

How professors use the language of “perception” to explain underrepresentation

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INTRODUCTION

We hear the numbers reiterated at the beginning of countless publications on underrepresentation. Despite a roughly thirty-five year history of research initiatives and interventions to recruit and retain women engineering students, they significantly underrepresented in engineering in Europe, Australasia, and North America [1-3]. Even more troubling is the fact that in recent years enrollments of female engineering students in the United States have actually declined from gains made in the 1980s and 1990s [4-5]. In 1991, women earned 15.5% of engineering bachelors degrees; in 2002 that number had risen to 20.9%; but by 2010 it had fallen back to 18.4%. The numbers of underrepresented minority women are even more staggering: they earn only 3.9% of doctoral degrees, 7.9% of masters degrees, and 10.6% of bachelors degrees in engineering. Engineering is considered a “low participation field” compared even to other science fields [5].

Explanations for women’s underrepresentation in engineering generally fall into one of two categories: *internal* or *external*. Internal explanations locate the causes of underrepresentation within engineering (or engineering education). External explanations locate the causes outside of engineering (or engineering education). Examples of external causes include childhood socialization, lack of awareness about engineering, and low self-efficacy. Examples of internal causes include the content and pedagogy of engineering courses, and cultures of engineering workplaces. The two types of explanations often fall along disciplinary lines, with external explanations being more common among engineering educators and

internal explanations being more common among scholars from the field of Science and Technology Studies, for example.

Based on an interview study with the overarching research question, “What and how do engineering professors think about gender in engineering and women’s underrepresentation in engineering?”, this paper examines one way in which engineering educators externalize the problem of underrepresentation - by discussing the problem in terms of “perception.” Naming “perception” as a *mechanism of externalization*, this paper aims to bring to light one way in which the language used to discuss underrepresentation in engineering serves to promote the status quo within engineering education.

1 BACKGROUND

To make sense of the numbers of women in engineering presented above – to understand and change them – there are different paths one can take. Most stakeholders have focused their research and change efforts on students. For example, identity, self-efficacy, *personal values*, spatial skills, stereotype threat, and networking are among the most common topics for research on women in engineering education [6-8]. Consequently, commonly recommended strategies to increase the participation of women also focus on educating and “fixing” women [9-10]. This way of approaching underrepresentation can be characterized as externalizing the problem, and scholars have identified ways in which such approaches are limited [9-12].

Of course, not all engineering education research on gender is characterized by such externalization. There is notable research that has focused on problems internal to engineering education cultures and practices. For instance, based on an in-depth qualitative study of an engineering program in Canada, Dryburgh [13] concluded that:

The rituals, ceremonies, stories, and symbols associated with engineering training are cultural forms that convey the masculine ideology of the engineering culture to aspiring engineers. The play culture reinforces the image of engineers as hardworking professionals who play hard to compensate for the stresses of their work. It further strengthens the public image of engineers as a tightly knit community. Women ally themselves with the play culture despite the masculine kinds of activities associated with it. By identifying with both of the work and play cultures, women project solidarity and confidence, reducing the chance that others will consider them unsuited for work in this male-dominated profession. (p. 681)

In-depth studies of engineering programs in Australia and the United States have likewise revealed gender biases and sexism [14-15]. In Europe, we have seen a focus on masculinities within engineering cultures [16-18], and efforts to educate all students, not just women, about diversity issues [19]. In *Gender Inclusive Engineering Education*, Mills, Ayre and Gill [2] discuss ways in which the following seven facets of engineering curriculum and pedagogy are gendered: 1) Assumptions about students’ experiences, values, and backgrounds, 2) Aims and objectives of the course, 3) Forms of assessment, 4) Course content, 5) Teaching and learning methods, 6) Teaching practices, and 7) Learning environment.

More specific examples of issues that have been identified as problematic for female engineering students include, *spotlighting*, unsupportive professors, and masculine

communication expectations [20-22]. In a related study of a computer science program in the United States, Margolis and Fisher [23] concluded that:

Women and other students who do not fit the prevailing norm are disproportionately affected by problems like poor teaching, hostile peers, or unapproachable faculty. Perhaps the most important place to start is the classroom experience.

In short, on one hand we have a body of literature and interventions focused on educating and changing women, and we have another body of literature focused on critiquing and changing engineering/education. The former can be thought of as externalizing the problem, and the latter can be thought of as internalizing the problem. While increasing diversity in engineering will likely necessitate a combination of both internal and external solutions, to date, external interventions have been dominant in engineering education scholarship. This paper sheds light on the phenomenon of externalization, which is so normalized that it typically goes unremarked, by calling attention to how the tendency to externalize permeates the way engineering educators talk about underrepresentation.

2 METHODS

In 2014 and 2015, semi-structured interviews were conducted with thirty-nine engineering professors from three different institutions in different parts of the United States. Interviewees represented a mix of Assistant (n=13), Associate (n=11), and Full (n=15) professors, and the full range of engineering disciplines that exist at each of the three institutions were included in the study. Several professors also held administrative positions. There were eighteen women interviewees and twenty-one men. Interviewees were recruited through a combination of maximum variation sampling and purposeful random sampling [24], and recruitment efforts have been discussed in greater detail elsewhere [25]. The goal was to recruit interviewees who were randomly selected in order to avoid a participant pool who all had involvement with women in engineering initiatives, such as would have been the case if recruitment was done through listservs for women in engineering organizations. Of course, this method did lead to enrollment of some participants with involvement in women in engineering initiatives. Public, departmental websites were used to randomly generate names. Yet, within the parameters of random sampling, purposeful steps were taken to recruit a full range of engineering disciplines, career levels, and an approximately even number of men and women. The interviews covered a wide range of topics that have been identified in prior scholarship as contributing to the gendering of engineering and/or women's underrepresentation in engineering, including students' backgrounds, content and pedagogy of engineering courses, cultures of engineering, and policy. The overarching aim of the interviews was to better understand what and how engineering professors think about gender in engineering. Through open coding [26], the language of "perception" emerged as a theme. Open coding methods were most appropriate given the novelty of the research questions being explored. Such grounded theory techniques [27] are appropriate for studies in which no pre-existing theory is used to guide the coding. They allow new themes to emerge from the data rather than confining it to the lens of a pre-existing framework [28].

3 FINDINGS AND DISCUSSION

The word “perception” was utilized by numerous participants in discussions about women’s underrepresentation in engineering. Sometimes these statements were vague, saying that engineering was not “attractive” or “desirable.” For example, a male associate professor said, “I guess there’s a perception among a lot of women that a career in engineering isn’t desirable.” Other times an interviewee would identify a more specific “perception.” For instance, several participants mentioned the perception that engineering is “hard” or requires “hard math”, and is not social. A female associate professor said:

... this probably has to do with the perception of engineering that...[it] requires hard math, hard science, it’s too tough for girls to do, and maybe in some cases it might be the association that when you’re working with engineering you end up working by yourself. There isn’t much of a social life or an interaction and sort of that you’re boxed into a cubicle.

Why such perceptions would steer women but not men away from engineering was apparently not in need of explanation, however. Another “perception” mentioned by several participants was that engineering was “male-oriented” or “male-dominated.” Going further, others said: “I know there’s perceptions of, maybe ‘hostility’ is the right word, or at least not a welcoming environment” (Male full professor), and women in engineering programs might have “perceptions of barriers” (Male assistant professor).

The language of “perceptions” also featured in discussions of solutions to the problem, as a female assistant talked about how the university could provide “students the opportunity to change their perceptions” to improve retention.

Yet, when asked if those perceptions were *misperceptions*, some (but not all) participants admitted that they were realities (for lack of a better word, and without invoking philosophical debate about the nature of reality). For instance, the male participant above who identified perceptions of “hostile” or “not welcoming” environments for women, when asked if that was a *misperception*, said, “I don’t think so.” The following exchange with a male assistant professor evidences the same point:

Interviewee: “I think the perception is engineering is hard, and very difficult...”
Interviewer: “Do you think that is a misperception that engineering curricula is hard?”
Interviewee: “I don’t think it’s a misperception that it’s difficult, but I think everything has it’s own challenges.”

In other words, when they could have said, “engineering is hostile to women,” for example, they would instead say “women perceive that engineering is hostile.” This matters. It is not inconsequential semantics. If the problem is only that women perceive barriers, then efforts can focus on changing those perceptions without changing anything else. Indeed, this is a common approach [29]. If, however, the problem is that there actually are barriers (as research has shown there are), then engineering/education, not women’s minds, is what needs to change.

Perhaps even more interesting were instances in which a participant was describing something they recognized as a reality, but still used the language of perception to discuss it. One such instance was a female full professor discussing how in group

settings women are often ignored, but when a man says the same thing, he is “heard.” She was saying that she believes this to be a real problem with engineering education, but she nonetheless frames it as a something women “feel” and perceive:

I've had a lot of women students in my office talking to me about their struggles to have their voices heard, especially in groups. A lot of women are feeling like when they come up with an idea, their perception is, somebody will say it differently quickly to a male student, and then everybody is excited about it, even though they [the woman] said it first.

In fact, this group work phenomenon has long been identified in many different work settings. Why then are we still taking about it as a perception? The professor is recognizing this as a real phenomenon but still describing it in terms that frame it as a problem of women’s feelings and perceptions. Similarly, a male full professor said:

It’s still not perceived as an occupation that women typically do, so I think that young women that come as students often see themselves as trailblazers and that there are some barriers to overcome, and they probably know enough from talking with people, other women that have either recent experience as students nor not so recent, that there are barriers.

Again, it is a fact that engineering is not a typically female occupation; that is not merely a perception. Likewise, another male full professor, said the following:

The fundamental assumption I have is I think women are not interested in the engineering discipline as it is in the world right now. So I think that the career opportunities that are perceived by high school female students are not something that’s consistent with their expectations...I just don’t think it’s a very attractive career for them...Maybe if somehow the problems [engineers] were solving matched more with [women’s] worldviews about helping people and doing things that are good for people. Maybe that’s more attractive, but then part of me also thinks that’s really a misrepresentation of what engineering is. There is a lot of alone time, there is a lot of time working with dirty machine – at least in my experience as an engineer. So I’m a little bit reluctant to lie to anybody about what it’s like.

Finally, here a male full professor couched his initial response, saying,

...if you’re aware of the fact that you’re a minority, it’s gotta leave a certain amount of discomfort because there’s naturally more attention on you, or at least you perceive that there’s naturally more attention on you.

These examples reveal that the language of perceptions permeated how underrepresentation was talked about, even when it seemed participants were not consciously trying to externalize the problem.

4 CONCLUSION AND FUTURE WORK

Saying “There are perceptions of barriers” is different from saying “There are barriers”. The language of perceptions reflects the way the engineering education community most often talks about and researches gender in engineering: externalizing it by making women the focus of reform. Even when discussing internal problems, professors would frame the problem as one of female students’ perceptions or feelings. Whether conscious or not, calling such factors “perceptions” implies that they are not realities (for lack of a better word), but are rather issues just

in women's heads. Yet, as discussed in the Background section, much research reveals that there are realities about engineering/education that are biased against women. Most work, at least in the United States, has been on changing perceptions while leaving realities intact.

This paper is part of an on-going project to understand what and how engineering professors think about gender and women's underrepresentation in engineering and engineering education. It presents new perspectives on the ways in which the engineering education community talks about underrepresentation and relates those ways to the larger research and intervention landscape for diversity in engineering. We have coined the term "mechanisms of externalization" to refer to ways in which a person externalizes the causes of (and solutions to) underrepresentation. Talking about *perceptions* was one of several mechanisms of externalization observed throughout the interviews. In a future journal article, all such mechanisms of externalization will be identified and discussed.

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