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Re-fashioning the Field: On Gender and Computer Science

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BIOGRAPHY

Jessica Nash is a junior at Case Western Reserve University majoring in Biology, with special interests in Spanish, Chemistry, and Neurobiology. As an aspiring medical student, she is deeply interested in socio-health related topics, such as bioethics and classical philosophy.

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Introduction

Dramatic changes in the field of CS over the past century have led to a new technological era that has transformed the way societies think, communicate, and navigate through daily life. Computers and electronic devices have become increasingly intertwined with modern life and play a defining role in how people construct their identity and interact with one another. At the heart of this cultural shift are the computer programmers and software engineers responsible for developing the field to its current state. The common perception of the expert computer programmer is that of a geeky, young to middle-aged white man with minimal social skills and average attractiveness. One of the potential implications of such a narrow population of people dominating one of the most influential facets of modern business and life is a one-sidedness in the design of the products and technological applications that have become both ubiquitous and indispensable to our culture.

Although it would be incorrect to assume that any stereotype could accurately portray the entirety of the group to which it refers, in this case the overall generalizations about the average computer scientist are alarmingly accurate, particularly with regard to gender. In fact, women are among the most grossly underrepresented groups in computer science (CS), earning only about 13.8% of all bachelor's degrees in CS in 2010 (Taulbee Survey Report, 2011). Furthermore, of all U.S. college freshman enrolled in STEM degree programs, only 5.7% of participants were women in CS compared to 27.1% for men in the same CS programs (Parviainen, 2008). Decreased retention in undergraduate CS courses and degree programs combined with an overarching inhospitable atmosphere for "atypical" CS students has had a direct impact on women's interests in contributing to this influential field (Beyer, 2014).

In order to understand the full impact of what this underrepresentation means for the technological community, we must analyze a number of factors and phenomena. These include historical trends, current statistics and employment trends across different cultures, the effect of stereotypes on public opinion towards women in CS, and the lack of female support figures and role models. Understanding the contributing factors for the lack of female presence in the field of CS is an essential first step in reversing this trend and discovering ways to motivate women to pursue careers in CS. Not only does this have the potential to benefit women in Western cultures, but it also shows promise for the improvement of CS as a whole if the field can integrate the unique perspectives of women into the development of innovative ideas, programs, and products that may not have been possible without diversified collaboration efforts.

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History of Women in CS

Women of the past have made rich contributions to the field of CS, shaping it into the discipline it is today. Nineteenth century mathematician Ada Lovelace pioneered a prototype of the modern computer as early as 1822, long before John Mauchly invented the Electronic Numerical Integrator and Computer (ENIAC) in 1942, the first true general purpose computer (Gurer, 1995). Jean Jennings Bartik and a team of six other female scientists were in charge of programming some of the very first lines of code for the ENIAC. Bartik recalls even then men looking down on her job, with the popular male opinion being that programming was not nearly as important as building the physical hardware of the machines (Gurer, 1995). Shortly thereafter, Bartik teamed up with Grace Murray Hopper, who wrote some of the very first programming languages while

working on projects for the U.S. military. She even coined the term "debugging" after removing moths from a malfunctioning computer (Gurer, 1995). Lovelace, Bartik, and Hopper are only three examples of how CS owes many of its brightest achievements to women, demonstrating that they not only have the capacity to contribute to CS but also to make groundbreaking discoveries.

In what appears to be a reversal of the American gender disparity within CS professions, different cultures from around the globe have had great success in the employment of women in CS jobs—in fact, they constitute roughly 50% of IT workers in countries like Malaysia, which is more than double the proportion of women working in U.S. CS jobs (Lagesen, 2008). The inclusion of women in the Malaysian technology market is not simply a result of a greater cultural appreciation of women's skills; rather, it is in effect a reversal of the masculine role characteristic of Western countries. In an attempt to protect women from harsh and potentially dangerous workplaces like factories and construction sites, women are encouraged to take up office jobs such as those in CS due to the safer environment of the office (Lagesen, 2008). When perceived as a feminine profession, the climate of CS seems to change entirely, although not for liberating reasons. From this, it may be important to consider a second point in the analysis of factors contributing to the current state of women in CS: cultural expectations of each gender have a significant impact on their interests to work in fields they perceive as compatible with their own identity.

The face of CS before and just after WWII was not necessarily a masculine one. In fact, the United States experienced a steady growth of women in CS and other STEM careers until about 1980, when the numbers of women enrolled in CS programs in college dropped significantly ("Women's Bureau Occupations," n.d.). A possible explanation for the change in depiction of the ideal programmer was the increased availability of personal computers that manufacturers marketed almost exclusively to young boys. The resulting cultural trend seemed to give boys a competitive advantage with programming even before arriving at college, leading many female students to believe that they were inadequate compared to male peers and better suited for other careers (Varma, 2007).

Gendered Stereotypes in CS

To quantify the stereotypical conceptions of computer programmers that have become widespread over the last few decades, Cheryan et al. (2013) at the University of Washington designed a set of studies to record opinions about computer scientists among students at various West Coast universities. Regardless of sex, undergraduates described computer scientists as asocial, unattractive, socially inept, devoted singularly to computers, pale, unathletic, and male (Cheryan et al., 2013). Many of these descriptors may seem unappealing to students who may have otherwise taken a great interest in technology-based studies. Intimidating CS classroom settings and media portrayals of CS geared towards men appear to be driving forces behind the general unwillingness of women to pursue a technology-related career. This combination of media portrayals and negative stereotypes typically did not deter men's pursuit of the field (Cheryan et al., 2013). Images of computer scientists prevalent in the media and society conflict with perceived feminine gender roles, resulting in a general sense that a female's skill level in CS is inferior compared to that of a male counterpart. This creates a positive feedback loop wherein both males and females act to perpetuate current stereotypes.

Overall, one of the most influential factors that was shown to impact a student's genuine interest in CS was taking an introductory class on the subject, regardless of whether or not he or she considered majoring in the field. Data from the surveys indicate that women who had not taken a CS course in college were more likely to provide stereotypically-

informed responses to questions about CS majors than women who had. This suggests that media and peer-driven perceptions of CS majors may play a role in promoting female disinterest in CS, especially if the individual has no experience in the field (Cheryan et al., 2013).

A second study by the same researchers was aimed to evaluate the influence of media on male and female perceptions of technology-related fields. A random sample of students at the same two colleges received either an editorial declaring that computer scientists adhered to current stereotypes or an editorial that portrayed a more inclusive view of CS. The study found that male undergraduates were less likely to change their opinions of computer scientists after reading the articles, while women were much more interested in CS as a career option after reading the more inclusive editorial (Cheryan et al., 2013). Data from both studies suggest that women may be more likely to disregard CS stereotypes that appear incompatible with female gender roles if participation in introductory CS classes were to increase. Altering the pervasive image of CS majors in the media is imperative to making the field more appealing and attainable for women.

A promising effort to effectively reduce the effects of gendered CS stereotypes early in life is underway in Norway, where a small village has opted to host a children's coding club. By providing exposure to coding techniques during childhood, this club has not only introduced CS as a potential career for these children, but has also better prepared them for life in a technology-driven world, regardless of their future profession (Corneliussen, 2015). By wiping out the gender gap in prior coding experience between college-age students, coding clubs have the potential to reverse some of the long-standing disadvantages that women have traditionally had when entering a competitive, male-dominated CS degree program.While the number of females in non-CS STEM degrees has generally risen over time, percentages of both women and men in CS over the last decade have fluctuated, with high rates of female attrition in CS programs currently defining the field (20% average attrition rate for women compared to 10% for men in the U.S.) (Cohoon, 2001). Certain schools' CS programs report female retention rates almost equal to that for males, while other institutions have much less success retaining female CS candidates. Among some of the most notable traits of universities with poor female participation in CS courses were a lack of supportive female faculty members and peer groups, limited opportunities for work after graduation, and an underfunded and understaffed CS department. These factors, in combination with external pressure from stereotypes, have contributed to women earning only about 13-18% of Bachelor's degrees in CS each year (Cohoon, 2001).

This inequality has not gone unnoticed. In an attempt to attract women to careers in CS, many concerned activists and school officials have asked how to change CS programs to better suit female students (Frieze et al., 2012). However, these initiatives, which rely heavily on the perceived differences between male and female personality traits, have experienced limited success. Male and female peers report that modification of the department's curriculum to create a more inclusive environment for females with less coding experience is not only detrimental to educational standards, but also linked to reinforcing the unfounded stereotype that females need special assistance to succeed in CS courses (Frieze et al., 2012). Similarly, implementing strategies such as the adoption of gendered CS tracks in the 1980s propagate the idea that men and women are inherently different—with men preferring 'legitimate' coding and women gravitating towards design and the application of computer programs to everyday life (Blum & Frieze, 2005).

In contrast, the CS department at Carnegie Mellon University has adopted an approach to mitigating the CS gender imbalance, focusing much less on perceived differences between women and men and more on leveling the

playing field regardless of gender. In order to revamp the stereotypical image of CS programs, Carnegie Mellon has introduced high school outreach programs for students and teachers that provide coding and application experience before college (Blum & Frieze, 2005). In addition to providing the skills necessary for all students to succeed and uphold a sense of self-confidence and accomplishment in challenging CS coursework, outreach programs have the additional benefit of recruiting students that otherwise may not have felt comfortable or even capable in a CS career. By advertising and exposing real-world tech career opportunities to adolescents, these programs increase interest among high school students regardless of perceived gender roles or personal values.

In addition, the technology department opted not to change the curriculum at the expense of educational standards but instead implemented a series of seminars for incoming freshman that act to provide multiple entry points into CS coursework for interested students of different backgrounds. The institution also altered the admissions criteria, paying less attention to prior coding experience and giving more weight to larger predictors of future success in CS careers, such as "evidence of giving back to the community" or "problem solving" (Blum & Frieze, 2005, p. 117). Additionally, the school hosts a professional organization called Women@SCS that focuses on motivating women to continue their studies in CS and to contribute their tech skills to a variety of causes on campus (Blum & Frieze, 2005).

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Such outreach strategies at Carnegie Mellon have been very successful, with a significant increase in the participation of women in undergraduate CS programs from the national average (13%) to about 40% over the course of ten years (Frieze et al., 2012).

In a survey with an 11 category-questionnaire designed to indirectly reveal students' underlying gender stereotypes, upper class scholars in Carnegie's CS program responded unanimously with answers that transcended traditional stereotypes. Instead of thinking of computer scientists as asocial nerds or geniuses, students reported that they thought of these individuals as "intelligent," "well-rounded," and "not the traditional geek." (Blum & Frieze, 2005, p. 113). These surveys also revealed that offering a level playing field to students highlights more differences among genders than between them. Students of both genders reported a wide range of personal interests, beliefs, and tech skills that were not bound by typical gender expectations. Some females were just as competitive in coding classes as males, while males also had great successes in design and application classes (Blum & Frieze, 2005). Strikingly, both genders thought of the computer more as a tool for tackling problems in everyday life than as a machine that defined their likes and interests. A male student summed up the effort as follows:

> Computing is going to be affecting our whole society and it probably makes a difference on who is giving input into this, but that's just from the societal point. As far as being fair, that should just be dependent on whether they are interested or not. I would hope that it could be that just traditionally the field hasn't attracted women because it hasn't exposed, hasn't properly recruited them, so let's give it a shot (Blum & Frieze, 2005, p. 116).

Similarly, other institutions have addressed these issues and developed successful programs that have boosted the participation of women in technical sciences. Instead of drawing on perceived differences between genders, Harvey Mudd College attributes its extremely high retention rates of women in CS programs to a system of skill-level specific introductory courses that place students with peers possessing a similar level of experience (Voosen, 2015). This strategy aims to mitigate the far-reaching effects of early male-oriented marketing strategies for computers, video games, and other devices that have left many women behind in hands-on experience as early as elementary school. In addition, Harvey Mudd boasts multiple skilled female faculty members and peer

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support groups for students to promote a comprehensive understanding of course material for women and men at all experience levels (Voosen, 2015). Studies show that increased female participation is not the only benefit of including female faculty in CS programs. According to survey results at schools across the U.S., both men and women were more likely to ask questions in class if the professor was female, perhaps suggesting that female students feel more comfortable when exposed to a diversified faculty that students can relate to (Cohoon, 2001).

The analysis of the current state of CS suggests some major reasons for the general lack of female interest in the field that can be addressed. Providing a network of supportive male and female faculty members as well as

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creating a hospitable environment for students of different experience levels are strategies that can have lasting impacts on the retention of women in CS programs. By altering the current asocial and masculine stereotypes associated with CS, it may also be possible to increase interest among a wider range of students by promoting and accepting a more inclusive image of the computer scientist. In the end, the gender gap present among CS professionals is largely the result of a self-perpetuated belief that the field belongs to a very select range of males who have an innate and calculating talent.

Although we often overlook them, culturally perpetuated stereotypes of what it means to be a computer scientist have played a dynamic role in the shaping of the field in the U.S. Instead of focusing on shifting the stereotype of CS itself to the opposite end of the spectrum, it may be more useful to recognize the talents and skills of a diversified group of men and women working together to produce a more inclusive view of CS. By addressing the factors that have prevented women in the U.S. from pursuing careers in CS, the realm of CS has the potential to benefit greatly from a well-rounded workforce.

References

Beyer, S. (2014). Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *CS Education*, 24(2), 153-192. http://dx.doi.org/10.1080/08993408.2014.96 3363

Blum, L., & Frieze, C. (2005) The evolving culture of computing: Similarity is the difference. *Frontiers: A Journal of Women Studies* 26(1), 110-125. doi: 10.1353/fro.2005.0002

Cheryan, S., Plaut, V., Handron, C., & Hudson, L. (2013). The stereotypical computer scientist: Gendered media representations as a barrier to inclusion for women. *Sex Roles*, 69(1), 58-71. doi:10.1007/s11199-013-0296-x

Corneliussen, H. G. & Prøitz, L. (2015). Kids Code in a rural village in Norway: Could code clubs be a new arena for increasing girls' digital interest and competence? *Information, Communication & Society*, (19)1, 95-110. doi: 10.1080/1369118X.2015.1093529

Cohoon, J. M. (2001). Toward improving female retention in the CS major. *Communications of the ACM*, 44(5), 108-114. doi:10.1145/374308.374367

Frieze, C., Quesenberry, J. L., Kemp, E., & Velazquez, A. (2012). Diversity or difference? New research supports the case for a cultural perspective on women in computing. *Journal of Science and Education Technology*, 21(4), 423-439. doi:10.1007/s10956-011-9335-y

Gurer, D. (2002). Pioneering women in CS. *Communications of the ACM*, 34(2), 175-180. doi:10.1145/543812.543853

Lagesen, V. A. (2008). A cyberfeminist utopia? Perceptions of gender and CS among Malaysian women CS students and faculty. *Science, Technology, & Human Values*, 33(1), 5-28. doi:10.1177/0162243907306192

Parviainen, M. (2008). The experiences of women in CS: The importance of awareness and communication. *Human Architecture: Journal of the Sociology of Self-Knowledge*, 6(8), 87-94. Retrieved from http://scholarworks.umb.edu/humanarchitecture/vol6/iss4/11/

Taulbee Survey Report 2011. Computing Research Organization, 2012. 1-69. Print.

Varma, R. (2007). Decoding the female exodus from computing education. *Information, Communication & Society*, 10(2), 181-193. doi:10.1080/13691180701307396

Voosen, P. (2015, Apr 6). Maria Klawe won't let CS remain a boys' club. *Chronicle of Higher Education*. Retrieved from http://www.chronicle.com/article/Maria-Klawe-Won-t-Let/229373

Women's Bureau. (n.d.). Data & statistics: Women in the labor force. *United States Department of Labor*. Retrieved from https://www.dol.gov/wb/stats/stats_data.htm

Zweben, S. & and Bizot, B. (2012). Taulbee survey report 2011. *Computing Research Association*, 1-69. Retrieved from http://cra.org/wp-content/uploads/2015/01/CRA_Taulbee_2010-2011_Results.pdf