Upward Bound: How do we increase adolescent interest in CS?
(Technical project)
Diversification of the Field: Why is CS so unpopular among women?
(STS project)

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By
Sadie Barton

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ADVISORS

MC Forelle, Department of Engineering and Society

Rosanne Vrugtman, Department of Computer Science

Introduction:

The field of computer science in the United States is currently male-dominated, causing gender disparities in many technical, software-reliant products. It is clear that diversity is a highly desirable quality for all workforces, primarily due to the necessity of ensuring that equitable products and opportunities are made available to everyone and that no one experiences undue discrimination. In subfields of computer science in the United States, this is unquestionably not the case, as current software-related products being produced discriminate against users for various reasons. One example of the current discrimination in software-reliant products is the manner in which the substantial majority of video games on the market involve combat, war themes, and automotive themes, all stereotypically male interests (Harrison et al., 2016). I would absolutely love to see more video games that cater to more typically feminine and gender-neutral interests, such as fashion, cooking, and roleplay, and all of my female friends are in agreement.

The lack of diversity within the computer science industry is a crucial problem because we need to create products that cater to everyone's needs, and this cannot be accomplished without first thoroughly considering everyone's needs and interests. This cannot be accomplished if we do not have a diverse group of individuals in the workforce to offer an equally diverse range of opinions and perspectives regarding the work being done and the products being produced (Smith & Shonfeld, n.d.). Moreover, some software is produced solely for the use of women, and women are absolutely essential to its production because they are the only ones that can truly understand what the intended consumer base needs. It certainly would

not be the best idea to have a group of solely men design and develop an application for menstrual cycle tracking, for instance.

Preliminary research shows that there is currently a wide variance in which subfields of computer science women tend to pursue for employment. Interestingly, past research has shown that a much greater number of women pursue careers in information technology (IT) instead of computer science (Maalouf, 2019). Specifically, the subfields shown to attract the lowest number of women in the past include machine learning, artificial intelligence, systems architecture, computer science, computer vision, and information security. On the other hand, the subfields of computer science which have been shown in the past to attract the greatest number of women include human-computer interaction, natural language processing, and information systems; however, the rate of female in these subfields still falls below 30% (Cheong et al., 2021). Another interesting fact is that past research has proven cultural differences in the number of women that pursue careers in computing across the globe. In China, 53% of researchers in top rank computer science research publishers were female; in the United States, however, the rate of female participation was a mere 37% (Agarwal et al., 2016) .

The cruciality of the problem is obvious, and thus research must be conducted in order to construct a framework to eliminate current gender bias towards the industry of computer science and increase the overall representation of women within the field. In my technical project, I will recount my experience from a youth learning experience involving the subfield of robotics within computer science to identify factors that increase adolescent girls' interest in computer science. In my STS project, I will investigate demographic information, conduct interviews, and review literature to determine what aspects of computer science cause it to be somewhat unappealing to women.

Upward Bound: How do we increase adolescent interest in CS?

It is not a surprise that access to education and opportunities is unequitable among people in all age groups, particularly due to factors such as financial resources, money, and geographical locations (Associate Professor, Dept of Cultural Technology and Communication, University of the Aegean et al., 2020). However, the US federal government has made some effort to alleviate the educational oppression of these disadvantaged through the establishment of tax-funded federal programs such as the Upward Bound program. The Upward Bound program is a federal program which offers support to low-income, set-to-be first-generation college students with a promising educational background in the form of free mentoring, financial resources, test preparation, tutoring, educational programs, networking, college tours, and anything else concerning postsecondary education (Upward Bound Program, 2021). Fortunately, I had the privilege of enjoying the benefits of this program for the whole duration of my high school years, beginning the summer before my freshman year of high school.

I became aware of the program when the guidance counselor at my middle school informed me that she thought I would be a great candidate for the program and asked if she could schedule an interview for me. One requirement for membership was participation in a summer learning experience at our local community college before freshman year of high school (Eligibility -- Upward Bound Program, 2009). Transportation was provided and we were randomly placed into a wide range of exploratory classes unlike anything we had ever had the option to learn about before. My main block class was entitled "Robotics I", which was a course that introduced programming and robotics basics in a language called ROBOTC. Throughout the course of the summer, we worked in teams to build our own robots and program them to complete various challenges, such as following a black line of tape on a white floor, adding parts

as necessary. Additionally, we took weekly quizzes to assess our knowledge on the subject matter. This class was the first exposure I ever had to computer science, at fourteen years old, and it piqued my interest so much that I ultimately decided to pursue a degree in the subject.

Ultimately, I would not be pursuing my current path without the influence of the Upward Bound program. This program introduced me to computer science, taught me the principles, paid for me to take my SAT, allowed me to tour UVA free of charge, and even provided transportation during move-in weekend for my first year at UVA. Without the assistance of this program, I never would have learned computer science in my rural area; I never would have applied to be a computer science major and I likely would not have applied to engineering school. I would not have had the same exposure to the subject matter without the Upward Bound program and its random class assignments, encouraging mentors, and learning support; consequently, I would have never known all of the possibilities in computer science. Ultimately, this program has opened up a world of opportunities for me, lessening the educational inequity. Unfortunately, many students do not have access to the same support offered by these programs; therefore, they need to be improved to be more widespread and inclusive.

Diversification of the Field: Why is CS so unpopular among women?

We need a greater representation of women in computer science, but we first need to understand what aspects of each subfield within the industry are appealing or unappealing to women. There is a very unique profile of women that decide to pursue a computer science degree in the United States which specifies notable differences between them and other women or even men that major in computer science. According to a study conducted by Lehman and other researchers, women majoring in computer science rated themselves worse than men on measures of academic ability, computer skills, intellectual and social self-confidence, leadership

ability, competitiveness, public speaking ability, and physical and emotional health than male majors. However, women rated themselves higher on measure of writing ability and artistic ability (Lehman et al., 2016).

Due to existing gender stereotypes and negative impacts, adolescent girls do not often take an interest in computer science, causing them to neglect considering pursuing a career in computer science in post-secondary education. Stereotypically, the field of computer science is seen to be socially devaluing, isolated, and unimpactful; these qualities were shown to have a negative effect on the attitudes of women towards computer science (Carrigan, 2017). Unfortunately, currently the stereotypical image of a girl in computer science is seen is helpless, uninterested, and unhappy with the subject matter, almost appearing technologically inept. A study conducted by Spieler and colleagues (2020) on the topics of stereotypes, impacts, and motivations of girls in computer science indicated that girls feel much less of a sense of belonging in computer science partially due to the lack of female role models. The study also indicated that girls' interest in STEM typically begins to decline around the age of 13-14, implying that the high school years are pertinent for the formation of a girl's interest in STEM and positive perspective toward the subject matter (Spieler et al., 2020). Additionally, there are a wide range of barriers, including school, family, computer games, role models, peers, work culture, and stereotypes, that prevent women from pursuing and obtaining a career in the field of computer science (Kordaki, M., Berdousis, I., & Dept of Cultural Technology and Communication, University of the Aegean, 2020).

Although there are marked differences between men and women in computer science regarding motivations and sentiments towards computer science, there are many characteristics that they share in relation to each other than typically do not correspond with nonmajors. A

study published in the *Journal of Women and Minorities in Science and Engineering* uncovered a major problem in regards to gender differences in presumptions about computer science: while both male and female computer science majors rated the pay compensation in computer science as roughly equal, nonmajor females rated the compensation significantly lower than males, indicating that female nonmajors are likely more unaware of the high potential salaries in the field (Beyer & Haller, 2006). This relative lack of knowledge could partially explain why men are more likely to pursue degrees in computer science than women. Additionally, more prestigious subfields of computer science, where employees are typically paid higher salaries, contain a significantly lower number of female employees. In turn, subfield prestige correlates with gender equality in a manner that results in self-segregation, causing women to be more likely to distribute themselves among lower-paying subfields in computer science (LaBerge et al., 2022). Furthermore, one of the largest reasons women decide to leave the computer science field is that they feel the field does not allow them to help other people or make the world a better place. Additionally, women struggle to see the general goals of the computer science field. However, women in the field note that computer science can indeed have a positive social impact; it simply is not advertised enough for most nonmajors to be aware (Carrigan, 2017).

Ultimately, we need to better understand the unique characteristics of women in regards to their future careers. Understanding the variables behind these unique characteristics could effectively be the key to feminine integration in subfields of computer science. Specifically, we can understand feminine motivations as well as ways to potentially inspire these unique motivations through the field of computer science.

Research Question and Methods

To investigate the issue regarding the lack of gender diversity in computer science subfields, my project asks: how we can increase adolescent girls' interest in computer science? In order to research this, I will consult existing literature regarding employment rates and demographic statistics of the computer science industry in order to construct a profile for women who choose to pursue careers in computer science. I will also consult existing literature regarding the success of current programs that attempt to offer more equitable access to education to identify positive influences. Most of the necessary literature can be acquired online; other necessary literature in print and digital format can be obtained by consulting a librarian. Additionally, I will conduct personal interviews with at least ten female college students, including computer science majors and other majors, to determine their deciding factors in career selection, their feelings towards various computer science industries and topics, and their exposure to computer science in adolescence. I will also conduct personal interviews with at least ten female high school students regarding their opinions towards various computer science topics, exposure to computer science, motivations, aspirations, and negative influences. Finally, I will synthesize the results to determine a framework for increasing adolescent girls' interest in computer science by determining the most effective way to present computer science to them in a manner that appears to their unique interests.

Conclusion:

The information I obtain from this research can be translated into a plan to begin to rectify the lack of diversity currently in the industry by increasing the percentage of female participants, which can eventually lead to numerous beneficial social outcomes, including a higher participation of women in the industry and more equitable software. The United States has a long history of self-segregation due to gender and other demographics, but it has gone on far

too long. Diversity is essential in producing good products and understanding consumer needs. If we cannot adequately diversify the computer science industry, we will continue to have unequitable products. Therefore, we must investigate the relative lack of feminine interest in computer science.

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