

Same Courses, Different Outcomes? Variations in Confidence, Experience, and Preparation in Engineering Design

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There is evidence in the literature that women have lower confidence in their skills and knowledge than men, particularly in areas considered crucial for engineering, like math and science. This difference has been linked to gender gaps in engineering enrollment and persistence. This study of engineering students extends research on gender differences by examining how confidence with design interacts with academic preparation and the frequency of design experiences in engineering coursework. Patterns of gender differences within the racial/ethnic majority and minority groups are also examined.

Implications of Findings

Overall, the analysis by gender and by majority (White/Caucasian and Asian American/Asian) vs. underrepresented minority (URM) (African American/Black, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, Mexican American/Chicano, Puerto Rican, Other Latino) status undertaken in this study provides insights into students' confidence to engage in engineering design activities, and their perceptions of the quantity and quality of design education they receive in their coursework. While corroborating some findings from earlier studies, this analysis has also uncovered longitudinal differences in the development of student attitudes during undergraduate study.

This study demonstrates that, at least for this sample and with respect to design, a commonly held understanding about gender differences in confidence does not extend to URM men and women.

The analysis revealed that in both the second and fourth year, men generally indicated significantly higher levels of confidence as well as course preparation for engaging in engineering design activities. The analysis also showed that the gender differences in confidence and perceived academic preparation to engage in design are primarily accounted for by the gender gap within the majority group. It was encouraging to see this gap diminish toward the fourth year of engineering study. However, while the magnitude of the gender effect diminishes, the general pattern of responses (men's perceptions are slightly more positive compared to women's) persists across the majority group through the senior year.

Perhaps the finding of greatest impact is the localization of the gender gap within the majority students in this study. This study demonstrates that, at least for this sample and with respect to design, a commonly held understanding about gender differences in confidence does not extend

to URM men and women. This has programmatic implications in that the marginal outcomes of programs designed to improve students' confidence to do design may be greater for majority women than for URM women.

The absence of any significant difference in how frequently students perceive they are being exposed to design in their coursework indicates that students in this sample all perceived they were receiving the same quantity of design education. At the same time, men rated their courses more highly with respect to preparing them to do design, indicating that there is a gender difference in the perception of the quality of design education students in this sample were receiving. Possible explanations for this combination of findings include: the perceived quality of design education may mirror differences in the courses and majors that students choose, with gendered patterns arising in these differences that our analysis would not detect; gender differences in what students understand course preparation to be; and that women in this sample perceived that their preparation to do design came more from extracurricular activities and/or work experiences than from their engineering coursework.

Finally, the design experiences that men and women have in their engineering courses may be qualitatively different. Both men and women are engaging in the same design activities in their courses, but perhaps in different ways. This has implications for instructors who aim to provide all students with equal opportunities to learn design. For example, instructors may want to pay greater attention to the individual roles that students play in their design teams and encourage students to take on different roles from time to time.

Method and Background

This study is part of the Academic Pathways Study (APS), a research element of the NSF-funded Center for the Advancement of Engineering Education (CAEE), which focuses on students' experiences as they move into, through, and out of engineering education. APS is a longitudinal study of 160 undergraduate engineering students at four diverse institutions (40 students at each institution). This analysis describes results from three related questions that were part of a larger, web-based APS survey administered to participants over four consecutive years. The comparisons reported here are based on data collected in the second and fourth years, in the spring of 2005 and 2007.

This study explored confidence to do design with respect to gender and URM status. This line of inquiry directly addresses differences between women and URM students as categories of students. Students' beliefs about the design education they received were also explored. This line of inquiry is important because it addresses a potential source of confidence—the perceived quantity and quality of the coursework itself.

The specific research questions addressed are:

- Does confidence to do design vary with the gender, URM status, and/or academic status of engineering students?
- Do students' beliefs about the quantity of design they are exposed to in their engineering education coursework vary with gender, URM status, and/or class standing?
- Do students' beliefs about how well their courses are preparing them to do design vary with gender, URM status, and/or class standing?

In the three survey questions asked of the students and intended to address the research questions above, engineering students at four institutions were asked to (a) rate their confidence in the ability to engage in each of eight engineering design activities, (b) indicate the frequency of engagement with these activities in their courses, and (c) rate how well their courses are preparing them to engage in each activity.

Demographic information was gathered from students in the first year of APS. Gender was determined based on students' self-reports. Reflecting the oversampling of women in the APS study, 37% of the participants in this sample were women. Students were also identified in terms of what the team refers to as *representation status* in this paper—that is, belonging to either the majority or the URM group. For a detailed discussion of methods and analysis, please see the full paper at the link below.

What We Found

In terms of the “confidence to do design” question, men expressed higher confidence than women in both Years 2 and 4, although the gender gap had narrowed somewhat by Year 4. There were no statistically significant differences between majority students and URM students in confidence to do design. At the same time, there were significant differences in confidence between majority men and women, but there were no significant differences in confidence between URM men and women. Therefore, the gender gap in confidence to do design is primarily accounted for by majority women.

For the question about students' “perceived *quantity* of design education,” in both years, no significant differences in perceived frequency of design experiences in coursework were found for the overall sample with respect to gender or majority vs. URM status. Within the majority group, men consistently rated their frequency of course experience with design higher compared to women, but the differences were not statistically significant. Differences in ratings on two of the eight design activities approached significance in Year 2, yet this finding appeared too weak to signal a trend toward consistently higher frequency ratings by men. There were no significant gender differences in either year within the URM group.

Lastly, findings for the question about students' “perceived *quality* of design education” were similar to the findings for confidence in design. Differences in perceived preparation between majority men and women account for the gender gap within the overall sample. At the same time, while no gender differences surfaced within the URM group, a graphical comparison of average responses of men and women in Year 2 and Year 4 reveals a potential emergence of a gender gap in perceived preparation within this group at a later stage of engineering study.

The explanatory power of these findings is limited by the significant overlap between representation status and institutional affiliation. It is possible that other factors influence perceptions and attitudes regarding self-confidence and preparation for design, including characteristics of individual institutions or programs.

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