Engineering Students’ Perceptions of Belonging through the Lens of Social Identity

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Abstract

Research shows that students who feel that they belong in an engineering department are more likely to develop a strong engineering identity and become situated in the engineering community. Perceptions of an unwelcoming academic culture are particularly detrimental for students from populations that are currently underrepresented. Additional research investigating students’ perceptions of engineering culture, engineering identity, and their own sense of belonging is needed. This study explored undergraduate engineering students’ perceptions of their sense of belonging in their engineering program, particularly as these related to their social identities. It was conducted in Chemical, Biological and Environmental Engineering at Oregon State University. Sixteen focus groups and 6 individual interviews were conducted with entering and soon-to-be-graduating students.

Our findings reveal that students who identify along social identity categories that are centered in US culture (e.g., white, able bodied, straight, male, access to resources…) experience a strong sense of belonging. Of this group, about half are unaware of the unearned advantages linked to their social location, while the other half articulate an understanding of their privilege. International students and students of color generally expressed a lower sense of belonging in the unit and experiences of marginalized status. A complexly layered and interacting set of student perceptions arose from the data. For example, a commonly expressed theme in the focus groups was the relative sense of gender parity in our engineering programs, but participants across the board consistently shared experiences of gendered microaggressions. The findings suggest avenues for future research, as well as provide insights for interventions to improve the climate and experiences of underrepresented students.

Introduction

Research on student choice of and persistence in engineering majors emphasizes the importance of students’ identification with a major or career in motivating their persistence and success [1-3]. Despite durable myths that students leave engineering primarily due to the difficulty of the curriculum, research has shown that students’ understandings of engineering culture and their role within it play a significant role in determining their persistence [2].

While the importance of students’ developing identities is well understood and documented in the aggregate (see for example the findings of the Project to Assess Climate in Engineering), more recent studies have noted the lack of understanding of how actual student experiences relate to their developing identities [4]. Newer studies are therefore turning toward students’ experiences and developing richer understandings of engineering students’ identities based on the input of students themselves [5-7]. A gap in the research remains, however, regarding the other side of this interaction: students’ perceptions of engineering culture, engineering identity and their own sense of belonging. This study engages with this gap in the research by investigating students’ experiences and the meaning they attribute to them.
Context
Our study was conducted following a survey of 270 students in the same engineering unit in the same year. The results from that study [8] showed that although the climate was perceived as generally welcoming (vs. hostile), there was a common perception that the departmental climate was more welcoming to men and students born in the U.S. than to members of 12 other identity groups. Both women and students of color perceived this gap to be wider than did men or White students. Climate perceptions predicted engineering identity and persistence, which were significantly lower for women and students of color. The interview study reported here provides a more in-depth look at the experiences that might lead to these results and the meanings students make of those experiences.

Methods
In order to investigate students’ perceptions of engineering culture, engineering identity and sense of belonging, we implemented an interview study, conducted in Chemical, Biological and Environmental Engineering (CBEE) at Oregon State University. Undergraduate students were recruited for focus groups via an e-mail sent to all first- and final-year students across three engineering disciplines; participation was voluntary. We focused on first- and final-year students in order to investigate potential differences between entering and soon-to-be-graduating students’ identification and belonging in engineering and to consider how those differences might be influenced by coursework or other program experiences. Students signed up for time slots online. When only one student signed up, they were interviewed individually.

Sixteen focus group interviews were conducted each with two to five students who were in the same year in school and enrolled in the same program. An additional six students were interviewed individually, three in-coming and three final-year students. All six individually-interviewed students identified as having non-dominant identities (e.g., along race, ethnicity, sexuality and/or gender). There were 56 participants in all. The focus group protocol included questions designed to examine undergraduate engineering students’ perceptions of their sense of belonging in their engineering program and in their future workplaces, particularly as these related to their social identities. The same focus group guide was used regardless of number of participants. Focus groups were recorded and transcribed verbatim.

Data analysis began with an initial reading and open coding of all focus group transcripts [9-10]. Members of the research team met regularly to compare open coding observations and to develop a code list based on our emergent observations as well as constructs derived from the literature on student belonging, identity and social responsibility in engineering education. We engaged multiple coding passes, during which we refined the code list based on emergent themes and constructs and finally implemented focused coding of all data. Each transcript was coded by two individuals and any coding discrepancies were discussed and resolved. Focus group data was first hand-coded during open coding, and subsequent coding work was conducted on ATLAS.ti, a qualitative data analysis program. We compared data within and across discipline and year in relation to our research questions, creating memos to support our emerging analysis [9].
Results and Discussion

The data from the focus groups, like the earlier survey, show that students generally view their unit as a welcoming, inclusive environment in which they feel they belong. In focus groups, the sense of belonging was especially strong for students close to graduation; they frequently described the unit as “comfortable” and “supportive,” and their engineering peer group as “close” or having a strong “sense of community.” However, there are a number of ways in which this overall, aggregated perception is complicated by nuances in the data, which will be explained in the subsections below.

Perceptions of diversity
When prompted to consider how social identities influence experiences as an engineering student, women and men were quick to note that CBEE was more diverse compared to other units in the College of Engineering (COE), citing gender parity based on assumed balanced numbers of female and male students in the unit as evidence. For example, one student said: “In CBEE the female to male ratio is very close to equal compared to the other engineering disciplines”, and another stated “[CBEE] is not as bad as maybe the other majors when it comes to maybe being excluded or being a minority because there’s a lot of us [women].” While CBEE does have more women undergraduate students (about 39%) relative to the average across the COE (about 20%), diversity along other axes of identity is starkly absent.

Many female participants supported the argument that CBEE was diverse and welcoming by describing specific acts of gender discrimination faced by female peers in other engineering majors outside CBEE, or discrimination they personally endured while enrolled in courses outside our unit (e.g., in civil engineering, general engineering, physics and mathematics). Although students did not use the term “microaggressions”, they clearly explained a type of interaction that closely fits Delgado and Stefancic’s [11] definition: “…one of those many sudden, stunning, or dispiriting transactions that mar the days of women and folks of color. Like water dripping on sandstone, they can be thought of as small acts of racism, consciously or unconsciously perpetrated.”

Personal experiences in contrast with general perceptions of gender parity
In the majority of focus groups that expressed a general perception that the unit was welcoming and diverse (at least in terms of gender), female participants also related consistent, common personal experiences of sexism in the unit, usually through the form of microaggressions. Women often expressed the perceived need to have to “work harder to [garner] the same level of respect” as granted their male peers and to have to “prove themselves” as competent to both peers and faculty. One woman said: “You have to prove something, because you’re a woman. It’s not just assumed that if you’re an engineer you’re smart and have everything taken care of… it’s like you’re a woman engineer, now let’s see it.” This type of gender bias is well documented and has been called “prove-it-again”, a phenomenon where women have to provide more evidence of competence than men in order to be seen as equally competent [12].

Several women expressed being treated in non-parallel ways relative to their male peers during office hours of male professors, and this was confirmed by several men in the groups as well. “I came into his office right after a guy walked out, and he [the male faculty member] switched
snaps fingers] how he was talking. It seemed dumbed down to me. He was sweeter and smiling more, but it was like, ‘you can’t absorb information I was telling the guy before you, so I’m going make this easier for you.’ It felt really gross.”

Women also consistently expressed being dismissed by male peers during team assignments. One expressed she had her calculator ripped from her hands “because she wasn’t calculating fast enough.” Others referred to being given “unsolicited help,” having male peers not take “feedback [from women] on anything,” and consistently being delegated “secretarial tasks” in group work while actively being dissuaded from contributing to the “technical aspects of the project,” such as coding.

Other less common, yet notable, experiences in CBEE involved female students receiving comments about their presentation style or appearance (e.g., clothing choice, lack of a smile, word choice). In some instances this was tied to their perceived level of competency, a gender bias pattern known as the “tightrope” [12]. The “tightrope” places women in a double bind where they cannot behave or appear in ways that are too feminine lest they be perceived as incompetent but also cannot act too masculine because then they will be perceived as unlikable [12]. “They don’t look at me because they think I have the answer, they are looking at me to check me out or something weird like that. They only think that I am there for looks, or for my nice handwriting. I have noticed that they won’t ask me any questions. But then, because I am not very quiet, if I say my opinion then they will look at me like I am really bossy, which I think whenever girls speak up they are just considered bossy but when boys speak up its just normal.” This phenomenon can easily skirt the boundaries of what could be considered sexual harassment as well. One student stated: “I mean, the list of boys trying to get me to go out with them by asking if I needed help - it wasn’t sexual harassment, it was just annoying and kind of immature. And, it didn’t feel super great.”

**Sense of belonging**

During the focus groups, participants were asked how their social identities influenced their sense of belonging within CBEE and influenced their interactions with peers and faculty. Responses generally fell into three categories, each of which will be discussed, in turn, below. Note that we discuss “centered” and “marginalized” social identities. In this usage, centered identities are those that align with social, political and economic power in a society. Some centered identities in the US include White, able-bodied, straight, male, and people with sufficient class standing to have access to resources.

*High sense of belonging, low perception of privilege, power and oppression.* About half of the students who identify along social identity categories that are centered in US culture expressed a keen sense of belonging in CBEE without acknowledging their unearned advantages, or that other students may experience the environment differently. Women who otherwise hold centered identities also fell into this group.

Most often these students explained the challenges they faced and emphasized their ownership over their own successes. A typical response in this category is represented by a male transfer student who notes but then minimizes the impact his late arrival to the program posed: “I started at a community college so it took me longer to build up a social network here but not that long.
People were pretty nice and welcoming.” Another white, male student moved straight to defending his whiteness, “My race has absolutely nothing to do with [my sense of belonging]. I don’t think that race has anything to do with success that you can have as an engineer.” Another student recognized his centered identities, “Well, I am a white male, a straight white male, and that is the vast majority of engineering students. I haven’t had to deal with my [identities] negatively effecting my studies.” However when asked if they positively affected him, he replied, “No, but that’s my perspective. From what I know, it seems normal.”

There were a number of dominant paradigm men who expressed more challenging views of diversity, inclusivity, equity and justice in their educational programs, ranging from color blindness to expression of troubling stereotypes to claims of “reverse discrimination.” For example, multiple times conversations emerged in the focus groups about affirmative action often migrating to how competitive scholarships and internship opportunities were being disproportionately allotted to women and students from underrepresented racial and ethnic groups. One student commented, “I’m a heterosexual white male from middle class, [and I] always hear comments like ‘there’s a cap on the amount of white heterosexual males that are going to get those [internships]’… but as far as success or what not goes I definitely feel like I haven’t been withheld or anything like that, I feel included.” In another conversation, a women expressed deflation after hearing her male peer argue: “You just got [the scholarship] because they’re looking for girl engineers.” She responded: “I thought it was my hard work that got me the scholarship. I never thought that it was because I was female until he made that comment. I thought it was just because ‘oh hey, look at me’ and then he said that and it made me feel bad about it.” While these types of responses were rare for soon-to-be graduating students, they were more common in focus groups of students entering our programs.

*High sense of belonging, acknowledgment of privilege, power and oppression.* The other half of responses from students who identify along social identity categories that are centered in US culture also reflected a strong sense of belonging in CBEE, but this group demonstrated some awareness of the privilege that came with their social location. For example, one student acknowledged her privilege saying, “I think most of my social identities, besides being a woman, are really majority, like, dominant, so I think I’ve had it pretty easy, honestly. I mean being white, being, like, privileged, being English as my first language, my parents went to college, I think generally it’s been pretty open doors for me.” Other students focused their comments on how they perceive experiences of subordinated groups, especially those marginalized by socioeconomic class, sexual identity, and nationality. For example, a student reflected on the financial safety net provided her by her parents and how this is not available to all of her peers.

My parents are helping me pay for college, so that's like, way less stressful… also, I know that if I absolutely was failing and I couldn't complete my degree because of money, they would help me. You know, so it's like a-- it's a safety net that I definitely have. And I know a lot of people that don't have that safety net, and so, I feel like that's an added stress for a lot of people. And it comes through, just, in your life, 'cause you're like, oh man, I don't have time to do this assignment 'cause I have to go to work. And you're like, 'well, just get less hours for work.’ And then, you know, some people are like, ‘ugh, I can't do that.’ I have had people in group projects that like, had to work a whole bunch, and I judged
them because I was like, come on, you can't make any group meetings, like, what are you doing? This is school, like, do you not care? And it was just, like, flat out, they had work, they had to work every day, and their job would not accommodate any schedule switching. And then I was just like, well, all right. You know, and then I did count that against them a little bit. And I was like, well, you know, probably shouldn't be doing that, but it definitely happened.

Similarly, a straight student spoke to his LGBTQ peers’ experiences. “They are not necessarily, it's not like anyone is going out and hurting them or anything, but that being said they are not usually very open about their sexual orientation. And at least from what I know about how people react when they hide things about themselves, it does create internal stress. It does affect your ability to perform if you need to. And it does affect your ability to interact with other people who aren’t comfortable with [LGBTQ] people that definitely affects the person's ability to succeed in the program.”

Low sense of belonging, high perception of privilege, power and oppression. The majority of international focus group participants and participants of color expressed a low sense of belonging in the unit and were quite aware of their subordinate positions. This was especially true for entering students who had not yet formed strong peer bonds across their cohort. Many students expressed feelings of “not fitting in,” experienced significant language barriers, or lacked family support both financially and emotionally. One student said: “I will go into a room and see a bunch of white faces and honestly I feel like an outsider. Like these people don’t know the things that I feel, they don’t have the same struggles.” In another focus group, a student expressed: “you get into class and go ‘well, I am the only black kid in here again’ especially in engineering classes… you start thinking ‘am I supposed to be here, am I meant for this?’

Many international students expressed frustrations with unfamiliar cultural norms. In particular, one student identified frustration with her longing to initiate conversation with peers and its conflict with expectations set by her culture of origin. “[I think] ‘you’re really sociable and awesomely funny,’ but I get so like every time I see [you] I’m like I want to say hi but I can’t because I feel like its disrespectful. There’s no room to talk. I was even taught that I’m not allowed to speak until a higher elder has introduced me to them.” Others experience barriers due to different academic expectations, including “different study patterns” and the quantity of assignments and exams that must be engaged. “I kind of have become a bit different than others. I understand a bit slower and talk slower and probably because of that I sometimes feel that I can’t be interactive. Sometimes I feel like I am not as participative in class as the other American students. So I feel that I need to learn the culture… and for now in class I feel like an outsider.”

Focus group data also point to the benefit of strong peer relationships between students who share specific marginalized social or cultural identities as providing essential support. One student stated: “I think being a female in engineering has been so impactful in so many different ways. My entire support system here, all my friends, are females in engineering. That’s always nice… I feel like being a female in engineering you need that support group even more because you’re kind of the odd one out.” Another student presented similar thoughts, “I will say that
when I met another Latina in CBEE that we clicked a little bit better, just because I was like, oh my goodness! We could even speak Spanish too! And that really helped.” Similar to the importance of strong peer-to-peer relationships identified in this study, Dennehy and Dasgupta [13] recently reported that female mentors protected women’s belonging in engineering, self-efficacy, motivation, retention in engineering majors, and postcollege engineering aspirations.

Similarly, focus group data suggested that students from marginalized groups seek out faculty who share similar cultural backgrounds or social identities. For example, a student who had received a competitive summer research position within CBEE was excited to be able to choose a mentor who shared his cultural background, “I’m half-Taiwanese, and I am choosing [a Taiwanese faculty member to serve as my research mentor] because of my social identity. I can connect with him.” And, a women reflected: “I find female professors a lot more - like I can go to them more, and not just with class stuff. I feel like they understand what it’s like to be female in engineering, so I definitely feel like they may be a little more understanding about things.”

While there were several students who identified these positive connections between themselves and faculty who share similar backgrounds, including white males citing the privilege they receive by identifying with the majority white, male professoriate, there were a similar number of comments pointing to a lack of diversity within the CBEE faculty, especially in terms of racial or ethnic diversity, and how that makes such connections impossible. For example one student said, “Being an Indian person, seeing all white professors and stuff, it’s not that big of a deal. But if I go to other departments…then I see other Indian professors, and when you first step your foot through the door it’s just one of those connectable moments for me, kind of thing. And so here, I didn’t really have that.”

**Conclusion**

When prompted to discuss their social identities and experiences in our engineering program, the majority of conversations quickly migrated to the topic of gender. One person even referred to the balance between men and women without stating she was referring to gender, “Our major is like 50/50. So it’s not a huge impact on me.” The salience of gender is intriguing and perhaps reflective of national conversations focused on increasing the number of women in STEM work. The predominately white student body may also find conversations about gender (as a binary) less threatening than conversations about race, ethnicity, religion, or sexual identity, for example, given the current political landscape in the US.

It is also remarkable that students express a general sense of gender parity within CBEE yet convey a plethora of personal experiences that point to gender inequity within the unit. This may be due in part to the current emphasis placed on the diversification of the engineering profession over concepts of inclusion, equity and social justice. Providing opportunities for our students to critically analyze engineering history and culture [14-15] may enhance their capacities to engage more meaningfully with these issues through shifting their cognitive and affective knowledge of power and privilege. Our professional conversations need to center social, political and economic power in the discourse on gender, race, class, and other social identities, examining the intersections of oppression and how their combinations play out in engineering education and practice [11].
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