
AC 2011-1381: COMPLICATING DIFFERENCE: EXPLORING AND EXPLODING THREE MYTHS OF GENDER AND RACE IN ENGINEERING EDUCATION

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Complicating Difference: Exploring and Exploding Three Myths of Gender and Race in Engineering Education

Abstract

This paper examines three myths of gender and race that operate in engineering education, and uses a review of the literature as well as findings from the authors' research to address them. First, we address the tendency to construct studies to look for difference and to interpret findings in ways that reduce results to gender- or race-based traits. Second, we consider the importance of getting beyond considerations of singular identities in isolation and considering the complexities of intersecting identities of race, class, gender, and sexuality. Examining a case study of longitudinal interviews with a queer-identified Latina engineering minor will elucidate the importance of considering intersectionality as part of a holistic analysis. Third, we argue for gender studies in engineering that attends to men and masculinities, not just women's experience.

Introduction

The participation of women and underrepresented minorities in engineering has been and continues to be the subject of a great deal of research in engineering education. For decades the dominant frame of the debate has been underrepresentation – noting that there is a problem when so few men of color and women from all racial and ethnic backgrounds are absent from engineering classrooms and offices.

Advances in feminist thought and critical race theory have been slow to enter the world of engineering education, yet they offer some important leaps forward for the engineering education community. In particular, they bring to light some problematic assumptions or myths that influence our framing of “the problem,” our development of research questions, our study designs, and our interpretation of findings.

This paper examines three myths of gender and race that operate in engineering education, and uses a review of the literature as well as findings from the authors' research to address them.

Myth 1: Gender Difference and Gender Essentialism

When engineering education researchers study gender, they often construct studies to look for difference. Studies reviewing the literature on why women are underrepresented^{1,2} reveal how central difference is to our explanations. For example, women's lack of self-confidence or self-efficacy (or math anxiety) is understood relative to men.³⁻⁵ Women are seen to lack female role models and peers relative to their male counterparts.^{6,7} A “chilly climate” that is hostile or competitive toward women drives women out,⁸⁻¹⁵ while men are more likely to stay. Stereotype threat, a reflection of perceived difference in ability, is seen to affect women and minority

students.¹⁶⁻¹⁷ Calls to alter curriculum and pedagogy focus on attracting women and minorities who are viewed to be more motivated by altruistic and social concerns than their white, male counterparts.^{10, 12, 15}

When difference is identified, by statistical significance tests with large quantitative samples or by qualitative methods, the “take home” message is often reduced to categorical absolutes or inherent attributes. A difference that men are more likely to be interested in topic x, or that women are more affected by factor y too often is functionally interpreted to mean that women are not interested in x, and that men are not affected by y.

When difference is crystallized into fixed traits, we see outreach efforts to young prospective female engineers take forms such as engineering lipstick,¹⁸ Barbie® computers (and “cooperative” or “nonviolent” games for girls),¹⁹ or for the teen and young adult set, the Nerd Girls® reality show.²⁰ In these instances it seems that hyper-performing femininity compensates for gender non-conformity in science and engineering. If you engineer in women’s sphere, cloak the computer in pink, or dress the engineer up in sexualized outfits, the phenomenon signifies as (sufficiently) feminine. There is no doubt that both Barbie and Nerd Girls are based in market research that demonstrates a real desire for this kind of extreme gender-stereotype reinforcement – they may be, as they say, “what women want.” It does not matter whether one believes the differences are biologically based or socially conditioned; ultimately these outreach strategies do not address the underlying gender hierarchies at play, and instead reinforce them. We should not be surprised if this gender essentialism gives way to gender determinism, where certain areas of engineering that fit gender stereotypes – for example, areas with environmental or humanitarian ends, for example – are carved out as “women’s sphere” much the way home economics was in the 20th century.²¹

Returning to the case of women and minority students being motivated by altruism or issues of social concern more than white men, our inferences may be far too strong. For example, discovering a gender difference does not necessarily mean that most or even many women and minorities find this to be their primary motivation for choosing engineering. The WECE study¹ asked over 9000 female engineering undergraduate participants in an open-ended web survey to identify their three most important reasons for wanting to become an engineer. 68.4% listed future job characteristics (salary, opportunity, etc.). 57.7% listed interest in engineering content or process (math, science, problem solving, etc.). Only 6.6% listed “to help people/contribute to society.”

In fact, at least one recent study suggests there is not even a gender difference when it comes to social concern as a motivator for engineering. The Engineering Pathways Study²² asked over 1000 senior engineering undergraduates to identify the most important motivating factors for choosing to study engineering. Intrinsic psychological factors (liking engineering as a subject or field) and intrinsic behavioral factors (liking what engineers do, e.g., play with equipment) were most important for women and men alike, followed by the opportunity to work for the social good, financial rewards, mentor influence, and parental influence. A significantly higher proportion of men identified intrinsic behavioral motivation compared to women ($p < .001$), and significantly higher proportions of women identified mentor influence ($p < .001$) and parental influence ($p < .05$). Interestingly, there was no significant gender difference in proportions

identifying social good. Here, the more interesting story may lie in the overlap rather than the difference. For both men and women, the motivating factors rank in the same order of importance overall.

Taking another angle, Jaffee and Riley's²³ open-ended interviews with engineering majors at a women's college highlight the importance of narratives that capture the complexities of students' decision-making influenced by myriad factors operating in social, cultural and economic contexts. It is important to understand not only the factors students identify, but also the ways in which they are able or unable to talk about those influences on their lives. Thematically, students talked about their choice of major in terms of individual interest in math/science; the influence of teachers, mentors, or opportunities to explore engineering; culture, language, and family influences; gender, race, class, and sexuality; and the promise of social impact in the profession. Jaffee and Riley were not seeking to order these motivations or influences, but rather to "complicate the data" to tell a rich story of how students in this particular context chose engineering. The focus then, is not on gender difference, or generalizing women's experiences, but listening to the particulars to more fully understand one group's experiences and decisions.

Myth 2: Singular Identities vs. Intersectionality

Structurally, in both our research and in our institutions, we often separate gender and race as discrete isolatable categories of analysis, when in fact these identities (and others) intersect. Feminists of color^{24,25} writing more than two decades ago critiqued gender (or race) as the sole category of analysis and characterized how multiple identities (race, gender, class, sexuality, ability, and other identities) operate simultaneously to shape experiences of oppression and privilege. While ASEE's Minorities in Engineering Division (MIND) and the Women In Engineering Division (WIED) co-sponsor sessions exploring (for example) the experiences of women of color in engineering, these separate structures, paralleled within and across other organizations in engineering, nevertheless present barriers to intersectional analysis.

Some researchers have begun to consider intersectionality within engineering, that is, how multiple categories such as race, class, gender, sexual orientation, and ability influence experiences of engineering. Foor, Walden, and Trytten²⁶ describe the experience of one multi-racial, working-class female student in engineering, considering how race, class, and gender influenced her experience as an undergraduate. Eglash²⁷ considers power relations at the intersection of race, gender, and nerd identities. Chinn²⁸ provides an insightful narrative analysis of female Asian and Pacific Islander engineers and scientists, exploring racial stereotypes among "model minorities" and analyzing the effect of Confucian ideas about gender on family life and participants' approaches to addressing the competition between gender and professional identity in engineering.

To illustrate the role intersecting identities can play in a college student's choice of major, we present findings from a set of longitudinal interviews with one queer-identified Latina initially interested in engineering who chose to study another subject and minor in engineering instead. Full consideration of the case merits its own paper,²⁹ but we strive to provide a sense of the value of intersectional analysis using excerpts from the interview text.

The student was interviewed her first, second, and fourth years (she studied abroad as a junior and was not available for an interview). The open-ended interview proceeded as described in Jaffee and Riley,²³ initially exploring larger life and career goals, focusing next on college and major choice, followed by course decisions and approaches to learning. The purpose of the case study is not to look for difference, but instead to understand the individual's experience through her narrative. The point is not to generalize from the individual to the group(s) of which she is a member, but to consider the roles that race, gender, class and sexuality play in shaping her particular experience. We highlight themes around her choice of major, the role of race, class, gender, and sexuality, the role of family and culture, and the role of personal exploration and self-determination. We omit potentially identifying information, and thus cannot be specific about certain details of her story.

The student's decision to attend college was heavily influenced both by class expectations and by her family's class and race background. High school carried strong college expectations, while her family presented both pressure to go to college and a context in which not all family members went to college. She felt a sense of obligation as a second-generation college student, noting it was important to her parents to be able to use their financial advantages to support her through college.

In my high school that's what you did once you graduated; you went to college.... That was the mentality of going in and that's why you did, that's why you were going to high school, that's what you are preparing for.

My family was really pushing me to go. My dad was the first one in his family to go to college. Still, not everyone in his generation went. It was just expected....I am the oldest child and cousin in my family, so everyone was looking up to what I was doing.

Basically I had to [go to college]... because they had this commitment to save money so that they could pay for it and I wouldn't have to worry about loans, that was like one of their big goals because they knew that they could help me out in that way and it would just be like kind of letting them down like you know not accepting that as a gift that they saved for so long.

This pressure to go to college has components related to righting inequality based on race/nationality as well as lack of opportunity of earlier generations grounded in race, class, and gender. She is the first in her generation welcome at some institutions to which she applied:

What was difficult was the fact that I knew that my dad couldn't get into some of the schools I applied to, he couldn't. He wasn't even allowed to apply to some of these schools, and I actually applied to some of the ones that he wanted to go to just on principle. I think that was really difficult for me and just the fact that my dad was the first to go to college ...there's so many people in his family that don't ...You know my grandmother always talks about oh I wish I could go to college and I'm like you still can there are so many programs you still can go to college you know and get that education, she's like no but I wanted to go when I was at

your age.

In her first year, the student discussed her attraction to engineering in terms of its relationship to social change, in terms of the rigor and symbolic capital associated with the degree, and in terms of engineering as an interdisciplinary field with room for pursuing a variety of interests:

The reason I decided to be an engineer is that I care about the environment and I care about society and equal rights and I knew I could make an impact without an education but after talking with my friend and thinking things through I decided that I could do a better job with a college education.

However, mixed in with this attraction is pressure from parental aspirations:

Even though they say they are supportive, they sometimes pull me back. That's really hard for me. They are pushing me towards engineering even though I'm not sure. I am the first child and that puts a lot of pressure on me.

In her sophomore year, the student is leaning toward a different major that holds many of the same attributes that originally drew her to engineering: interdisciplinarity that accommodates her ranging interests, symbolic capital associated with the field/degree, and the ability to work for social change. Cultural and racial identity play an important role in the student's new choice of major; she chooses to study Latin America in part as a way to counter the erasure of her family's history in her previous education:

The only thing I learned in grade school about Latin America was the Aztecs, Incans and Mayans; those are indigenous groups from Mexico and Central America. I did not know very much the history of [family's country of origin] or Latin America. I didn't know anything about it and it was such an important part of my family. It was always a general interest. I always felt there was something missing like I did not know that I should know because of my background.

She casts her departure from engineering as a choice of "something I love" vs. "something that my parents wanted." A new balance is struck between her family's expectations and her self-determination. Self-determination comes to be associated with freedom to prioritize relationships over security and prestige in career.

[This field] is a symbol of my independence but also ties to my family at the same time. Independence because it is something I chose on my own against what my parents wanted me to do, but it also ties me to my family because...Latin America in general is important to my family especially because a lot of them came from [country].

[Engineering] was something that my parents wanted me to do, it was not necessarily something I wanted to do...I realized what is more important to people because to my parents it is more important the money and the social status and how you look to other people, but I realize that to me it was more important

my friends, my family and my relationships. I realize that's what makes me happy and that's what I wanted to focus on in my life. I changed majors for two reasons: 1. To have more time with my friends and family; 2. To do something I love, not something my parents wanted.

Rigor, once an attractive feature of engineering, is now cast as time-consuming and competing with her relationships, which are of central importance. This is true both in terms of her family and in terms of her girlfriend. Valuing her relationship with her girlfriend takes on a different dimension when it is understood in terms of acceptance of a sexual identity that is not universally supported in her family and in the rest of her experience.

I want to be happy, be with someone whom I love for a long time, preferably most of my life; I want a family...for me the most important thing is to be happy with who I am with and the people around me rather than the job I have or how much money.

Race, gender and sexuality factor centrally in her desire to prioritize family relationships, and especially in negotiating sexual orientation and her partner's being of a different cultural background, this becomes both centrally important and difficult.

I do feel bad because [family member] called me and said such and such is going on and I can't do anything about it, I can't be there. Family is more important. So how do I achieve my own goals in life and take care of my family? It is difficult to be gay in that situation because nobody in my family knows except for [family member]. I don't expect them to be very supportive and I am also going out with [a member of another cultural group] so it adds to the complexities of everything.

Her struggle for self-determination challenges gender, race, and cultural expectations:

Being a minority in general; a lot of people say I can't do what I want and should only do certain jobs, so why am I getting an education and why am I going so far from home because I live in [state] and not be with my family, especially because I am the oldest daughter and I am supposed to stay around the family and watch over people.

Her change of major coincides with a shift away from seeing herself as proving engineering culture can be survived by women of color; instead she moves toward being a role model for self-determination and exploration.

One of the reasons I wanted to do engineering before was because I wanted to be a minority in engineering and show people that a female minority can do it and I can mentor other people especially girls who are interested in science...obviously I cannot mentor people in the sciences because I am not going to do anything with the sciences, but I can still encourage people to do what they want.

Ultimately, intersectional analysis reveals how the student's choice of major does not boil down to one primary factor, cannot be understood in terms of race alone, or gender alone, but must be understood in its layered complexity of multiple intersecting identities, within a larger context of family, culture, and societal influence.

Myth 3: Assuming Gender means Women

The third myth seeks to challenge the erroneous assumption that studying gender necessarily means studying women. Feminist Technology Studies scholar Wendy Faulkner³⁰ traces a progression of four research foci in her field: (1) women *in* technology, focused on the problem of underrepresentation; (2) women *and* technology, focusing on the impact of largely male-designed technology on women; (3) gender and technology, focusing on relations between men as well as between men and women to better understand women's relationship to technology; (4) men/masculinity and technology to make gender visible in those domains where women are not present. Tanja Paulitz³¹ pushes this work forward, noting that earlier work has often constructed masculinity too monolithically, relying too heavily on gender binaries.

In engineering education, the lion's share of the work continues to be focused on women's underrepresentation in engineering. However, at least as much can be learned by broadening the focus to gender and engineering, and more pointedly by studying men and masculinities in engineering education and practice. Studying the range of gender identities, and leaving room for multiple masculinities in engineering can open up new research questions and new insights.

For the engineering education community, studies of gender are often equated with studies of women. Nelson and Pawley³² used domain analysis of the engineering education literature to document the dominance of women's underrepresentation as the central framing of the discussion on gender in engineering education.

Researchers in science and technology studies (including feminist science and technology studies and engineering studies) have been examining gender and technology with a focus on men and masculinities. While there is an entire body of literature that cannot be comprehensively reviewed here, we focus on some key articles and authors that may provide an entry point for engineering education researchers.

Most familiar to engineering education scholars will likely be studies of engineering culture that document hegemonic masculinity (the dominant cultural norms for male behavior in engineering classrooms or workplaces), although the early studies were carried out with a view toward women's participation/exclusion rather than a study of masculinity per se. In the mid 1990s Tonso studied the male culture of US engineers^{11,13} while Sue Lewis, Chris McLean and colleagues studied Australian engineers,³³⁻³⁴ documenting cultures of crude and sexist behavior as a male cultural norm in engineering in both countries.

Foor and Walden's 2009 study of Industrial Engineers³⁵ presents a model for incorporating masculinity in considerations of gender in engineering. Though this particular work was published in the gender studies literature, these scholars may be familiar to engineering education researchers as they have published in engineering education journals and attended

engineering education conferences. Wendy Faulkner's work^{36,37} also studies engineers in contemporary contexts. While her focus is more on engineers in the workplace than the experience of students, her work provides essential background on masculinities in the engineering profession. She and Maria Lohan edited a 2004 special issue of *Men and Masculinities* focused on engineering and technology which provides additional examples of this kind of scholarship.³⁸

Another body of scholarship considers engineering masculinities in historical perspective. Tanja Paulitz³⁹ studied German engineers at the turn of the 20th century; Ruth Oldenziel⁴⁰ studied engineering and technology in the U.S. in the late 19th through mid-20th century, and Lisa Frehill examined the emergence of masculine archetypes in engineering in the late 19th and early 20th century.⁴¹ These historical works can help document the range of performance of masculinities and help us think about masculinities in the present.

Conclusion

This paper has begun to unpack three myths that trouble the study of gender and race in engineering education. There are other myths, and these myths can be further examined to locate problematic assumptions, approaches and analyses. A re-alignment of research priorities and analyses that are in closer conversation with the fields of engineering studies, feminist science and technology studies, and critical race theory can help move the conversation forward in engineering education, opening up new lines of inquiry.

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