CONFIDENCE IN COMPUTING: A CAREER PREPARATION COURSE FOR UNDERGRADUATE STUDENTS

INVESTIGATING THE GENDER GAP IN UNDERGRADUATE COMPUTER SCIENCE PROGRAMS

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By

Mara Hart

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Technical Project Team Members:
Jonathan Gordon
Andrew Ni

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

ADVISORS
Caitlin Wylie, Department of Engineering and Society
Thomas B. Horton, Department of Computer Science

INTRODUCTION

Colleges are known for graduating their students with little experience and a lot of debt (Pascarella, 2019) when experience-based learnings are highly regarded in the new grad job market (Thompson, 2014). My technical project focuses on introducing students to industry-relevant skills early in their academic career. But before we get to college, there are barriers that may discourage young girls and women from pursuing a computer science degree. My STS topic focuses on this lack of gender inclusion. Whether it's perceived that femininity in STEM is unachievable (Wadley, 2012) or the lack of retention of women of color (Garcia and Scott, 2016, 1), only 18% of computer science majors are women ("Report - S&E Indicators", 2018). There are both intrinsic and extrinsic factors that play into a young woman's decision to pursue a computer science degree.

TECHNICAL TOPIC

13% of college graduates between the ages of 25 to 34 are unemployed ("Employment rates of college graduates", 2019). In a world where college drop-outs like Mark Zuckerberg and Bill Gates can create highly regarded corporations, why do we need a college education? In the United States, intelligence scores are a better measure of job potential rather than a college degree. Employers value logical thinking, creative problem solving, and adaptability, yet a college transcript only shows how well someone can regurgitate memorized information (Chamorro-Premuzic and Frankiewicz, 2019).

With students paying hundreds of thousands of dollars to attend university, they're looking for a high return, especially in future earning potential. My technical project is a career preparatory course that works to increase the self-efficacy and career expectations of computer

science students who before undergraduate studies have relatively low self-confidence, social support, and computing experience.

This specific course was taught over two semesters with a teaching staff of 5-7 student teachers and 2 professors who oversaw the curriculum and class structure. It's a semester-long course that focuses on industry practices not explicitly taught in the current university curriculum. The course targeted students earlier on in their college career, as it's often the newer students who are unsure of their position in their career (Kapoor and Gardner-McCune, 2019, p. 14).

The goal is to measure student improvement throughout the semester in terms of professional development and self-confidence. The constraints of the course are that it is an asynchronous, online class due to the COVID-19 pandemic and may result in disengagement. As it's only a 1-credit course, we can only expect 3 hours/week of study, forcing the teaching staff to limit depth into introduced topics. For both semesters, we administered surveys to measure the effect of the course on different aspects of confidence in computingThe Fall semester featured weekly topics that were chosen to enhance the clarity of CS tools in the workforce.

With each topic, there was an accompanying YouTube video(s) as well as an assignment where students were given a week and a half to complete unless there were extenuating circumstances. These assignments were typically guided with a demo video that walked through a similar problem. Students were expected to pass approximately 75% of the total assignments, rated from incomplete for no attempt made to unsatisfactory for incorrect/uncompleted work to satisfactory for completed work. Outside of these weekly assignments, students were expected to complete professional development activities that involved attending workshops, participating in practice interviews, attending hackathons, or more.

At the end of the research, there will be corresponding surveys that show the data of each semester's effect on the student, whether self-perceived or extrapolated. The data will be analyzed in three different categories: gender, racial/ethnic identity, and prior experience. This experiment focuses on only 30 people in the fall, 19 people in the spring. Because of this, the study will focus specifically on the effect of class on these specific people while taking into account their identity. There is also a public record of these assignments on YouTube that everyone, not just undergraduate computing students, can watch and gain knowledge from.

STS TOPIC

The gender gap in computer science may not close even in the next hundred years. While computer science articles have increased in author quantity, the proportion of female CS authors is still predicted to be less than 30% and projected to only be at 45% by 2120 (Wang et al., 2021, p. 81). More diversity in the technology sector breeds more revenue, more innovation, and more representation (Montilla, 2020). Currently, in the field, companies are attempting to make women fit a mold or believe that women don't possess the same talent or skill that their male counterparts may have (Wynn, 2019). With both of these solutions, none look at why this may be happening.

My STS paper will dive into the reasons that gender gaps in technology may exist whether it's from lack of interest or discouragement or anything in between. I'll be using the Actor-Network Theory (ANT) to look into different factors, human and non-human, that may enlighten the general about the delicate intricacies of the technological gender gap and how we can work to bring more gender diversity to technology.

To first look into the gender gap, it's important to learn about different resources to measure the gender gap. Verdugo-Castro et al. looked at four different tools that could be used to

measure the gender gap in STEM education. They analyzed the Cooperative Institutional Research Program (CIRP) Questionnaire, which looks into new college students and their characteristics, the Relevance of Science Education (ROSE) Questionnaire, which seeks to learn more about the students' interest factors for learning science, the STEM-CIS, a survey that looks at a students' affinity in the four different categories of STEM, the IRIS Q Questionnaire, which utilized both closed-ended and open-ended questions, and the Sustainability and Gender in Engineering (SaGE) survey that looks at factors affected by choice of studies (Verdugo-Castro et al., 2019, p. 4-6).

Universities all over the world are analyzing why these disparity may exist, such as the Universidad Complutense in Madrid, Spain which proposed a class that utilized four strategies to look into the gender gap: 1) a masterclass and informal debate, 2) an invited lecturer, 3) a short essay, and 4) a social impact project. In this study, it was found that the sample of male students had less awareness of the gender gap, but both male and female students were receptive to this issue and willing to take action (Roman, 2019, p. 2-4). At the University of Adelaide in Adelaide, South Australia, three students created a research project where they conduct interviews and based on word choices used different sentiments to categorize them, showing just one tactic to research the gap (Falkner et al., 2015, p. 112-113).

While at other universities, they're actively encouraging gender diversity in their classes. Framing the class to be more creative and collaborative, UC Berkeley's then "Introduction to Symbolic Programming" now "Beauty and the Joy of Computing" started pair exercises and class discussions of technology news articles and found that their gender ratio plummeted. 2014 was the first time since 1933 (their oldest digital record) that there were more women than men in introductory computer science. But still, even students in the course who even returned to

assist in the class have trouble shaking the perception that men are better, citing they have more years of experience (Brown, 2014).

While looking at these correlations, it's also important to analyze any implicit biases that these young women themselves may have. In a study done by the University of Michigan, they analyzed the effect of perceived femininity and desire to get more involved in science, technology, engineering, and mathematics (STEM). The study looks into "how middle school girls perceive female STEM role models" and found that if these women are successful in their field, "others dislike them and label them less attractive, not competent or unable to secure high salaries," (Wadley, 2012). The first study referenced involved a gross of sixth and seventh-grade girls who were asked about their favorite subject -- if it involved math or science, they were categorized as "STEM-identified." After seeing role models with feminine characteristics (makeup, pink, etc.) versus gender-neutral characteristics (dark clothes, glasses, etc.), the girls who saw the more feminine role model showed a decreased self-rated math interest. The second study looks into "why girls who disliked math and science were least motivated by feminine STEM role models," (Wadler, 2012). They concluded that the feminine role model looked like an unattainable goal and therefore intimidated them rather than motivated. This is a great argument for why feminine role models in STEM may not matter to younger girls but doesn't attack the root issue which looks at why this may seem unattainable.

Another argument often used for the gender gap is that "girls just aren't interested." Based on this proposition, Khan and Luxton-Reilly, professors from the University of Auckland, found women were found to be more interested in computing science after reading a fake newspaper article that stated that the industry is breaking out of its stereotypes (Cheryan et al., 2013 from Khan and Luxton-Reilly, 2016). With this previous research, Khan and Luxton-Reilly

look into whether computing for social good and incorporating students' values in a project changes the involvement and would help decrease the gender gap in computing. In their study, "females ranked two of the humanitarian projects positively, but none of the projects were ranked similarly by males," (Khan, Luxton-Reilly, 2016).

These articles are only the tip of the iceberg in the discussion of gender disparity in the technology field. With further research, I will analyze the gender gap at different life stages to learn more about the "pipeline" (refers to women losing interest as they get older) and why this may be.

CONCLUSION

While the barriers in entry to the technology field have decreased in recent years, there is no perfect system. These papers will look at the root problem of the gender gap and lack of preparation for the real-world after graduation, as well as analyze potential solutions and look into ones that may not yet exist. The gender gap in technology is an issue that limits creativity in the field, economic expansion, and representation for new members. After fighting the odds, students still have to struggle with the disconnect of the academic standard and employers' expectations. Though nothing is perfect, there is still room for improvement.

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