Investigating strategies of pre-tenure women engineering faculty to overcome microaggressions in the classroom

Catherine G. P. Berdanier
Department of Mechanical Engineering
Pennsylvania State University
University Park, PA, USA

Sanyukta Baluni
Department of Computer Engineering
Pennsylvania State University
University Park, PA, USA

Carey Whitehair
Department of Mechanical Engineering
Pennsylvania State University
University Park, PA, USA

Abstract— **Though considerable attention and resources have been dedicated over a few decades to improve the representation of women in engineering fields, the issues of underrepresentation still exist, especially among the tenure track and research faculty. "Chilly" climate models of underrepresentation discuss these and other barriers to women's persistence, including implicit gender bias in the department. For women of color in faculty roles, these biases overlap to become serious barriers to persistence. Microaggressions in the classroom can lead to depreciation of contributions of women faculty, disregarding their accomplishments and limiting their effectiveness within social and educational contexts. One area that is underexplored are the microaggressions that occur intentionally or unintentionally in the engineering classroom when (young) women faculty teach upper-level or graduate courses in traditionally gendered subjects such as internal combustion engines, computer programming, or rocket propulsion. The purpose of this research is to qualitatively investigate experiences and strategies that junior women faculty in engineering disciplines use in the classroom to overcome student bias and microaggressions through content analysis of semi-structured interview data. This Work-in-Progress paper will present preliminary themes and strategies by which women faculty establish credibility with predominantly male students.**

Keywords—women in engineering; teaching; engineering education; women faculty

I. Introduction

Although women have matched or surpassed men in many educational fields such as college access and persistence [1], they remain underrepresented in science, technology, engineering, and mathematical (STEM) fields. This underrepresentation is very prominent at higher levels of academia due to multiple factors that deter women from continuing their career as an engineering faculty or worker. According to the National Science Foundation, only 5% of full engineering professors were women in 2008 [2], which in turn affects the population of women available to climb into senior or administrative positions with policy-making authority [3, 4]. This trend is even more prominent in the male-dominated fields of engineering.

At least two paradigms for the underrepresentation of women in STEM exist: the "leaky pipeline" model and the "chilly climate" model. The leaky pipeline model represents the career trajectory of an engineer in terms of a pipe, with each degree or phase of life being a different section of pipe. At each junction of pipe (e.g. at each life transition) women and underrepresented minorities leave the pipeline for other opportunities, often leaving engineering altogether. The chilly climate models investigate the reasons people leave engineering or academia. Women and people from underrepresented groups experience microaggressions from their schools or workplaces, and become so uncomfortable that they decide to leave.

Considerable research has been done to understand more about the lived experiences of women faculty in engineering, especially related to issues of tenure and promotion. However, this work-in-progress paper investigates the experiences of junior (pre-tenure) women faculty in engineering, particularly focused on their experiences in dealing with discrimination and microaggressions from students in the engineering classroom.

II. Literature Review

A. Underrepresentation of Women in Engineering

Under-representation of women in engineering is cause for concern from several viewpoints. Primarily, women comprise almost half of the total U.S. workforce, but percentages of women faculty remain low. According to the American Society for Engineering Education even the highest represented disciplines, female tenure/tenure track faculty only comprise 23.9% of the faculty across all discipline. From a combined climate and pipeline point of view, women experience number of issues that deter them from entering engineering in the first place. Some of these reasons include lack of advising, lack of contact with women in science, gender discrimination and a lack of encouragement [5]. Parents and teachers may unintentionally dissuade girls from pursuing a career in STEM through messaging [6, 7]. As engineering is generally viewed as masculine profession [5] girls often do not consider careers

as engineering, limiting the number of women attempting engineering degrees.

Many studies investigate the attitudes and beliefs that encourage students to persist through engineering undergraduate degrees. One challenge for the retention of women is the "weed-out" practice at large universities, in which students take classes designed to "eliminate an unwanted excess of prospective students" [8, p. 7]. Defined by a rapid curricular pace and rigid evaluation system, this pedagogical model is more likely to negatively affect women than men. For doctoral students, women are more likely to drop out due to factors such as marriage and plans to have children (though researchers have found that being surrounded by a "critical mass" of other women improves retention significantly [3]). To date, few studies in engineering investigate the issues of underrepresentation in engineering industry [9] or faculty [10,11]. Initiatives like affirmative action programs, antidiscrimination policies, mentoring or training programs; flex-time and child care support have been proposed to increase the ability of women in academia to succeed [12].

B. Research on Bias in the Engineering Classroom

Implicit bias of students in the classroom can affect the climate of the classroom and question the credibility of the female professor. Just like oppressive classroom environment can impair learning and academic performance of students, it can also affect the teaching effectiveness. By introducing the labels "classroom climate" and "chilly climate", Hall and Sandler [13] named a problem that had long existed but had remained largely invisible. Many of these issues have been raised in studies investigating women faculty of color: Pittman [14] conducted 17 in-depth interviews with women of color at large, predominantly white research institution. Specifically, the study depicts white male students challenging women professor's authority, teaching competency, scholarly expertise as well as offering subtle and not subtle threats to careers.

Socialization of both women and men in terms of appropriate characteristics play a role in the cause of implicit bias. As one example, the speech patterns can play an important part in getting the attention of the students in the classroom. Men are believed to have speech patterns which are highly assertive, competitive and more "impactful" than women. However, when women try to teach students in a classroom by adopting more masculine traits they are still evaluated poorly: a double-edged sword. The expectations for women faculty to be more caring and nurturing sets women up to be devalued as a "helper" rather than a scholar; however, without addressing this gender role, they can be viewed unfavorably by students [15]. Similarly, women who are of smaller physical stature than their male students can have trouble maintaining authority; and in our research, no works describe the perceptions of students when their engineering professor is visibly pregnant. This study aims to collect solutions for women faculty to tackle the microaggressions faced by them in an engineering classroom setting.

Particularly of interest is how youth (or the appearance of youth) affects credibility for professors in engineering, which is highly male-dominant. Indeed, it is a sociological and cultural expectation that older individuals hold more expertise than younger people, and this is true as well in engineering. The purpose of this research is to qualitatively investigate experiences and strategies that junior women faculty in engineering faculty in engineering disciplines use in the classroom to overcome student bias and microaggressions. Especially when teaching upper level undergraduate and graduate courses, implicit biases of students can influence the "climate" of the classroom, forcing the professors to spend valuable class time establishing their expertise. The research questions investigated are as follows:

1. How do junior women faculty in underrepresented engineering disciplines mitigate the "Chilly climate model" in teaching experiences?

2. What are the strategies and tools women faculty in classrooms use to establish their credibility with predominantly male students?

III. Theoretical Framework

The theoretical framework that guides this research project is ideal worker theory [16]. Ideal worker theory is a sociological lens which posits that one reason that non-normative groups (women, underrepresented persons) are more criticized, undervalued, and not taken seriously especially in scientific and academic jobs is that the "ideal" worker is normative in all physical and psychological attributes and devotes all time to his field of expertise. As discussed in academia overall [17-19], this "ideal worker" is white and male. Women and underrepresented groups who deviate from this image are by nature already non-ideal, and therefore need to work extra hard in order to establish credibility among peers, colleagues, and administrators. In academia, the "ideal worker" is well established in his field; academic success and merit is inextricably linked with age, race, and gender. The colloquial phrase of an "old grey-beard professor" manifests from this image. This image is as salient to the expectations of students in their professors (especially at the upper-level undergraduate or graduate classes) as it is to colleagues within the department.

Through this lens, we examine the experiences, strategies, and philosophies of young un-tenured women faculty in engineering. By being so visibly "non-ideal", young women faculty may devise extra strategies in order to convince their students of their authority and expertise. These strategies will reflect the navigation of societal expectations of "professorship," gender, and age at the same time within the engineering classroom, which is relatively insular (i.e. there is not much administrative interference in the running of a college- or graduate-level classroom). The findings will be useful to other new faculty, to engineering departments, and to administrators as the "culture" of engineering is changing.

IV. Methods

A. Participants, Recruitment, and Sampling

This study used a "snowball" sampling method: we started off with a few known participants and used the suggestions of these candidates to find other potential participants. This means that participants were not recruited at one time but rather

throughout the study. Initial recruitment was of colleagues and personal contacts of the PI. Participants had to meet the following criteria: (a) identify as a woman, (b) be a tenure track (or tenured within the past two years) professor in engineer (or a related field), (c) be actively teaching upper-level or graduate courses in engineering, and (d) be fluent in English. These selection criteria resulted in a set of participants who could offer insights through first-hand experiences. Each potential participant received a recruitment email describing the purpose of this study and what would be required of them if they chose to participate. As this study is in-progress, our end goal will be to have at least 20 participants from a variety of backgrounds. Of express interest is to recruit participants, some of which are single, some with a partner but without children, and some who have children and have been pregnant while teaching.

Each participant was interviewed through semi-structured interview techniques. Interviews were recorded with permission from participants. The interview protocol includes 15 open-ended questions, with probing questions asked as necessary to encourage in-depth responses from participants [20, 21]. The questions focused on participants' experiences as women in engineering during both their studies as well as their professorship. Specifically, many of these questions delve into experiences in the classroom. Some examples include: "Have you encountered either overt biases or microaggressions in the classroom?" and "What advice would you give a new female professor entering academia as a tenure-track engineering faculty?"

Data are transcribed and analyzed using open-coding content analysis methods in a constructivist paradigm [22] in order to best capture the realities of our participants. Open-coding mechanisms allows for an emergent coding system to manifest, rather than being restricted to a set of a priori codes. The work presented here represents a small sample of participants and therefore, the qualitative coding is by no means complete and a complete codebook for this project has not been yet established. The preliminary results presented here are a sampling of the interesting themes that are emerging from the data, prior to the collection or analysis of a complete sample.

V. Preliminary Results

Preliminary findings indicate that the junior professors' classroom experiences in teaching upper-level undergraduate and graduate classes took them by surprise. While they had expected needing to establish credibility based on age, the age-gender interface was unexpected. Strategies for establishing credibility were discussed, and an underlying theme through many interviews was the importance of role models and mentors for women in engineering—especially those that may become faculty.

A. Strategies for Establishing Credibility in the Engineering Classroom

Participants discussed their experiences teaching advanced engineering courses and the types of students who generally enroll in the courses. One participant discussed her senior-level students:

> "I teach [a senior level class], Internal Combustion Engines. Last year, it was me and 68 dudes; this year it's me and 38 dudes and two women. Most students take this class because they're motorheads. […] They're psyched about engines but a number of them are bummed that there will be theory. […] I immediately got the vibe the first time I taught it last year, they were just not with me the first class. I was like "I gotta change this up."[…] The next class, I talked about what I do in engines, there were a few stories of things blowing up, a lot of high speed video, and then they were with me."

She continued to discuss her graduate level combustion class, finding that graduate students tend to care more about "who" their professors are, noting that her students seemed upset that they were learning combustion from "a chick" instead of the combustion "greats" at the university. These factors, she mused, influenced her ability to connect with the class and best facilitate their processes. She continued:

> "I knew, I had gotten advice from a couple mentors, senior faculty that were…it was mostly about my age… 'you look kind of young, just dress the part, and don't take crap from anyone. You're new but you still know more.' but in my head I had just associated that with age. I didn't realize I was going to have to build "bro cred" as well."

This participant reflected on teaching that particular graduate class twice, and not being able to establish legitimacy either time. However, she remained optimistic: Though not teaching it for the last couple of years, she said she would teach it next year, and expects it to be better as in the past few years she has established herself as a strong researcher though grants and publications.

B. Past Experiences Migrate Into Current Experiences

A second theme was how past bad experiences carry over into current experiences. Some of the interview questions asked about experiences in undergraduate and graduate school with microaggressions and discrimination, and participants noted that past experiences serve as a lens through which they interpret all new scenarios. Recounting an experience from graduate school, one participant remembered:

> "That same guy told me once—we were driving to Home Depot to get stuff for the lab—and he told me 'it's nice that you're getting your Ph.D. and doing this for yourself, and when you settle down and have kids and get out of the workforce, this will be a nice thing to think back on.' And I was like, 'You jackass! I'm staying in the workforce! I'm not doing all of this for my own edification!' I want to *do* something with my career!'"

This sentiment was echoed by strategies that faculty use to help themselves and others overcome issues they face as a woman in engineering:

> "So I think the recurring theme has been that you're a diversity pick and that […] you haven't earned your spot. I have completely gotten over the idea—at first, this idea that you haven't earned it, that you are a diversity pick, whatever… it doesn't matter how you got in, it matters what

you do once you're here. That's how I approach everything here, and that's what I tell my female students, because I know a lot of other people have this going through their head. And it's not just women, it's underrepresented groups as well."

In this quotation, it is noteworthy that even though this participant notes that she has "gotten over" the diversity-pick issue, later in her interview, she muses about her class this semester:

"This semester, my class isn't doing that well, and I'm wondering if their performance is linked with how seriously they take me. […] I tend to interpret things through this lens of like, "Is it because I'm a woman?"

This juxtaposition is realistic of many circumstances—while personally adopting habits of mind to get over the negative messaging that can come with being a woman in engineering, past bad memories can haunt current experiences. This participant carefully noted that she can't be sure that her perceptions are real, and although she knows "not everyone is a raging sexist," her bad experiences stay with her even in her success.

C. *The Importance of Mentorship and Models in the Engineering Classroom*

A final preliminary theme from the interviews to-date include the importance of mentorship. This is a common theme in the underrepresentation literature to encourage persistence, but in this case, participants note the importance of women professor mentors when they were students, as well as women mentors in their careers that can discuss this issue. One participant discussed her female professors through undergrad (often a rarity in engineering departments):

"Yes, [I did have female professors] but they were visions of unattainability […] One of them was this incredible [person], and I don't know why this mattered: she was gorgeous, and she ran Iron Man marathons […] they were all this level of unattainability, so I had no vision for what a normal female professors looked like."

The participant continued to discuss how useful it would have been as a student to have women mentors that represented a variety of "models' for women in engineering" –some that were unattainable, some that were very approachable—in order to be able to collect strategies for future success.

These discussions of mentorship were echoed in the need for male allies that could see the points of view of their women colleagues. When asked if her graduate advisor provided any guidance in navigating classroom issues, one participant noted that although she had a wonderful and very supportive advisor, there were many things, both professional and personal, that she felt she couldn't discuss with him:

"I was never going to ask my advisor, with the world's most amazing wife, but she was a stay-at-home mom (and super psyched about it)…that thought process (dealing with gender issues in academic careers) had never crossed his mind. As nice and supportive as he was and is, having some sort of mentorship would be very helpful."

This same participant discussed how these experiences shaped who she has become as a mentor, a research advisor, and a classroom teacher, noting that one of her most marked successes in teaching to date came from an anonymous teaching evaluation the prior year:

"One of the girls in my class said, "I've never had a woman professor, and it was so refreshing to have a woman professor I can see myself liking, and that I can see myself aspiring to.'"

This quote demonstrates that although the mentorship has not necessarily been strong, the junior women faculty who are learning to succeed in academia right now are interested in establishing pathways for mentorship to ease the way for future generations.

VI. Discussion, Conclusions and Future Work

Future work includes continued interviews with junior women engineering faculty. We are aiming for approximately 20 interviews, but will sample until "saturation" of the data. At that time, all interview recordings will be transcribed and coded through rigorous qualitative methods.

Although this work is just beginning, we feel that the classroom experiences of junior faculty are worth studying, especially with respect to the strategies that they develop in order to build credibility with their predominantly male classes. In the most underrepresented engineering disciplines, women faculty may struggle to achieve credibility because they deviate from the students' expectation of an "ideal" professor, both because of gender and age. Although we do not explicitly study race in this research, we would expect that faculty from different ethnic and racial backgrounds carry with them additional layers of past experiences and doubts. In addition, the backgrounds of students with respect to gender, race, and even who their past professors/mentors have been also impact the climate in the engineering classroom. These classroom topics have not been explored much in literature, especially at the graduate level. We expect that by collecting these stories, experiences, strategies and women's visions for how "climate" can be changed, we can begin to make recommendations for professors, engineering departments, and colleges of engineering overall.

Acknowledgment

The researchers acknowledge the participants in the study and thank them for their time, their stories and experiences, and their wisdom.

References

[1] Bettinger, E. P., & Long, B. T. (2005). Do faculty serve as role models? The impact of instructor gender on female students. *The American Economic Review*, *95*(2), 152-157.

[2] Falkenheim, J. C., & Burrelli, J. S. (2012). Diversity in science and engineering employment in industry. Arlington, VA: National Center for Science and Engineering Studies, National Science Foundation.

[3] Karpman, D. (2015). Leaning into Engineering: Tenured Women Faculty and the Policies and Programs That Support Them.

[4] Fox, M. F. (2008). Institutional transformation and the advancement of women faculty: The case of academic science and engineering. In *Higher education* (pp. 73-103). Springer Netherlands.

[5] Blaisdell, S. (2006). Factors in the Underrepresentation of Women in Science and Engineering: A Review of the Literature. *Women in Engineering ProActive Network*.

[6] National Academy of Engineering (2013) Messaging for Engineering: From research to Action. National Academies Press. www.nap.edu.

[7] National Academy of Engineering (2008): Changing the Conversation: Messages for Improving Public Understanding of Engineering (2008).

[8] Bystydzienski, J. M., & Bird, S. R. (Eds.). (2006). *Removing barriers: Women in academic science, technology, engineering, and mathematics*. Indiana University Press.

[9] Ross, M., & Godwin, A. (2015, October). Stories of Black women in engineering industry—Why they leave. In *Frontiers in Education Conference (FIE), 2015. 32614 2015. IEEE* (pp. 1-5). IEEE.

[10] Sambamurthy, N., Main, J. B., Sanchez-Peña, M., Cox, M. F., & McGee, E. (2016, October). Asian-American women engineering faculty: A literature review using an intersectional framework of race, class, and gender. In *Frontiers in Education Conference (FIE), 2016 IEEE* (pp. 1-7). IEEE.

[11] Sanchez-Peña, M., Main, J., Sambamurthy, N., Cox, M., & McGee, E. (2016, October). The factors affecting the persistence of Latina faculty: A literature review using the intersectionality of race, gender, and class. In Frontiers in Education Conference (FIE), 2016 IEEE (pp. 1-9). IEEE.

[12] Bilimoria, D., Joy, S., & Liang, X. (2008). Breaking barriers and creating inclusiveness: Lessons of organizational transformation to advance women faculty in academic science and engineering. *Human resource management*, *47*(3), 423.

[13] Hall, R. M., & Sandler, B. R. (1982). The Classroom Climate: A Chilly One for Women?.

[14] Pittman, C. T. (2010). Race and Gender Oppression in the Classroom The Experiences of Women Faculty of Color with White Male Students. *Teaching Sociology*, *38*(3), 183-196.

[15] Sandler, B. R. (1991). Women faculty at work in the classroom, or, why it still hurts to be a woman in labor. Communication Education, 40(1), 6-15.

[16] Acker, J. (1990). Hierarchies, jobs, bodies: A theory of gendered organizations. *Gender & society*, *4*(2), 139-158.

[17] Ward, K., & Wolf-Wendel, L. (2004). Academic motherhood: Managing complex roles in research universities. The Review of Higher Education, 27(2), 233-257.

[18] Cech, E. A., & Blair-Loy, M. (2014). Consequences of flexibility stigma among academic scientists and engineers. Work and Occupations, 41(1), 86-110.

[19] Bleijenbergh, I. L., van Engen, M. L., & Vinkenburg, C. J. (2012). Othering women: fluid images of the ideal academic. *Equality, diversity and inclusion: An international journal*, *32*(1), 22-35.

[20] Roulston

[21] Vogt, W. P., Gardner, D. C., & Haeffele, L. M. (2012). When to use what research design. Guilford Press.

[22] Charmaz, K., & Belgrave, L. (2002). Qualitative interviewing and grounded theory analysis. The SAGE handbook of interview research: The complexity of the craft, 2(2002).

.