Research Brief
Center for the Advancement of Engineering Education
NSF Grant ESI-0227558

Creative, Contextual, and Engaged: Are Women the Engineers of 2020?

Authors: Deborah Kilgore, Debbie Chachra, Heidi Loshbaugh, Janice McCain, Marcus Jones, and Ken Yasuhara
Source: 2007 American Society for Engineering Education Conference

Educators, professionals and policy-makers alike recognize that contemporary engineering must be studied and practiced in context. The National Academy of Engineering (NAE) envisions an "Engineer of 2020" who demonstrates "dynamism, agility, resilience, and flexibility" to design for an uncertain and rapidly changing world. The increasingly diverse engineering workforce and marketplace require "cultural competence": that is, a willingness and ability to consider culture in engineering problem-solving.

Implications of Findings

The implications of this research are significant, given the ever increasing need in the U.S. for more highly skilled engineers. Analysis of the data described below revealed that women define engineering, approach engineering problems, and engage in their overall engineering education more broadly than men. Interestingly, the women considered contextual factors in addition to (rather than instead of) factors oriented toward the details of the artifact being designed (the retaining wall, in the example from the first year of this study). In this sense, their approaches to the engineering task were broader than the men's. Given that this difference was observed in the first year, early emphasis of such practices is critical.

Findings from the students' first year of study suggest that women were more aware of how an engineering task is situated within and interacts with its context.

Prior educational research has also suggested that underrepresented minority populations are more successful in higher education environments that place high emphasis on context. These findings are highly suggestive for how engineering education might do better recruiting women and underrepresented minorities. However, the findings that male participants are more dissatisfied with their engineering education experience and less engaged than females could also be useful in addressing concerns of persistence among the traditional engineering population, white men. With greater mechanisms for engagement, engineering colleges might find all their students to be more satisfied with their undergraduate experiences. If these findings were used to restructure engineering programs, a more holistic approach might help to graduate students who are better prepared as practitioners to meet the national need for engineering talent.

This analysis is seen as further evidence that women are as prepared, if not more prepared to study engineering than men, considering their greater attention to context. Given the vision of the Engineer of 2020, engineering education should be more responsive to women's interests and qualities and should do a better job of providing opportunities for all students. Shifting curricula

from traditional practices into reliance on engaged pedagogy and campus communities will improve our ability to attract and retain diverse students and will also produce the kinds of engineers we envision to meet the needs of a global society.

Method and Background

Data were collected from students at four of the partner universities of the Center for the Advancement of Engineering Education (CAEE) Academic Pathways Study (APS). CAEE is a multi-institution, mixed-method, longitudinal study which examines engineering students' learning and development as they move into, through, and beyond their undergraduate institutions. Data collection methods include surveys, structured and unstructured interviews, and ethnographic observations.

The study was designed to collect data from 40 students at each of the four institutions. In the first year, structured interviews and performance tasks were administered to 32 of those students from each institution, and unstructured interviews and ethnographic observations were conducted with the remaining 8 students at each institution. (See full-text article at the link below for a complete description of methods.)

What We Found

In the interpretation phase, research team members came together for a 2-day workshop to compare emerging findings. The authors had each observed modest gender differences while analyzing their respective data sets. The researchers used the overarching "engineering in context" theme to frame the examination of findings of gender differences and commonalities emerging from each of the methods.

Findings indicate that women and men conceptualize engineering differently. Regardless of the respondent's sex, responses tended to be similar in length and complexity. However, men's answers tended to be more linear, direct, and technically based. In contrast, women tended to define engineering more broadly.

Findings from an engineering problem administered to participating students indicated that women and men frame engineering problems differently. Students were asked to write their answers to the question, "Over the summer, the Midwest experienced massive flooding of the Mississippi River. What factors would you take into account in designing a retaining wall system for the Mississippi?"

On average, women's answers contained a statistically significant greater number of distinct ideas than men's. While women and men had roughly the same number of ideas oriented to the detail of the design problem, women gave greater attention than men to the context of design. These findings from the students' first year of study suggest that women were more aware of how an engineering task is situated within and interacts with its context.

Women reported less disengagement in both their engineering courses and liberal arts courses when compared to their male peers; women also reported less disengagement overall. This finding suggests that women currently are taking greater responsibility for their own learning, a necessary prerequisite of lifelong learning. In addition to their relatively lower academic disengagement, female students report higher levels of extracurricular fulfillment than their male colleagues, suggesting they are more fully engaged with their academic environment.

Our data show that students acknowledge that their engineering knowledge comes from educationally productive activities, but they are differentially engaged in those activities. In addition, while engagement in extracurricular activities presents complex effects depending on whether the activities are engineering related or not, engagement in these productive activities also shows positive outcomes for students, and women show higher levels of engagement here as well. Consistent with their lower levels of disengagement in both engineering and liberal arts courses, as well as higher levels of satisfaction with extracurricular activities, female students appear to be closer to the ABET target of broadly educated, contextually aware, self-direct learners.

Our rich, multi-method view of context and engagement offers interesting new directions for further research to better understand how engineering education can adapt itself to meet national needs for more and better engineers.

www.engr.washington.edu/caee July 2007