

Women Becoming Engineers

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Abstract: In this paper, I present a case study of a student becoming an engineer to highlight the ways in which women become engineers. Drawing on theories of situated learning and feminism in engineering education, I analyze the gendered practices of engineering education. My analysis suggests that the construction of gender in engineering education has implications for how engineering learning occurs, resulting in implications for both engineering education and learning theory more broadly.

Introduction

In a recent article in the *Journal of Engineering Education*, Johri and Olds, along with multiple contributors from the learning sciences, argue that the research communities of engineering education and learning sciences can both benefit by their mutual engagement and collaborative research (2011). The authors argue that the theory of situated learning in particular is gaining prominence in both fields and is a promising theoretical lens to approach studies of learning in engineering. The research presented in this paper is the result of this type of collaboration between learning scientists and engineering educators. This work comes out of a broader, ongoing ethnographic study called *Cognitive Ethnographies of Engineering Design* in which engineering educators and learning scientists are investigating engineering design practices in both undergraduate courses and workplaces. My individual focus, however, is on women becoming engineers through their undergraduate coursework.

According to the NSF (2013), women represent less than 18% of all engineering enrollments. Much of the research to date on women in engineering focuses on quantitative measures of women's success and/or persistence in the field (Beddoes and Borrego, 2011). My research focuses on *how* women are succeeding and/or persisting. The goal of my research is to uncover how undergraduate classroom practices, and institutional structures and policies, enable and/or constrain women's success in undergraduate engineering; or more succinctly, how women are learning to be engineers. This work has implications for the ways in which gender is taken up in learning theory, and has the potential to inform ways in which women's success can be increased in engineering.

Conceptual Framework

To investigate women becoming engineers I draw from theories of situated learning and feminism in engineering education. Both theories focus on the individual in context. While situated learning has explanatory power regarding the ways individuals navigate pathways and trajectories, feminism highlights how these pathways and trajectories are gendered.

Situated versus Cognitive Theories of Engineering Learning

Situated learning takes learning to be a function of the activity, context, and culture in which it occurs; it is a fundamentally social phenomenon. This stands in opposition to cognitive approaches to learning in which learning is thought of as the acquisition of decontextualized concepts transferable to other situations at other times. In documenting how students become engineers, Stevens et al., (2008) demonstrate that persons are always and without exception, persons in context. The broader organizational practices individuals engage with influence the pathways in or out of a community and there are both official and unofficial routes to becoming an engineer. This results in some students pulled in and other students pushed out of the discipline.

Interactional versus Liberal Feminism

The majority of research regarding women in engineering is implicitly based in a liberal feminist tradition (Beddoes & Borrego, 2011). Although valuable in its seeking of equality between men and women, liberal feminism is limited in that "woman" is seen as a homogenous category, often universalizing white, western, middle class women. Interactional feminism, on the other hand, is concerned with the ways gender is produced in the encounters and processes of every day. By focusing on discourse, interactional feminism rejects presumed binaries, and attempts to uncover gendered behaviors and interactions to produce new explanation as to how and why masculine biases persist in engineering.

Methods

This study was conducted at a large, US public university. It is based on the analysis of observational data collected in two undergraduate engineering courses. This first course was a general engineering freshman design course with 30 students enrolled. The second course was a senior mechanical engineering design course with 100+ students enrolled. The freshman course met three times a week; the first session was a one-hour course lecture; the other two were two-hour working labs. The senior course met twice a week for one hour and fifteen

minutes. In addition to these courses, this study includes observations of the weekly planning meetings for instructors teaching freshman design, weekly staff meetings held by the instructor of senior design, and weekly team meetings from one senior design team. The data includes fieldnotes from over 100 hours of observation, as well as informal interviews with students, instructors, and teaching assistants in the design courses.

A Case Study of Becoming an Engineer

Preliminary findings underway suggest that gender is made salient in undergraduate engineering education in ways that impact potential learning. Engineering classroom practices as well as institutional structures continue to prescribe gender norms resulting in fixed categories of expectation. In my poster, I will expand upon these practices and my analyses, but I offer the following vignette as a representation of my preliminary analysis.

Vignette: Ares. The engineering center is a collection of buildings, connected by a labyrinth of walkways so that you never have to go outside to get from one building to the next. There are computer labs, and machine shops dispersed throughout with some labs underground three floors. Signs are suspended from the ceilings directing you which way to go, and directing you to the women's restrooms. The women's restrooms were retrofitted from previous men's restrooms with the urinals left in tact. I navigate this maze to the freshman design classroom. Outside of the classroom are pictures of engineering projects for third-world countries under the caption "engineering with heart" only the heart was the symbol and not the word. It is in the freshman class that I first met Ares. Ares would often sit in the back or the corners of the classroom, slouched in a chair. With black pants and black shirt, Ares seemed invisible. Ares could pass for a twelve year-old boy; awkward and shy like many other freshmen. For the first few weeks of observations, I thought she was male. It wasn't until the class was split into their project teams that I realized she was biologically female. Instructors are strongly encouraged to pair females in group-work so that no one female is left with the secretarial tasks. After many observations and informal interviews, Ares gender remains ambiguous. She has told me that at times she binds her breasts to suppress her femininity, but likes her feminine eyeglasses. She plans on double majoring in aerospace engineering and French because she likes both the hard science aspect of engineering but enjoys communications. In more ways than one she defies categorization.

Discussion

As this vignette suggests, gender is made visible in engineering education at every literal turn. The signage that points to the women's restrooms containing men's urinals serve as a reminder that as a woman you don't belong here, or at least you didn't at one time. The imagery on the wall of engineering with a heart is strategically placed outside of the freshman design classroom to entice female students into engineering by appealing to their sensitive emotions, one of the many practices that essentializes women's identities in engineering education. Ensuring that women are not lone participants on a team is another strategy designed to improve women's experience (Tonso, 1996), but when probed as to why, instructors often cite that is so women can *share* secretarial duties, not to prevent them from doing it in the first place. Women are categorized and then essentialized in engineering education. What, then, do we make of Ares? She is confronted with imagery and practices that remind her you can only be one gender, and she is placed on a team based on her sex, but can we say her experience is improved because of it? This remains to be seen and needs further investigation.

The learning sciences as a field continues to explore the connections between identity and learning, and yet, a salient feature of identity, gender, continues to be under-theorized. As Ares' case suggests, understanding gender and learning is complex, and we need to advance our learning theories to address this complexity.

References

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