Gender Differences in High School Students' Decisions to Study Computer Science and Related Fields

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ABSTRACT

Increasing women's participation in Computer Science (CS) is a critical workforce and equity concern. The technology industry has committed to reversing negative trends for women in CS, engineering, and related fields. Building on previous research, we surveyed 1,739 high school students and recent college graduates to understand factors influencing decisions to pursue CS-related college degrees. Results indicate social encouragement, career perception, academic exposure, and self perception are the leading factors for women, while the influence of these factors is different for men. These factors are actionable, and understanding differences in their influence on men and women will inform our approaches to achieving gender parity in tech.

Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computer and Information Science Education – *computer science education.*

Keywords

Gender differences; factors; high school; college; encouragement, perceptions; self-confidence; K-12 education.

1. INTRODUCTION

Previous studies that examined the factors that motivate students to pursue education or careers in technology typically: 1) had small sample sizes, 2) were conducted with students from a particular institution or geographic region, and 3) measured 2-3 independent variables. Our study: 1) surveyed 1,739 men and women, 2) was nationally-representative, 3) considered 91 variables identified in the literature, 4) grouped them into factor scores, and 5) controlled for all significant variables in our analysis. Our analyses allowed us to stack-rank the influence of each variable on young women's decisions to study Computer Science, along with engineering or information technology (IT) fields. Social encouragement was determined to be one of the most powerful influencers on the decision to pursue these fields – considerably stronger for women than for men. This paper focuses specifically on gender differences in the influence of these factors.

SIGCSE '15, Mar 04-07 2015, Kansas City, MO, USA
ACM 978-1-4503-2966-8/15/03.
http://dx.doi.org/10.1145/2676723.2691920.

2. RELEVANCE

Women make up only 26% of Computer Science and Mathematical Science professionals in the US [1]. These numbers are starker when considering that while degree conferment for women in STEM is trending upward, female participation in CS, specifically, has declined to 18% from a 37% peak in the mid-1980s [2]. This lack of female participation in CS exacerbates a problem with labor supply shortages: the overall need for computing professionals has severely outstripped the number of graduates entering the workforce [1]. Moreover, evidence has shown that more diverse teams produce better products [3].

Prior research has investigated factors that promote girls' interest in STEM and CS [4,5]. Societal influences include a lack of females in STEM in popular media [6], negative stereotypes about girls' abilities, and negative perceptions about computing [7]. Parental encouragement of science and mathematics increases the likelihood of a young adult pursuing [8] and persisting in STEM careers [9]. However, parents' perceptions and encouragement of their children's interest in STEM, as well as their evaluation of their children's abilities, differ by child gender [10,11]. Girls who are encouraged at home develop more positive perceptions of CS-related fields [12,13].

3. METHODS

We reviewed existing studies to: a) determine influencing factors; b) identify strengths, limitations, and best practices; and c) refine our study's hypothesis. We identified 91 statistically relevant factors that influence a decision to pursue CS, math, IT or engineering. We developed a survey to measure these factors' influence. We used factor analysis [14] to group the 91 variables into 25 similar factors and logit regression [15] to rate their importance. To ensure statistical relevance with a high level of confidence (≥95%) and small margin of error (≤5%), 1090 women and 649 men were surveyed as below:

- Geographically and academically diverse, across the US
- 50% high school, 50% recent college graduates
- 50% interested in or had studied a computing-related field

4. RESULTS

Results suggest that the most influential factors occur before college; they contribute to 60.5% of the dependent variable in high school. Encouragement and exposure are key controllable indicators for whether or not young women decide to pursue a CS-related degree. We provide descriptive data highlighting notable gender differences for the top four influencers below.

4.1 Social Encouragement

Social encouragement includes positive reinforcement from family, peers, and other adults. For the high school model, it

comprises 28.1% of a young woman's decision to pursue a CS-related degree. Non-family encouragement (11%) is almost as important as familial support (17%) for young women.

For both the high school and college models, parent occupation was statistically insignificant when controlling for other variables: what matters most is encouragement, not technical expertise. Importantly, encouragement appears to be more influential for women than for men. After controlling for other variables, family encouragement predicts 17% of the decision to study CS fields for women compared to 8% for men. Similarly, encouragement received from non-family members predicts 11% of the decision for women and did not seem to have an independent influence for men (0%). Despite this greater importance, women who did not choose to study CS-related fields were almost half as likely as men to receive encouragement. For example, 30% of male non-CS grads had nonetheless received encouragement from fathers, compared to 19% of female non-CS grads.

4.2 Career Perceptions

At 27.5%, a high school girl's perception of CS and its associated careers is the second most potent explainable factor influencing the pursuit of a CS degree. This includes the familiarity with and perception of computing as having diverse applications and a broad potential for positive societal impact. For example, our data show wanting a career that helps people accounts for 6% of girls' decisions to pursue a CS-related degree.

4.3 Academic Exposure

Participation in CS courses and activities accounts for 22.4% of the explainable factors influencing whether girls want to pursue a CS-related degree. This includes participation in structured and unstructured activities. Among college graduates, those who had taken the Advanced Placement (AP) CS exam were 46% more likely to pursue a CS-related major. This is particularly true for women, who are 38% more likely to pursue a CS-related degree after having taken AP CS. Yet high school girls interested in CS most often cite full classes or full schedules as reasons for not having taken CS. Regardless of how they were exposed, women who had opportunities to learn about computers were more likely to consider CS-related degrees than those without opportunities.

4.4 Self Perception

Finally, girls' interest in and perceptions of their own proficiency in Mathematics and problem-solving significantly influence their wanting to pursue a computing-related education. In the high school model, this perception comprises 17.1% of the explainable factors. Among college students who had studied CS, women are significantly more likely than men (57% vs. 41%) to agree with the statement "I love math."

5. SIGNIFICANCE

Our most heartening finding is the limited role that uncontrollable factors play in influencing the pursuit of a CS degree. For example, for high school girls, household income and ethnicity contribute only 4.9% to the explainable factors. We also found that the most influential factors are associated with pre-college experiences.

Further, our research suggests the implicit biases that may be at play in the treatment, perceptions, and opportunities of boys versus girls in CS-related fields. Based on our findings, we recommend the following to help get more girls into CS:

- *Social Encouragement*: Provide encouragement and support for participating in CS activities.
- *Career Perceptions*: Find role models and mentors and introduce broad applications of CS.
- *Academic Exposure*: Find opportunities to be creators, not just consumers, of technology; if opportunities don't exist in the community or school, create something.
- *Self Perception*: Help develop building and spatial skills, problem-solving, resourcefulness, and creativity; offer a truly introductory CS course without pre-requisites.

The four factors most related to female participation in computing fields are actionable. Understanding differences between how they influence men and women will inform how we take action.

6. ACKNOWLEDGMENTS

We would like to thank our colleagues who worked on this study – Iveta Brigis, Sarah Chavis, Kristen Gil, Nancy Lee, Eduardo Samuel, Heather Thorne, Danny Young, and many others – as well as Applied Marketing Science, the research firm that partnered with us to design and execute the survey.

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