

Being and Becoming: Gender and Identity Formation of Engineering Students

Authors: Debbie Chachra, Deborah Kilgore, Heidi Loshbaugh, Janice McCain, Helen Chen
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For undergraduate engineering students, development of an engineering identity is an important outcome of their education as they progress towards their professional selves. This process is reflected in engineering colleges' frequent practice of referring to engineering students as "engineers" (even in the earliest days following matriculation) in contrast to students in other disciplines.

Implications of Findings

Results of this study showed that there was little difference in the degree of identification as an engineer between men and women, at least in the first- and sophomore year. However, men were more likely to perceive engineering as the application of math and science (that is, highly technical) and to prioritize "building" as a design activity, while women were more likely than men to prioritize "seeking information" in their first year. These differences suggest that, when men and women express their degree of identification with engineering, they are actually identifying with a slightly different set of activities.

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The development of an engineering identity is strongly fostered by the culture of the engineering school and is considered to be an essential part of the educational progress of students towards a professional engineering identity. However, data presented in this paper suggest that the interaction of gender with the development of engineering identity is complex and multilayered, requiring:

- a consideration of how men and women develop an understanding of what constitutes an engineering identity
- an understanding of how students of both genders develop their own identities and how this relates to engineering identity

While observed differences in the self-identification of students in the first two years of their education were few, gender differences in the perception of what constitutes engineering and design may affect students' identification with engineering. The nature of student understanding of engineering changes over time and differs between male and female students, thus a complete picture of how students develop an engineering identity is complex.

Methods and Background

Given the gendered history of engineering schools and their cultures, the team hypothesizes that men and women develop engineering identities in different ways. This paper presents data from the Academic Pathways Study (APS), a component of the Center for the Advancement of Engineering Education (CAEE), that explores the complex interactions between gender and engineering identity. CAEE is a multi-institution, multi-method study which examines engineering students learning and development as they navigate their undergraduate careers.

Data were collected at each of four institutions (pseudonyms used in this paper): Technical Public Institution (TPUB), a public university specializing in teaching engineering and technology; Urban Private University (UPRI), a private historically black institution; Large Public University (LPUB), a large public university; and Suburban Private University (SPRI), a medium-sized private university. Methods include surveys, structured and unstructured interviews, and ethnographic observations.

APS specifically addresses questions about undergraduate students' experiences and decisions to pursue and persist in an engineering degree, relative to their learning and identity development, as they acquire the necessary skills to be professional engineers. With respect to identity, APS asks the following questions:

- How do students come to identify themselves as engineers?
- How do students' appreciation, confidence, and commitment to engineering change as they navigate their education?

What We Found

A series of questions designed to assess engineering student identification with engineers was administered to the longitudinal cohort of students twice, once in the first year and again in the sophomore year. Survey items focused on: the extent to which the student defines him/herself as an engineer (centrality), the extent to which the student feels positively or negatively about engineering and engineers (private regard), the extent to which the student perceives others feel positively or negatively about engineering and engineers (public regard), and the value individuals place on being an engineer.

In general, there were few differences between men and women in their identification as engineering students, at least at these two time points. No statistically significant differences between men and women were found in the first year, but trends toward differences were observed during the sophomore year. Women reported a higher degree of centrality of engineering identity than men, and men reported a higher perception of public regard for engineers than women.

The team also looked at perceptions of engineering and of engineering design. The definition of engineering varies widely and depends on its source and purpose. Study participants were asked as part of a structured interview, "*In your own words, would you please define engineering?*" This data revealed that a greater number of students defined engineering to include the action components of engineering (e.g., problem solving, application of math and science skills) in contrast to the thinking component of the definition (e.g., brainstorming, critical thinking).

Themes that saw an increase in response between first and sophomore year students included *problem solving* and *improving humankind*. There was a significant decrease in the frequency that students used *designing/creating/building* to define engineering. In another analysis, we found that most engineering students cannot always communicate or *define* what the discipline of engineering encompasses. When data were reviewed by gender, the researchers found that male students perceived engineering in terms of math and science application to a greater extent than their female counterparts.

These observed gender differences put the nominally similar identification of women and men with engineering into a new light—since they have differing perceptions of engineering, the nature of what they are identifying with is presumably different. This is explored further in terms of perceptions of engineering design.

The survey portion of APS included a question designed to elicit engineering students' conceptions of design. This question was administered to APS participants in each year of the engineering study, allowing for longitudinal comparison of the responses. In the first year, women and men were largely in agreement, with many students prioritizing activities such as “understanding the problem,” “communicating,” and “brainstorming.” However, there were some statistically significant gender differences. Women were less likely than men to select “building” and “prototyping” and more likely to select “seeking information.” Differences in how men and women perceive themselves as engineers were elaborated upon by some students at Large Public University during semi-structured interviews in their fourth year. One young woman described how men in engineering get more respect than women, and how consequently they are more confident. Many respondents perceived that women had an advantage over men with respect to opportunities for scholarships, internships, and jobs. This led to the perception (by both men and women) that women did not necessarily merit the recognition they received.

During structured interviews, students were also asked about their level of commitment to completing an engineering major and their intentions to use the degree after graduation. The majority of study participants planned to work or pursue an advanced degree after completing their undergraduate engineering degrees (35.7 percent planned to go to graduate school; 60.7 percent were more likely to join the workforce). Though 86.7 percent of junior engineering students stated they were “very committed” (vs. 13.3 percent of students selecting Not Very Committed or Not Committed) to completing their engineering education.

Data from the first and third (junior) year surveys indicated that females are more likely than males to report feeling overwhelmed by engineering coursework. Despite this, women identified the engineering campus culture, as well as the challenge of becoming an engineer, as aspects they liked. Women also reported higher levels of fulfillment from extracurricular engagement. In the ethnographic data, women more frequently reported feeling academically “burned out,” while men expressed less dissatisfaction with the workload.

The combined stresses associated with the demands of challenging coursework, the need to partake in social activities, and meeting family expectations all support the idea that the development of engineering identity is derived from numerous sources – both internal and external to the academic institution.