design problems, we have helped them feel like they belong in engineering. As we continue to refine our curriculum, we will build on these findings, supporting our students to maintain multifaceted identities while adding new engineering facets.

References

Holland, D., Lachicotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Cambridge, MA: Harvard University Press.

Mejia, J. A., Drake, D., & Wilson-Lopez, A. (2015). Changes in Latino/a Adolescents' Engineering Self-efficacy and Perceptions of Engineering After Addressing Authentic Engineering Design Challenges *Proceedings of American Society for Engineering Education Annual Conference* (pp. 1-14). Seattle, WA: ASEE.

Paris, D., & Alim, H. S. (2014). What are we seeking to sustain through culturally sustaining pedagogy? A loving critique forward. *Harvard Educational Review, 84*(1), 85-100. doi:10.17763/haer.84.1.982l873k2ht16m77

Tracy, S. J., & Trethewey, A. (2005). Fracturing the Real-Self↔ Fake-Self Dichotomy: Moving Toward "Crystallized" Organizational Discourses and Identities. *Communication Theory, 15*(2), 168-195.

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