Identifying gender differences in undergraduate Computer Science students: Women aren't so different

Dr. Carl Siebert(A), Kathleen Mullen(A), Dr. Noah Salzman(B)
Boise State University, (A) Dept. of Curriculum Instruction and Foundational Studies (B) Dept. of Electrical & Computer Engineering

I. Abstract

STEM employment is growing at twice the rate of other occupations, with computer-related fields demonstrating the greatest growth. Yet, as the need for talent grows, the proportion of computer-related baccalaureates awarded to women declined from 28% in 2000 to 18% in 2013. As part of an NSF-sponsored project, we examined gender differences as a first step to explaining the low numbers of female Computer Science (CS) graduates. Our survey of 393 CS undergraduates found no significant differences in psychological traits like self-esteem and self-efficacy, but more women reported high stress. Data pointed to possible differences only in student-faculty engagement. Future work will investigate why CS is losing or not attracting talented women.

II. Background

STEM education and training pathways vary but skills often advance through participation in postsecondary programs (National Science Board, 2015). Female undergraduates major in Computer Science (CS) at lower rates than male and are more likely to leave the major (Babe-Vroman et al., 2017; National Science Board, 2016). Low completion levels are seen in the proportion of CS-related baccalaureates awarded to women, from 28% in 2000 to 18% in 2013 (National Science Board, 2016).

Researchers seeking to understand gender, looking at biological differences to sociocultural influences (Ceci, Williams, & Barnett, 2009; Cheryan, Ziegler, Montoya, & Jiang, 2016; Cohoon & Aspray, 2006; Hill, Corbett, & St. Rose, 2010; Sax et al., 2017; Singh, Allen, Scheckler, & Darlington, 2007). Research shows that women stereotypes promote stress and disengagement (Corbett & Hill, 2015.), that computer science departments privilege male "geek" norms (Margolis & Fisher, 2002) negatively impact aspirations, and that the view that professors both do not take women seriously and underestimate their abilities (Beyer, DeKeuster, Walter, Colar, & Holcomb, 2005).

NSF has funded multiple 5-year projects to address participation of women and minorities in STEM fields.

III. Method

An online questionnaire gathered information on beliefs and experiences from undergraduate students who identify as Computer Science majors, minors, or currently taking Computer Science classes (N=1168). Five rounds of email invitations (35-day period), 522 responses, and data cleaning (reliability and validity) resulted in 393 cases. (33.6% response rate) – 317 males, 76 females, 80.7% and 19.3% respectively.

Among the respondents; 81.4% identified as CS major/minor, 3% identified as non-STEM, 13.7% first-year students, 21.1% Sophomores, 22.6% Juniors, and 28% Seniors, 25.7% 20 years old or younger, 33.3% were 21-24 years old, 21.6% were 25-30 years old, and 19.2% were 31+ years old, 9.9% identified as Hispanic or Latino, 8.4% identified as only Asian, 79.6% as only White, and 1.3% as only Black or African American.

Multiple CS-related questions were asked;
- *I believe the current list of Computer Science classes will prepare me for successful employment.*
- *I believe the class content taught in the Computer Science department matches what employers are looking for in new hire candidates.*
- *In general, the teachers/professors are able to teach effectively the content taught in Computer Science classes.*

Question topics included unequal treatment or perceived bias for males or females in the curriculum, teacher behavior and favoritism, and favoritism/bias of other students.
- *Some content taught in class is better understood by males than by females. Race/ethnicity of the instructor influences how well students learn in class.*
- *I feel I am able to communicate with my teachers/professors whenever I want.*
- *I find it easier to work in a team where everyone is the same race than when the team is more diverse, Minority students have an easier time finding work after graduation than other students.*

Scales included self-efficacy (Schwarzer & Jerusalem, 1995), self-esteem (Rosenberg, 1965), perceived stress (Cohen, Kamarck, & Memelstein, 1983), and resistance to change (Oreg, 2003). Overall, the questionnaire included 90 quantitative and qualitative questions covering a wide range of beliefs and experiences. We hypothesized that we would find statistically significant gender differences in all these areas.

The four validated scales were tested for reliability (Cronbach's Alpha); Self-efficacy ($\alpha=.86$), self-esteem ($\alpha=.89$), perceived stress ($\alpha=.85$), and resistance to change ($\alpha=.82$). In addition, the univariate and bivariate analyses on all the variables verified the usability of validated scales, and we looking for possible differences between responders who did and did not answer the sexual identity question. We visually compared response distributions, ran t-tests, and ANOVAs.

IV. Findings

We found no statistically significant gender differences regarding student engagement, beliefs or experiences regarding CS course quality, program preparation for employment, cultural cohesiveness, or teacher/instructor interaction. Using G*Power (Erdfelder, Faul, & Buchner, 1996), a post-hoc power analysis determined a necessary effect size of 0.36 (power=.8, alpha=.05, sample sizes of 317 males and 76 females), suggesting that a moderate effect size would be needed to achieve significance. However, visual examinations of response distributions show two possible differences in responses between males and females.

(6-pt likert-type scale from Strongly disagree to Strongly agree)
- *Personality of the instructor influences how well students learn in class.*
- *Some instructors favor either males or they favor females when helping their students.*

V. Conclusion

These findings suggest that engagement with professors may be different for male and female students in CS education. In our study, a larger proportion of women than men report that professors/instructors favor either males or females, and that professor/instructor personality influences how well students learn. In addition, the percentages of highly-stressed individuals suggest that more females than males are dealing with high stress during their undergraduate education.