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English 101

8 Mar 2020

Women in STEM: The Gender Gap

When applying to colleges, I remember seeing a handful of universities proudly showcasing on their websites that 20 percent of the students in their Computer Science program were women. I almost would have guessed that these universities were boasting the lack of women in their computer science programs, rather than the relative abundance, had I not been one of few, if not the only woman in most tech-related ventures that I had pursued throughout my life. Given my past experiences, one in five was promising. My many experiences of being a minority as a woman in tech are certainly not unique to me, nor are they even unique to other women interested in computer science as a career path. Most other career fields under the umbrella of STEM, which stands for Science, Technology, Engineering, and Math, are experiencing similar statistics in the realm of gender distribution, despite the fact that women earn 57% of bachelor's degrees awarded in the United States (National Science Foundation). Though women have been able to make significant strides towards equality in other high-paying and well-respected fields like law, business, and medicine, there is something about STEM that is evidently pushing women away, with women constituting just 29 percent of the overall STEM workforce (National Science Foundation). The insistent pervasiveness of this pattern has inspired me to investigate some of the cultural, social, and biological factors that may have some role in the STEM gender gap.

The STEM gender gap was brought into the media spotlight a few years ago when a Google employee by the name of James Damore published a memo titled “Google’s Ideological Echo Chamber: How bias clouds our thinking about diversity and inclusion.” His memo is chiefly concerned with how Google handles diversity, his main point being is that it is bad for Google’s business and unfair to qualified applicants for the company to be going out of its way to hire people from underrepresented populations. On the topic of the gender disparity, he claims that oppression is not the only reason that there are fewer women in technology, and gives some biological reasons why men, by nature, are more supposedly suited for work in tech than women, based on average preferences between genders (Damore). Damore cites several reliable studies in this memo, which are used as sources for things like “Women on average are more cooperative” or “Women on average are more prone to anxiety,” and while these are valid results and conclusions, Damore’s document is flawed in its tendency to pin these assertions on biology alone instead of contextualizing the biological differences between men and women in society and culture (Damore).

However, Damore is correct in that estrogen and testosterone do affect the brain differently, which can indeed be linked to a woman's interest and comfort in pursuing and excelling in a career in STEM. Specifically, it can be linked to math confidence levels. In the paper “Women 1.5 Times More Likely to Leave STEM Pipeline after Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit” by Ellis, Fosdick, and Rasmussen, they examine the mathematical confidence levels of male and female students relative to their SAT math scores. They focus on students taking Calculus 1 across several universities, since the course is an important lower-level foundational requirement in just about every STEM major curriculum. They found that of STEM-intending women who did not take Calculus 2 after

Calculus 1, 35% of them reported that they did not feel like they understood Calculus 1 well enough to proceed, but only 14% of these STEM-intending men said the same. Generally, the study finds that among women and men of similar mathematical ability, women are far more likely to report themselves as being worse at math. The paper also says that if women and men left the pipeline at Calculus 1 at the same rates, there would be 75% more women continuing in their STEM degrees (Ellis et. al.). Given this, it seems that self-perceived math ability is a major factor in whether a woman continues to pursue STEM. This pattern is echoed in other scholarly papers, such as "Explaining the Gender Gap in Math Test Scores: The Role of Competition" by Niederle and Vesterlund, which also ties the competitive and risk-taking tendencies of males to perceived mathematical ability (Neiderle and Vesterlund).

However, none of these papers delve into exactly what is causing these gendered differences in confidence, or risk-aversion, or competitiveness, only really asserting that these differences exist, and that they may affect a woman's comfort in doing and pursuing math. Kay and Shipman, in an article titled "The Confidence Gap," investigate the roots of this pattern, beginning their analysis on the subject of male and female brain chemistry, specifically in how the two sexes react to challenges and threats. They report that women, according to fMRI scans, are more likely to form "strong emotional memories of negative events" than men are (Kay and Shipman). They also report that estrogen discourages conflict and risk taking, while testosterone does the opposite, citing research that shows correlation between level of testosterone and likeliness to take risks.

Kay and Shipman also investigate the elementary school environment for clues as to how the confidence gap may be nurtured in a woman's youth as opposed to just biology. They explain that when boys roughhouse, play, and make fun of each other in their youth, they are learning to

"take failure in stride" (Kay and Shipman). They also cite the renowned Stanford psychology professor Carol Dweck in that, in elementary school, boys receive eight times as much criticism for misbehaving as girls do. Girls are thus rewarded and praised for not causing trouble or making mistakes, and as a result, they never learn how to fail (Kay and Shipman).

Math fundamentally differs from reading in that there can, more often than in math, be multiple interpretations for something. There can be multiple correct answers to a question in an English class, as long as you explain your thinking. An answer in an English class is less likely to be labeled completely "wrong" than a math question, which is entirely black-and-white. Therefore, it is harder to get discouraged when it comes to reading, so this may be a reason why more reading-centered fields like law, business, and medicine have seen women make strides unparalleled in most STEM fields. When someone does a math problem, they either get it right or wrong. Either the number is the correct number, or it isn't the right number, and the answer is incorrect. Thus, when a young woman encounters math problems that she may not be able to do correctly, she is more likely to take her mistakes to heart and be discouraged by them. She might think she is just not good at math if she makes a lot of mistakes, which can be further justified by the popular stereotype that boys are good at math and girls are good at reading.

Such stereotypes give girls an excuse to be "bad at math," especially when paired with a lack of confidence that discourages them from trying lest they get a problem wrong. This leads to some young women having what Dweck describes in "Is Math a Gift? Beliefs That Put Females at Risk" as a "fixed mindset" pertaining to math, meaning that they are accepting and internalizing their math ability as a fixed variable that cannot change, and will always negatively affect their math performance. This is as opposed to a "growth mindset," which is the belief that their ability can change if they try, and they have confidence in themselves. Dweck and her team

conducted a study discussed in this paper where, over eight sessions, they taught a group of male and female middle schoolers the scientific basis of the growth mindset, mostly concerned with how the brain makes connections, and how this knowledge was relevant to them as learners. The control group, another group of middle schoolers, also received an eight-session course, but they did not learn about how intellectual skills could be improved. Both groups showed declining math grades before the eight-session interventions. In the control group, the students' math grades increased, but the score gap between genders was maintained. In the experimental group, however, the difference in math grades between genders was almost gone (Dweck).

It seems that instilling the idea that anyone can be good at math, or any intellectual skill, is a step towards increasing the number of women in the STEM workforce, but then it becomes a question not of whether a woman can excel in STEM, but whether or not that woman wants to. The words "scientist," "programmer," or "engineer" might conjure up less than glamorous images of men, sometimes smelly, awkward men that sit in front of screens in their poorly-lit rooms for 10 hours per day, as opposed to the clean and distinguished images of the lawyer or the doctor. Women do not fit the image of the scientist, programmer, or engineer, so they do not become the scientist, programmer, or engineer. This leads us into a cycle of self-perpetuation, where women don't pursue STEM careers because of the stereotype that it's for men, and the stereotype that STEM is for men is because women don't pursue STEM careers. Furthermore, it is often unappealing and discouraging to be a minority in a space. It is a lot easier on one's psyche to simply go where they are represented (in this case, a woman would switch to a major with more women), negating the need to prove themselves as worthy despite their differences from those who surround them.

In conclusion, there are a myriad of reasons that a woman might not want to go into STEM. She might feel discouraged when she tries, or she might simply like something else. To what extent these feelings are evolutionary and instinctual versus learned through culture is up for debate, but it is more likely than not that both factors are contributors. On top of the lack of representation and the popular image of STEM workers, it is clear that the gender gap in STEM has many complex and intertwined culprits across many fields of study.

Works Cited

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Kay, Katty, and Claire Shipman. “The Confidence Gap.” *The Atlantic*, May 2014, https://www.theatlantic.com/magazine/archive/2014/05/the-confidence-gap/359815/.

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In this paper, Carol Dweck, a well-renowned psychologist and professor at Stanford University, explores how students' attitudes toward math ability and intellectual growth disproportionately affect women and their likelihood to pursue math. The fixed mindset, she says, is harmful to women in particular, because of the stereotype that women are worse at math, so when women experience setbacks, they believe that they do not have a gift for math. Dweck asserts that the solution is to raise awareness that math is a skill and not a gift. She then discusses a study where a group of 8th grade students, male and female, were taught about how intellectual skills could be developed, and how to develop these skills, and were tested in math skills at the end of the year against a control group that received no such course. The goal of the course was to instill a growth mindset. In the group with the intervention, the gender gap was nearly gone in math scores at the end of the year.

Ellis, Jessica, et al. "Women 1.5 Times More Likely to Leave STEM Pipeline after Calculus Compared to Men: Lack of Mathematical Confidence a Potential Culprit." *Plos One*, vol. 11, no. 7, 13 July 2016, doi:10.1371/journal.pone.0157447.

This paper, written by 3 assistant professors is Colorado State University's departments of math and statistics, investigates the finding that women are 1.5 times more likely to give up on STEM after taking calculus than men. To begin the study, they surveyed college students before and after taking calculus 1 at a number of universities about their math confidence level, how well they reported knowing the material, and whether or not they intended to take calculus 2. The ACT and SAT scores of all students surveyed were indicators of math preparedness. They found

that among men and women of similar math ability, women reported much lower confidence, and were far more likely to deem themselves unprepared for calculus 2. They report that if women left the STEM pipeline at the same rate as men around calculus 1, the STEM workforce would have 75% more women.

Kay, Katty, and Claire Shipman. "The Confidence Gap." *The Atlantic*, May 2014, https://www.theatlantic.com/magazine/archive/2014/05/the-confidence-gap/359815/.

This article provides some answers to why "Women feel confident only when they are perfect. Or practically perfect" (Kay and Shipman), exploring reasons from nature and nurture. Kay and Shipman are distinguished journalists who have done much writing and research about this gap in confidence between the sexes. This is a pattern seen in math as mentioned in several other places. One of the possible answers they present has to do with the effects of testosterone and estrogen on the brain, since testosterone encourages risk-taking, while estrogen encourages social connections and avoiding conflict. They also discuss how young girls receive praise for being neat, quiet, and perfect in elementary school, while boys are accepted to be more rambunctious, as well as socialized to take and deal with failure on the playground and sports field more so than young girls.

Sax, Linda J. "The Gender Gap in STEM: The Unique Case of Computer Science." The Gender Gap in STEM: The Unique Case of Computer Science | UCLA Women in Tech, UCLA GSEIS, 9 Sept. 2016, womenintech.ucla.edu/resources/gender-gap-stem-unique-case-computer-science.

This is a presentation by Dr. Linda J. Sax, the director of the UCLA BRAID initiative. Sax is a professor at UCLA's Graduate School of Education and Information Systems. The presentation first shows that women, as the majority of college graduates, are well represented in all fields except STEM. Sax primarily studies the components of the educational setting that may be pushing women away. She studies the CIRP survey, which took data from 8 million students entering college from 1971-2011 to look at patterns in background traits, self-ratings, community-orientation, and career aspirations. Her findings on these fronts lead her to conclude that computer science tends to attract women who are creative and artistic, but may have low emotional and physical health. Some of the solutions to the disparity she suggests are the promotion of the interdisciplinary potential of computer science, community building, and K-12 outreach.

Vu, Shana. "Cracking the Code: Why Aren't More Women Majoring in Computer Science?" UCLA Newsroom, UCLA, 27 June 2017, newsroom.ucla.edu/stories/cracking-the-code:-why-aren-t-more-women-majoring-in-computer-science.

In Vu's article about the UCLA BRAID (Building, Recruiting, and Inclusion for Diversity) Initiative, she highlights some of the elements of computer science that might be pushing women away from the field, as well as some of the strategies that could be used to fix this issue as identified by the BRAID research team. The chief goal of BRAID is to foster a sense of belonging as well as confidence in computing skills among minority students. The article comes from UCLA's official newsroom, and cites BRAID studies for its statistics. It also uses direct

quotes from the program's director to explain and provide further insight into the research done. A specific BRAID study is cited here as well.