

Same courses, different outcomes? Variations in Confidence, Experience, and Preparation in Engineering Design

Center for the Advancement
of Engineering Education

Andrew Morozov, Deborah Kilgore, Ken Yasuhara, Cynthia Atman

Conceptual Foundation

- Underrepresentation of women in engineering
- Design is a key aspect of engineering academic experience
- Confidence linked to preparation, persistence
- Role of gender & racial/ethnic background

Research Questions

Do...

- **confidence** to do design
- **quantity** of design in engineering coursework
- **preparation** to do design

vary with...

- gender
- racial/ethnic group
- class standing of engineering students?

Sample

- Longitudinal Cohort
 - True-longitudinal subset of 2nd and 4th year engineering students (n=110)
- Respondents
 - Racial/Ethnic Majority group (n=73)
 - White, Asian American/Asian
 - Underrepresented Minority (URM) group (n=37)
 - African American/Black, Latino, Multicultural
 - Women make up about 38% of each group
 - No majority students from UPri, half of URM students from UPri

Instrument

- Three design-focused questions on the Persistence in Engineering (PIE) survey:
 - How **confident** the student is in her or his ability to do design
 - How **often** the student engaged in design activities in the current academic year (quantity)
 - How well courses are **preparing** the student to do design (quality)
- Each question included a list of **8 design activities** rated on a Likert scale
- Mann-Whitney U statistical test, p-values adjusted to account for Type I error

Engineering Design Activities

Full wording as presented in questions	Abbreviated Name Used for Analysis
Defining what the problem really is	Problem definition
Searching for and collecting information needed to solve the problem	Gathering information
Thinking up potential solutions to the problem	Generating ideas
Detailing how to build the solution to the problem	Modeling
Assessing and passing judgment on a possible or planned solution to the problem	Feasibility analysis
Comparing and contrasting two solutions to the problem on a particular dimension such as cost	Evaluation
Selecting one idea or solution to the problem from among those considered	Decision
Communicating elements of the design in sketches, diagrams, lists, and written or oral reports	Communication

Overview of the Findings

- Students in both their 2nd and 4th years felt **confident** in their design abilities and that their courses are **preparing** them well.
- Women
 - are less **confident** in their design abilities and feel less **prepared** by their courses than men, though...
 - engaged in design activities in their coursework as **often** as men
- Gender differences within majority group account for gender differences in overall sample.
- No significant gender differences observed among URM students in the study.

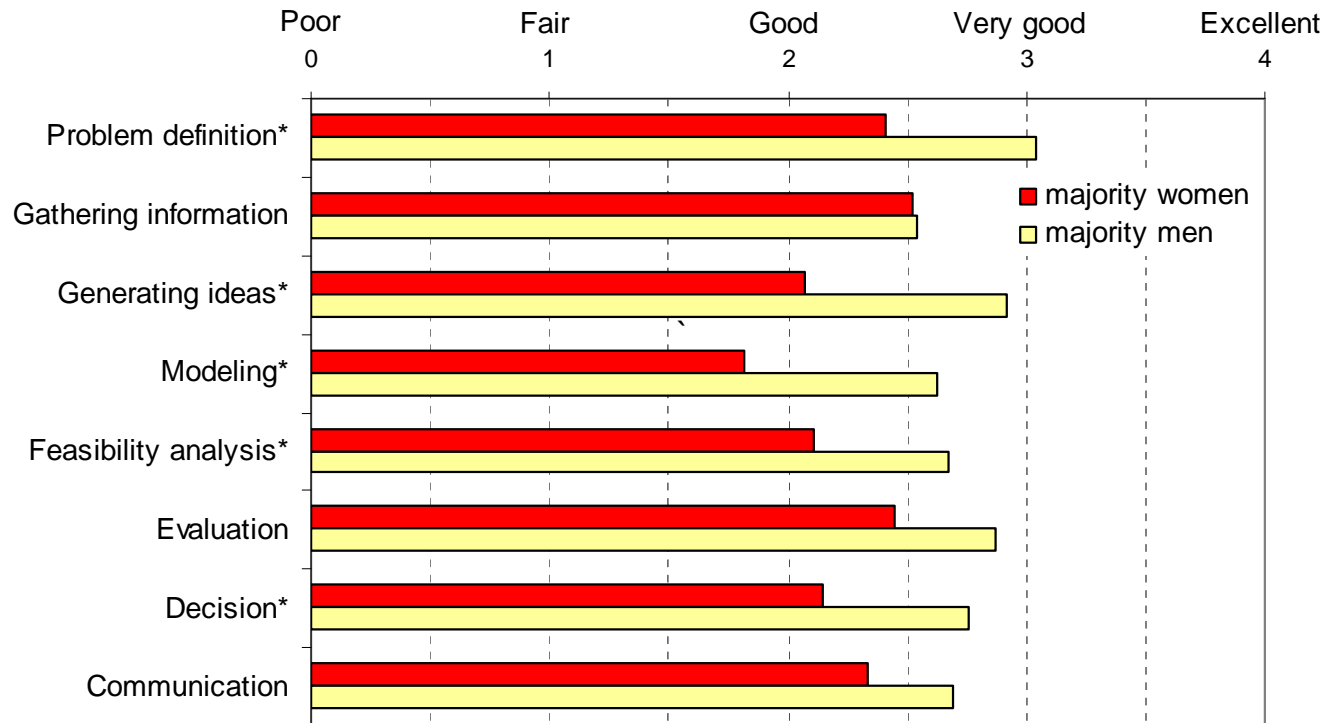
Confidence

- Average confidence level rated “good” to “very good”
- **Majority Group:**
Men > Women on 5 activities in Y2,
2 activities in Y4
- **URM Group:**
No significant gender differences

Majority Group: Confidence by Gender

Year 2

Confidence in ability to perform design activities, Year 2

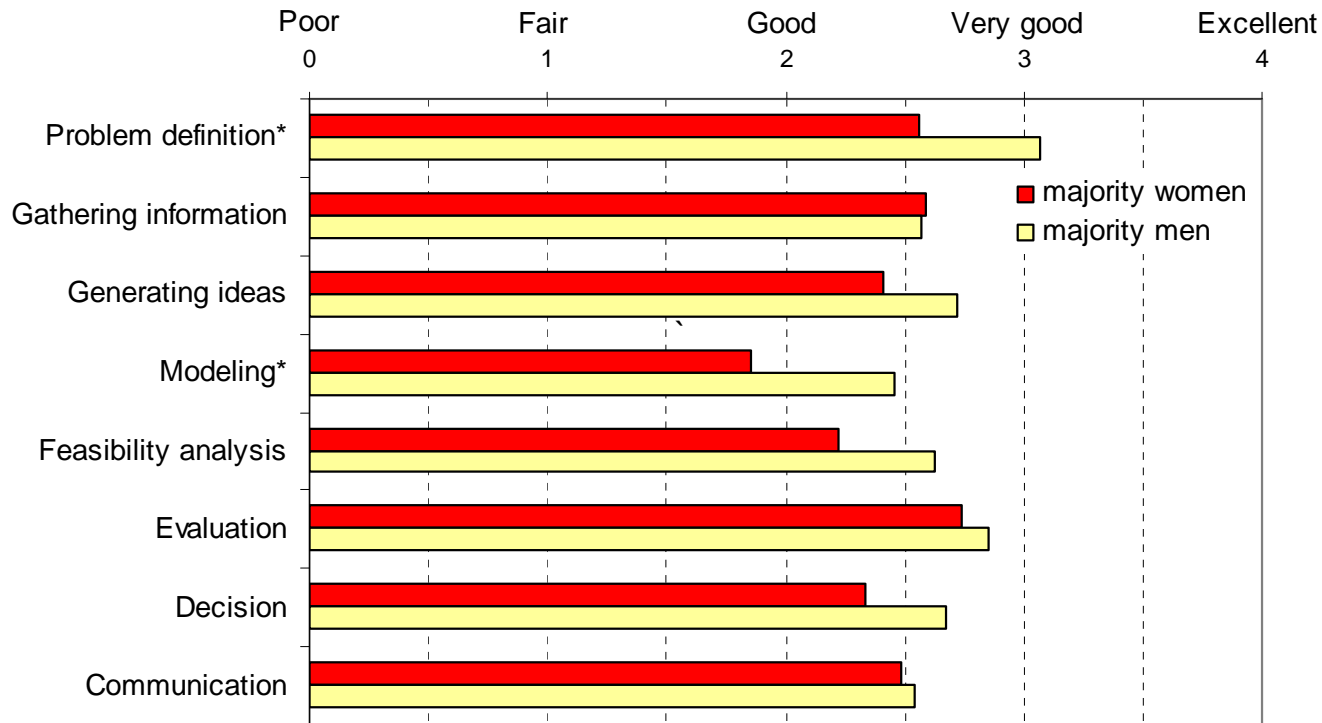


Asterisks indicate significant gender differences ($p \leq 0.014$, Mann-Whitney U; $n = 27$ women + 46 men).

Majority Group: Confidence by Gender

Year 4

Confidence in ability to perform design activities, Year 4



Asterisks indicate significant gender differences ($p \leq 0.014$, Mann–Whitney U; $n = 27$ women + 46 men).

Preparation

- Average preparation level rated “well” to “very well”
- **Majority Group:**
Men > Women on 6 activities in Y2,
no difference in Y4
- **URM Group:**
No significant gender differences

Quantity

- Students typically said they engaged in each of the design activities from “2-3 times a week” to “1-2 times a month”
- No significant gender differences

Discussion

- Students are **confident** in their design abilities and believe that their courses are **preparing** them well.
- Women
 - are less **confident** in their design abilities and feel less **prepared** by their courses than men, though...
 - they say they engage in design activities in their coursework as **often** as men
- Gender differences within majority group responsible for gender differences in overall sample.
- No significant gender differences observed among URM students in the study.

Discussion, continued

- What accounts for the difference in confidence and preparation to do design, if women and men engage in design equally often?
 - Different choices of courses and majors?
 - Different standards of confidence, preparation?
 - Different source of preparation for women, e.g. extracurricular activities / employment?
 - Qualitatively different gendered experiences in design classes?
 - Other?

Discussion, continued

- What accounts for the findings of gender differences among majority students but not among URM students?
 - Institutional effects?
 - While still in the minority among engineering students, UPri women comprise 70% of the overall student body.
 - For example, Fleming *et al.* showed that the significant difference in gendered experiences among the APS students was the relative lack of role models for women.
 - Effects of other affiliations/life experiences?
 - For example, Donaldson *et al.* described a difference in confidence between students at different SES levels.

Acknowledgement

This material is based on work supported by the National Science Foundation under Grant No. ESI-0227558, which funds the Center for the Advancement of Engineering Education (CAEE). Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



CAEE is a collaboration of five partner universities: Colorado School of Mines, Howard University, Stanford University, University of Minnesota, and University of Washington.