

Problematizations of Women's Underrepresentation: Comparing Educator Interviews with the Literature

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Abstract – Various arguments for increasing diversity and the presence of underrepresented groups in engineering have been put forth. However, little attention has been paid to those arguments themselves or their implications. The goal of this paper is to call attention to the need for further reflection upon and analysis of how engineering educators understand and discuss underrepresentation and diversity. Specifically, it examines the motivations of a diverse group of engineering educators to undertake work on feminist engineering education initiatives. It builds on prior scholarship from the field of Science and Technology Studies (STS) of the ways in which underrepresentation has been framed as a problem. Participants' responses to the question of why underrepresentation is a problem are quoted at length and discussed. They are compared with prior findings from an analysis of the framings found in engineering education publications. Several differences between the publications and interview data are identified and the implications of these findings for engineering education, engineering education research, underrepresentation, and diversity more broadly, are then discussed.

Index Terms – discourse, diversity, feminism, social justice, underrepresentation

INTRODUCTION

Women are underrepresented in engineering in many parts of the world [1-7]. In fact, increasing diversity within engineering has been cited as one of the major drivers behind the growing international interest in engineering education research [8-9]. Despite the fact that concerns about women's underrepresentation in engineering have been shared among a group of engineering educators around the globe for decades, the extent to which their concerns are shared by the engineering education community as a whole is unknown. Yet there are indications that a recognition of and interest in the issues of underrepresentation and gender biases in the field are not widespread and are considered to be outside of the real concerns of engineering [2, 10-12]. Furthermore, underrepresentation persists despite the decades of efforts to address it.

It seems, then, that this lack of progress warrants both closer and more critical inspection. Because the ways in which a problem is framed, or problematized, shape how the problem is understood, for whom it is a problem, and the paths that are pursued to solve it [13-16], it is important to examine how underrepresentation is framed in engineering education communities. In other words, it is a fact that there are fewer female engineers than male engineers; however, the meanings and interpretations we give to that fact can be studied through discourse analysis. And, moreover, if that fact is taken to be a problem, then how we frame the problem matters for the solutions we imagine. This process of identifying a problem as such is called *problematization* [17].

Scholars in Science and Technology Studies [14, 18] and business [19] have studied and theorized about how underrepresentation is problematized. Similar studies have been largely absent in engineering education however, with the notable exception of a 2002 FIE paper [16] and a forthcoming discourse analysis [20]. Yet, engineering educators have begun to argue that it is important to pay attention to how we understand and discuss underrepresentation and diversity [11, 21]. For example, they have argued that it is important to name the narratives we use to discuss the engineering profession, and the assumptions therein, because doing so opens up those narratives for critical analysis and reflection [22-24]. Additionally, recent engineering education scholarship has argued that knowledge about engineering educators' motivations is important [25, 26]. Adams et al. contend that stories have distinct benefits over traditional presentations and publications because they provide deeper insights into the rationales, motivations, passions, and decisions that guide research and career decisions [25]. As readers will see, the interview data presented in this paper serve a purpose similar to that Adams et al. found in storytelling.

The purpose of this paper is three-fold. First, it compares interview data with publication data from a prior study that examined how underrepresentation of women was problematized – or framed as a problem – in engineering education literature. Second, it allows for elaboration and nuanced explanations of the problematizations that are not present in journal articles and conference papers. Third, it suggests that conversations about how we understand and

discuss underrepresentation and diversity deserve to be a more important part of engineering education and engineering education research.

LITERATURE REVIEW

As is discussed in more depth elsewhere [20], scholars in the fields of engineering education, STS, and business have examined the different ways in which underrepresentation has been problematized [14, 16, 18, 19]. Pfatfeicher & Tongue identified six potential drivers of diversity: regulatory requirements, educational equity, workforce deficiencies, workplace demands, social justice, and professional development [16]. Slaton, Lucena, and Thomas & Ely have all traced changes in justifications or motivations given for needing to increase the participation of various minority groups in STEM fields and business over the past 50 years. Lucena documents that discourse at the NSF shifted each decade to accompany shifts in national security, economic, and social, concerns [18]. Slaton discusses rationales and efforts to recruit and retain African American engineering students in particular [14]. Thomas & Ely discuss business rationales for diversity more generally [19]. Importantly, These scholars all demonstrate how the framings of the problem shape the solutions that are imagined and the ways that diversity is conceptualized. Moreover, Slaton and Lucena demonstrate that economic competitiveness arguments have come to outweigh social justice arguments.

Extending these studies to an empirical examination of international engineering education publications revealed four categories of problematizations: economic competitiveness, professional service and representativeness, women's attributes, and social justice [20]. *Economic competitiveness* arguments were characterized by the idea that engineering is vital to the economic success of countries in today's globalized world. Partly related to economic competitiveness, *professional service and representativeness* arguments were characterized by the idea that, as a profession, engineering needs to be more representative of the diverse clients and customers it serves so it can better understand and meet their needs. *Women's attributes* arguments, which are often essentialist in nature, can be summarized as the idea that women bring desirable and beneficial skills, traits, or abilities to engineering. This category was distinguished from the second category by the focus on specific skills or traits that are related more to the internal relationships and practices of engineering, as opposed to external relationships with clients and customers or engineering products. Finally, *social justice* arguments were characterized by the idea that women's underrepresentation is a matter of equality, fairness, morality, or ethics.

These categories were not all wholly separable (e.g., being able to serve a more diverse clientele is tied to economic competitiveness), and several problematizations were often observed in a single publication. However, it was found that social justice was the only problematization that

did not stand on its own. It was always accompanied by another justification, almost always economic competitiveness. Although economic competitiveness is a seemingly powerful and commonsense rationale, recent work suggests that it may be used to gain support for agendas and initiatives while scholars' true motivations actually lie elsewhere [26, 27]. Furthermore, it was found that all problematizations in the publications were short, often single sentence explanations in the Introductions that were not elaborated upon.

As a post-structural discourse analysis [28-32], the publication analysis study focused on highlighting the fact that each of the identified discourses was the product of specific historical, social, political, and cultural locations, and should not be taken as "givens," or as beyond examination. This means that there is not one correct or "True" problematization. It identified critiques of each problematization, including what they potentially hide. In contrast to that study, the goal of this study is not to recount those same arguments (although several are touched upon in the Discussion and Conclusion), but rather, to compare the published rationales with interview data and to allow elaboration. Given that many engineering stakeholders do not see the lack of diversity in engineering as a problem [2, 10, 12] and that underrepresentation persists in many parts of the world despite decades of efforts to address it, further articulation of and reflection on the problematizations of underrepresentation are warranted. Therefore, the lengthy quotations presented here facilitate the elaboration of motivations in ways that engineering education publishing norms currently do not or have not.

METHODS

I. Participant Selection

Participants included fifteen educators, ten US-based and five Australia-based, who were primarily identified through their affiliation with a self-labeled "feminist" engineering education initiative, including publications and research group membership. Two interviewees were included after being recommended by an originally identified participant. Participants included current and former faculty at all career stages. They had degrees in anthropology, economics, education, engineering, math, psychology, and sociology. Eleven worked in engineering departments, one in sociology, one in economics, and two were educational consultants and former faculty. IRB approval was obtained and potential interviewees were contacted by email.

II. Data Collection and Analysis

Semi-structured interviews [33] were conducted between April 2009 and December 2010. The interviews lasted between 15 and 83 minutes, with an average length of 49 minutes. The author conducted 3 in person at engineering education conferences and 12 via telephone or Skype. All interviews were recorded and transcribed by the author.

The interview question that is the focus of this paper was: *Can you tell me why you believe that people should care that women are underrepresented in engineering and engineering education?* Responses were coded into categories based on the presence of certain words or topics, which is discussed in more detail in the following section. Transcripts were edited for clarity and readability, removing false starts and fillers such as “um” and “you know.” Ellipses represent other words removed. Brackets represent words I inserted for clarity. Prior to submission for peer review, the paper was sent to all participants for review, and their feedback was then incorporated into the final version of the paper. The interviews also covered many other questions that will be discussed in future work.

The aim in including both US and Australian educators was not, in the first instance, to compare the two countries, but rather, to present international perspectives. Regarding the data that is the subject of this paper specifically, US and Australian responses were largely similar, and any notable differences are discussed in the Findings.

FINDINGS

I. General Summary

Three of the four categories of problematizations found in the publications [20] were reflected in participants’ responses: social justice, professional service and representativeness, and women’s attributes. However, for the purposes of this paper, I have divided responses into two categories, rather than three, because of the ways in which *women’s attributes* and *representativeness* were linked in interviewees’ answers. Therefore, for the purposes of this paper, I coded responses into two general categories: 1) *social justice*, and 2) *improving the profession*. Responses in the *social justice* category included words such as *ethics, equality, justice, right, and wrong*. Responses in the *improving the profession* category included discussions of the ways in which the profession is negatively shaped by underrepresentation. No one gave economic competitiveness as a reason. One participant, whom I did not put into either category, answered that it was “an interesting political issue,” which she elaborated to mean that it is interesting that the fields of medicine and law have increased their numbers of women while engineering has not. Table I summarizes the number of responses that fell in each category.

TABLE I: SUMMARY OF RESPONSES

Reason	# of Participants
Social justice	2
Improving the profession	5
Social justice and improving the profession	7

It is important to note that while answering this question, many participants qualified their responses by explaining that they do not see or frame their work as limited to the issue of representation, but rather as encompassing issues related to how the field of engineering itself is gendered. Many also emphasized that they are concerned not

only with women in engineering, but other minority groups as well.

II. Social Justice

The nine participants who framed the problem as one of social justice or equality explained that biases and structures that prevent women from equally enjoying the benefits and opportunities provided by an engineering career are unjust. Some emphasized that biases in the field are unjust. For instance, one stated, “For me it is just a question of justice. I have a hard time understanding why professions tolerate or accept when there are inequities in their particular structures.” Likewise, another said, “There is a question about social justice. There is also a question of legalness. Like if we’ve set up structures that systematically discriminate against half of the population...I think that is wrong.” Expressing similar beliefs, a third participant stated, “To me really what it is is our organizations, our society, is inherently biased. One of the biases is around gender...And that is why it is fundamentally the right thing to do.”

Others emphasized the career opportunities that women may be missing out on. One explained that, “Basically because I think it is ethically right. I think everyone should have access to study and to be productive in ways that are best for them. Everyone should have an opportunity.” Similarly, another said, “Women are missing out on opportunities which are opportunities to have a satisfying job, high status, and a reasonable income.”

One participant spoke of the issue as having implications for gender equality in society more broadly:

I think the primary reason it matters is if there are areas where women are denied or men are denied it just makes it much slower in pursuing goals of gender equality. It is only when we might be able to freely pursue all areas that we are able to move closer to that goal.

Two discussed that they were aware that their social justice framing contrasted with more common framings, namely economic competitiveness and women’s attributes. As one explained: “I know that is perhaps a different argument than is commonly made in the literature. I see in the literature more strategic arguments are being made that are about work force needs...” Similarly, the other said:

The other levels are you’ll hear the argument of ‘oh you know we just don’t have enough bodies. So on a practical level, we need more bodies and there are a bunch of women and so we should add [women].’ Or that we’ll get better ideas if we have more diverse people at the table...So those are both kind of practical, even economic reasons. We’ll be able to compete better in the global market place.

III. Improving the Profession

The twelve participants who framed the problem as one of improving the profession generally explained that the profession, and those it serves, loses out when diverse perspectives, life experiences, and learning and

communication styles are not represented. The majority of answers in this category emphasized that engineering influences lives in many ways and should therefore be representative of the entire society. For instance, one elaborated:

I think that people should care because engineers have a tremendous amount of control over, or contribute a tremendous amount to things that frame people's lives, that make things possible or not possible in people's lives. And I don't think that men understand or can from their own experience understand enough about either women's ways of life or the circumstances in which women have to go about what they do in the everyday world to always make the best decisions about technology or other things that people from diverse perspectives [can] ...And I think that women's needs are underserved in our society.

Likewise, another similarly explained:

Engineering impacts so many important parts of our lives and everyone's lives that it is very important that we have all the brightest minds working on solutions to technological problems whether its communications or poverty or transportation or whatever, and if we don't have all minds regardless of gender or color then we are missing out on effective solutions to problems. And if we don't have everyone at the table then there just are voices that we don't hear and things we don't think about doing. So I think it makes for better products overall.

Another response, which reflected both understandings of how the profession impacts lives and concerns with social justice, was:

Engineering is a powerful profession. It structures buildings. It structures work environments. It structures home environments. It structures policies. It does and could be structuring further a huge number of institutions that we as humans interact with and if women aren't equally participating in that then there is a problem because those are powerful structures.

Others spoke more generally about the value of having diverse perspectives at the table because they will enhance “engineering thinking” and “improve the quality of teams.” One raised the issue of whether or not there will need to be a critical mass of women in the profession before their presence could change the problems that engineering addresses and the ways in which it addresses them:

I don't think it has been fully explored yet but I think the nature of the discipline will change when women move en masse into engineering in the way that they have done in law and medicine and economics. When the numbers really increase it is not just about having women there but the sorts of problems that get examined, the way those problems are approached and so on, I think will also change, but we haven't really seen that to any great extent in engineering because of the low numbers.

Ascribing certain attributes to women as a group without regard to their social construction is commonly called *essentializing* and/or *universalizing*, and was common in the engineering education literature [20]. However, interview participants generally avoided doing so while discussing how women's presence would improve the profession. In fact, four participants specifically discussed awareness of the problematic aspects of essentializing and universalizing women and of assuming that their mere presence will necessarily change aspects of engineering and/or engineering education. They explained how their views differ from essentialist arguments. One explained that she commonly observed in the literature arguments that are “to some degree almost essentialist in nature, this idea that women have something to contribute because they are women to engineering and I'm cautious of those kinds of statements because of the way in which they kind of re-inscribe traditional gender roles onto women and so I'm somewhat skeptical of those claims.” Another explained that what really matters is the extent to which individuals are actually able to *be* diverse, not the mere presence of more female students, which is commonly all that is sought and accounted for. She explained that, “The mistake that we are making is that we count people's bodies. We count whether or not they have male or female physical bodies as if that dichotomy really matters. And we count their skin color as if that really matters. But what actually matters is the ways in which people's categorizations” allow for or inhibit diverse perspectives, thoughts, and practices to be lived and expressed in engineering education contexts. Another interviewee expressed similar beliefs that simple “head counts” of women are not the best way to approach gender diversity and reflect a simplified, inaccurate dichotomy between men and women. He focused on why it is important to consider gendered identities – in which gender is understood as traits a society commonly associates with men or women but are not inherent to them - as opposed to understanding gender as a biological dichotomy between men and women that creates homogenous groups:

I don't think there's anything that is any sort of monolithic notion of men and I don't think men who are engineers are all that much the same, I think there is a lot of diversity among the kinds of men who practice engineering...I don't necessarily believe in the dichotomous gender discussion, women versus men, I believe it is more of a spectrum, and I believe it is possible for a man to have a feminine identity and it is possible for a woman to have a masculine identity...and so for me it is more important to look at individual identities and what they bring to the table.

IV. Personal Struggles with this Question

One other aspect of the responses is worth noting as well. In response to this question two participants, who were both Australian, also discussed concerns over whether they even should be encouraging women to enter engineering—or

trying to convince others to do so—given what they know about the masculine environment and culture. One (an engineer) had resolved this with herself and now believed that work needed to be done on both fronts, bringing more women into the field, and making the field less hostile for them. The other (a social scientist), however, said she did not think she should be telling people that women should be in engineering if they were going to have a “terrible time of it when they get out of university.” I did not specifically ask participants whether or not they felt tensions around this issue, and while reviewing this paper, one participant commented that she believed these struggles are much more common than 2 out of 15 indicates. It is possible, therefore, that had I asked, more than two participants would have discussed similar struggles.

DISCUSSION

The interview data differ from problematizations found in engineering education publications in three notable ways. One is the absence of economic competitiveness arguments. A second is the significant weight given to social justice arguments. The specific interests that characterize the participant population might partly explain these differences. Yet, they also raise questions over the discourses engineering educators may feel compelled to perpetuate in publications, an issue that engineering educators have only recently begun to discuss [26, 27]. The discrepancy should make us at least consider what it means if engineering educators’ true motivations for their work cannot or will not be discussed in engineering education journals and conference papers. Indeed, in a rather unique *JEE* article by Adams et al., Julie Martin Trenor and Alice Pawley recently contemplated whether “we have had to diminish the social justice issue to get attention from funders to study race, class, and gender in engineering education? What have we sacrificed (or what people are not participating) if we make that bargain with funders to support our work?” [27]. Downey has observed a similar trend vis-à-vis international engineering education initiatives [26]. One participant added, after reading this paper, that economic arguments can be used to get a foot in the door first, so that other arguments, such as social justice, can be articulated later.

A third difference is avoidance of and expressed awareness of the problems with *women’s attributes* rationales that ascribe (and therefore, prescribe [34]) certain traits or abilities to women as a group. Essentialist arguments about women and the idea that women necessarily change the practices and content of science and engineering have been critiqued and contested [13, 14, 35-39]. Yet the widespread presence of *women’s attributes* problematizations found in the literature mean that that scholarship has largely not been grappled with by the engineering education community. This provides further evidence that as a whole the engineering education community has not lent much attention or weight to critically examining the arguments put forth to increase diversity. It also provides evidence of the value of having

conversations about our motivations so that more nuanced and critical problematizations can potentially gain credibility.

In addition to highlighting the fact that publications may not represent engineering educators’ full or true motivations for wanting to increase diversity, the interviews also allow elaboration upon the problematizations found in the literature. As noted, in the literature the problematizations are short and often unclear, leaving readers to make assumptions about what the authors meant. Perhaps most notably in this regard, participants elaborated upon their social justice and professional representativeness motivations. Upon reviewing this paper, one participant noted that it is common for peer-reviewed publications to lag behind the frontiers of critical discourse that have emerged within a community.

CONCLUSION

Scholarship on how the framing of a problem shapes the solutions that are imagined and enacted [14, 16, 18, 23] provides evidence that the framing of underrepresentation matters and that therefore stakeholders should be concerned with which framings hold sway and which do not. The findings from the interviews reveal a lack of alignment with the literature regarding weight given to economic competitiveness and social justice arguments. This alternative valuing of economic competitiveness and social justice is significant and worth contemplating in future work for several reasons. First, despite the fact that economic competitiveness rationales are often assumed to be the most persuasive, or taken as an unquestionable truth, and may prove successful in acquiring funding, they have failed to eliminate women’s underrepresentation in engineering. Second, economic competitiveness arguments have been subject to much critique [12, 14, 37, 40], including that they are largely unexamined and gloss over issues of justice and privilege in the workplace, as one participant noted in review. Third, the extent to which social justice arguments hold sway within a community has implications that extend beyond the issue of underrepresentation. For instance, the extent to which social justice, ethics, and fairness are acceptable or persuasive problematizations of underrepresentation is likely related to the value placed on those issues in engineering curricula itself. In fact, it has been argued that if engineers became more sensitive to fairness and democracy it would positively affect their work [14]. Therefore, the boundaries of discourses of underrepresentation have implications for the boundaries of engineering and engineering education more broadly, and research and venues that allow new, different, or more nuanced motivations for studying underrepresentation and diversity to come to light are valuable.

As noted, it is important for the engineering education community to understand the passions, goals, and motivations of its members in order to advance engineering education [25]. This paper is a step toward having more of those conversations about why underrepresentation and

diversity matter. Furthermore, it raises questions, as one participant pointed out, about what opportunities and venues exist for having such conversations. It would also be useful for future research to study a sample population that is perhaps more representative of the entire community who study women and gender in engineering education in order to see if their responses similarly differ from published accounts. Finally, while this analysis has focused only on women, similar critical questions could be raised about other minority groups and types of diversity as well.

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