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Female Underrepresentation in STEM

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Rethinking the 'F Word': Feminisms for the 21st Century
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Blue is for boys, pink is for girls. Legos are for boys, dolls are for girls. Science kits are for boys, Easy Bake Ovens are for girls. Computer science and engineering are for boys, the humanities and caregiving are for girls. Ad infinitum. While oftentimes overlooked, society has the tendency to enforce and naturalize restrictive binaries for children, most often in relation to gender identity. These binaries cultivate an acceptance of gender stereotypes and promote a bias that carries over into adulthood. The nature of this gendered oppression weighs heavily on young girls' opportunities and career aspirations. When girls are discouraged from or otherwise unaware of their potential future in a diverse array of jobs, their talents and abilities are suppressed. The objective of this paper is to examine the lack of women pursuing and practicing science, technology, engineering, and mathematics (STEM) relative to the number of men active in these fields. In order to illustrate the gender disparity in STEM fields, the National Girls Collaborative Project, in conjunction with the National Science Foundation, indicates that, "Women make up half of the total U.S. college-educated workforce, but only 29% of the science and engineering workforce." In other words, while the workforce of the United States equally represents the sexes, women are severely underrepresented in science and technical fields. Furthermore, although this statistic discloses a gendered discrepancy in the United States, underrepresentation of women in STEM is a global phenomenon. Based on data collected from 2014, the UNESCO Institute for Statistics indicates that women comprise 28.8% of total researchers in the world, with the most severe female underrepresentation found in South and West Asia, where women account for only 19% of researchers.

This paper will examine the potential barriers as to why women, despite immense gains in recent decades, still remain underrepresented in STEM. I explore the myths related to women's ability to participate in STEM as well as the source of prescriptive gender roles and

stereotypes. Additionally, the workplace climate of STEM professions will be examined in order to gauge why women "choose" to leave or not pursue STEM careers in the first place. With that said, I argue that the reason for the dearth of women in STEM cannot be attributed to a single cause, nor is it directly linked to biological differences between sexes and women's perceived intellectual inferiority. Rather, it is a result of multiple, intersecting societal norms and beliefs that have become ingrained sexist and misogynistic practices that accumulate in various life, education, and career stages.

Prior to even entering the K-12 educational system, girls are exposed to restrictive stereotypes through gendered toys. Prescriptive gender roles, learned during the formative years of childhood via gender-specific toys, impact female involvement in STEM and act as deterrence. According to the Institution for Research and Technology, "Societal stereotypes driving these gendered listings [of toys, including STEM-related toys] could be having a knock-on effect for the next generation of engineers, especially girls, impacting their future career choices" (qtd. in Weale). Essentially, gendered-toys and their marketing have serious, long-lasting repercussions due to the images and skills these toys promote. This is especially important for the STEM professions because science and engineering toys are usually marketed to boys. Anders Nelson, an associate professor in Educational Sciences at Halmstad University in Sweden, in his analysis of 4- and 5-year old children's play, asserts that "differences [in toy design] represent social and cultural stereotypical ideas about what men and women are or should be" (74). To Nelson, differences in toys for girls and boys are a reflection of society's expectations for the sexes. Typically, boy-oriented toys promote practical jobs, skill building, and leadership positions whereas girls' toys depict the unrealistic profession of princess and restrict young girls to caregiving positions, as evident by numerous baby-doll products. These

gendered toys therefore enforce and effectively ingrain gendered expectations into the developing and easily influenced adolescent brain.

The sheer power and influence of these prescriptive gender norms are exacerbated as girls progress through K-12 education, higher education, and into the workplace, areas in which we see declining female participation in STEM. According to the American Academy of University Women's (AAUW) 2010 research report, *Why So Few? Women in Science, Technology, Engineering, and Mathematics,* during K-12 education, the distribution of girls and boys enrolled in science and math courses is approximately equal (Corbett et al. xiv). Overall, during K-12 education, the level of participation by girls and boys in STEM-related courses does not indicate a wide divide between the sexes. This is not to say that disparity between sexes during this stage of education is completely absent, but rather that any difference is negligible. Upon enrollment in undergraduate degree programs, the number of women in STEM courses begins to dwindle, as evident by the intended major declarations of first-year students (Corbett et al. 7). Mary J. Amon, a postdoctoral research fellow at Indiana University's Developmental Cognitive Neuroscience Laboratory, drawing on a statistic from the National Science Foundation, indicates that a prominent deficit is apparent between men and women in graduation from advanced degree programs, in which the ratio of men to women is 2.5:1 (2). This trend of decreasing female presence in STEM continues into the workplace, where female involvement declines even further (Amon 2). Overall, gender disparity is most pronounced at the post-education level. As a result of fewer women in STEM, major implications can arise. For instance, in male-dominated fields, women are less likely to advance at the same rate as their male colleagues. This bars women from leadership roles and imposes economic hardship. Additionally, according to Patricia Valoy, civil engineer and contributing writer for *Everyday*

Feminism, "[…] products that are almost exclusively used by women are designed by men." For instance, men, likely with minimal consideration of unique female needs and sheer practicality, originally designed oral contraceptives and menstruation products, like Tampax tampons. This shows that all women suffer due to female underrepresentation in STEM. To add to this, innovations from female scientists and engineers that would benefit all of society are effectively silenced when women enter these fields at lower rates. Most notably, however, fewer women in STEM perpetuates a cycle of male-dominated careers in the way that it presents a lack of female role models to inspire future generations.

As bell hooks argues in *Feminism is for Everybody*, feminism is a movement for both men and women to fight back against the system of sexism, instead of against a specific gender or sex. The issue of a shortage of women in science, technology, engineering, and mathematics is pertinent to the feminist agenda as disproportionate representation stems from sexist stereotypes about women. Today, women and girls remain trapped by the chains of outdated social convention and are pressured to pursue "feminine" careers related to caregiving, such as nursing or teaching. There is nothing wrong with these types of professions; rather, it is the limiting of choice and options, as prescribed by society, which creates problems and enforces restrictive binaries. Therefore, bearing in mind bell hooks's definition, feminism should be concerned with the lack of women in STEM because addressing this societal problem entails breaking down restrictive binaries and sexist stereotypes that limit women and girls.

To discern why there are fewer women in STEM positions than men, we have to pause and ask ourselves: Is there a socially constructed or an absolute, biological difference between the brains of men and women? Jacob Clark Blickenstaff, in an article evaluating the explanations presented in literature over the past several decades concerning the underrepresentation of

women in STEM, indicates that, for over a century, researchers have explored biological differences between men and women's cognitive abilities. Blickenstaff, who views biological difference as an insufficient explanation for gender disparity in STEM, discloses that, in the past, "Head size was seen as an indicator of brain size, and so indirectly a measure of intelligence" (372). In turn, scientists attributed female "intellectual inferiority" to the difference in size of men's and women's brains (Blickenstaff 372). The belief that inherent biological factors dictating intelligence exist between men and women is a relatively modern concept and while research now indicates that brain size is correlated to body mass and not indicative of intellectual ability, there are still individuals insistent upon male intellectual superiority who cite this as a reason for why there are fewer women and girls in STEM. On the contrary, there are also those who question the gender-linked cognitive ability debate and find instances that undermine the validity of such an argument. Linda Billings, Director of Science Communication at the Center for Integrative STEM Education at the National Institute of Aerospace, stated in an interview that, based on her observations in the classroom, there are "noticeable gender-based differences in social behavior but no noticeable gender-based differences in cognitive ability or style" among second and fourth graders (qtd. in Kelly 34). Billings's observations indicate that there are behavioral differences between boys and girls, but no overwhelming group difference in regards to intelligence. Notably, cognitive ability and style tend to differ from individual to individual (qtd. in Kelly 34). Billings does not reference a specific sex in her observation of individual cognitive differences, meaning that boys and girls both exhibit a range of mental capabilities and that intelligence cannot be pinpointed. Nevertheless, Billings's observations seem warranted to me, as my personal experience in the classroom corroborates these findings: my quiet nature is

not reflective of my intellectual abilities, though it could be linked to the expectation that women are supposed to be silent and demure.

While research and observation indicate that there is no concrete biological difference between men and women in regards to intelligence, multiple sources point to a deficiency in women and girls' spatial ability. Spatial ability involves visualization and the capacity to understand and remember the dimensional relations among objects or space. The report from AAUW specifies that boys and men consistently outperform women and girls in terms of spatial ability, which contains skills construed as vital to success in engineering and other related fields (Corbett et al. xv). However, it is important to note that spatial skills are easily developed with practice. Therefore, women and girls should not be limited by their perceived cognitive ability and skills because the brain can change and develop over time. Cognitive ability, unlike immutable biological and genetic differences, is dynamic.

Despite all of this evidence that discredits the link between biological sex and intelligence, there are still those who continue to uphold it. For instance, in the article "Fewer Women in STEM Fields: No, Its Not Sexism" from the conservative political magazine *The American Spectator,* the author, also the managing editor of the magazine, rejects sexism as the cause for gender disparity in STEM. Rather, she argues, "[…] men have a more natural facility toward science and engineering and math" (Mackenzie). Her choice of the expression "natural facility" implies biological difference. Mackenzie concludes her article by stating that women will "have to get used to it", with "it" referring to men's natural inclination to STEM professions. Mackenzie's argument, reflective of widely shared, popular beliefs, is sexist in itself. The author presents women and girls as inferior by debasing their intellectual capabilities. The perpetuation of the belief that there are inherent biological differences in terms of cognitive capability is

dangerous because nothing can be done to fix these differences. This then permanently fixes women and girls in a position of inferiority with real, lifelong, material consequences.

In addition to their supposed cognitive deficiency, women and girls' stamina, or essentially their ability to compete with men and boys, is also cited as an explanation for their underrepresentation in STEM. In order to examine this reasoning, we turn our attention to the popular far-right website Breitbart News and the ideas of former senior editor Milo Yiannopoulos, who has since left the company due to controversial statements regarding pedophilia. To Yiannopoulos, and to the thousands of website viewers who likely share his opinion, women leave STEM "not because there are sinister and mysterious patriarchal forces at play, but because they […] can't cut it in highly competitive environments". In other words, sexism and gender expectations do not contribute to women's abandonment of STEM. Instead, women are simply not cut out for the demanding nature of STEM professions because they cannot cope with the male competition. This argument is a surface-level deduction that fails to examine the specifics and is merely attempting to convince the audience that there should be a limit to the number of women pursuing STEM. Women probably drop out of STEM due to a lack of supportive resources, not because they are unable to "handle it." Yiannopoulos's comments originate from a place of fear – women's presence in STEM is a threat to men's patriarchal privilege. It is this fear that permeates into society's evaluation of women and consequently works to limit their entry into STEM.

Women, when applying and interviewing for jobs in STEM-related professions, are faced with barriers rarely presented to their male counterparts. In the hiring process, we see that women typically confront higher expectations and scrutiny as a result of implicit sexism. Based on the results of a study assessing the gendered barriers to obtaining faculty positions within

male-dominated engineering departments of five research-focused universities, women, despite impressive curricula vitae, are "still assumed to be less competent, are challenged, sometimes excessively, and therefore have less time to present a coherent and compelling talk" (Blair-Loy, et al.). Compared to male job candidates, women are unable to accurately and fully explain their research and experience when applying for faculty positions. For example, during job talks, women experience more frequent audience interruptions. In addition to audience commentary, women are also asked more questions, which deducts time from their presentation. The silencing of women during job talks is a detriment to their entry into the workplace. Additionally, the questioning of a woman's competence fuels the widely accepted stereotype that casts women as less adept at math and science compared to men. Therefore, despite the study's inability to confirm the number of job candidates hired and the female-to-male ratio of hired candidates, this specific case can be extended to a universal scope: Implicit gender biases that manifest during the hiring process, without notice, hinder women's success at entering STEM fields.

By examining the workplace experiences of those women who survive the hiring process to enter STEM fields, we gain a deeper understanding of the factors that influence female aspirations to and retention in these fields. What we find is that after women surmount the initial barriers to a career in STEM, gendered challenges do not disappear. For instance, the AAUW indicates that many women cite feelings of isolation, lack of support, demanding schedules, and vague rules related to advancement as influential factors to their dissatisfaction in the STEM professions (Corbett et al. 24). Undeniably, these factors make it difficult for women to progress in STEM and obtain leadership positions. While men may confront some of these same difficulties, women suffer disproportionately from the additional daily pressures of sexism and misogyny in the workplace. A case in point is H. Ahmed, a woman who works at a major

research institution in the United States. Ahmed reports, in an article for *Science,* that her own research has been "mansplained" to her via email. "Mansplaining" is when a man explains something to a woman in a condescending manner. Talked down to and treated like a child, Ahmed discloses the occurrence of sexist jokes in the workplace. She narrates how a seminar speaker once likened the V-shaped structure of phospholipid tails to the splayed legs of a woman, to which the room erupted in laughter and Ahmed was called "too sensitive" for not being able to take a joke. It is impossible to determine if the laughter was out of courtesy for the speaker or the result of a genuine, but sexist, resemblance of a biological structure to a woman's body. Perhaps it was a mixture of both. Whatever the case, it is utterly ridiculous that phospholipid tails become gendered and sexualized in public, academic spaces. More importantly, such laughter upholds a culture of acceptance for sexism. As a result, the workplace becomes an unsafe, misogynistic space where daily havoc is wreaked on women's mental fortitude.

Equally detrimental to female representation in STEM are the sexist attitudes and behaviors that actually cause women to leave their jobs. In reflecting on her personal experience, Julie Libarkin, Associate Professor of Geoscience at Michigan State University, discusses micro-aggressions, objectification by male colleagues, and physical assault. She describes her frequent encounters with sexism as "psychologically damaging." She additionally observes that the scientific community does not acknowledge the stress-inducing, hostile environment of the workplace. She responds to this, stating, "[…] I'm pretty successful, but it makes me want to quit" (qtd. in Jarreau). Countless women in STEM are subjected to these draining and recurrent misogynistic practices. Moreover, these women are unsupported in the workplace, as evidenced by an employer's disregard for addressing and counteracting sexism. Some women, like

Libarkin, will remain in their career despite rampant sexism, whereas others will quit for the sake of mental, emotional, and physical wellbeing. The AAUW reports, for example, that 52% of women in STEM quit their jobs by midcareer due to the roles of workplace environment and bias (Corbett et al. 19, 24). This is not because women are weak and unable to handle the stressful environments associated with STEM professions; rather, it is the naturalized imposition of patriarchal stressors that burdens women and contributes to their decision to leave their career.

Since the sexism that leads to female underrepresentation in STEM is so entrenched and normalized, we need to ask ourselves what we can do to make this better. In order to encourage young girls to not shy away from STEM careers, female role models need to be made visible. Images of these women, as well as their voices, must be amplified and circulated. Their narratives are especially important because they "emphasize not only the path these women took to arrive at their chosen careers, but also the joy they found in their work, as well as their personal interests and family stories" (Milgram). In essence, by providing physical evidence of female success in STEM *and* in life outside of work, it is possible to increase the self-efficacy of girls and demonstrate that their aspirations, as well as work-life balance, are tangible and attainable. The global influence of the Internet is, and will continue to be, imperative to increasing successful female role model visibility. As an example of the Internet's role in encouraging STEM aspirations, in my research, I encountered the website colorsofstem.org, which aims to "give young girls of all colors under the rainbow role models in STEM by telling the colorful and inspiring stories of STEM women world-wide." The website includes a page dedicated to the self-submitted stories and experiences of women in STEM professions. Overall, successful female role models have the power to undermine the restrictive societal norms and myths that deter female participation in STEM.

Second, and keeping with the idea of visibility, outreach programs and social media posts sponsored by major corporations and nonprofit organizations can assist in addressing the underrepresentation of women in STEM by redefining gendered expectations and activities. Recently, Instagram feeds have included sponsored posts about Microsoft's #MakeWhatsNext campaign, which encourages girls to enter technology and science fields and assists these girls in making their STEM dreams a reality. The interest of a multinational technology company in solving the problem increases awareness and prompts society to acknowledge the fact that there is something inherently wrong in the way it treats girls. On the nonprofit side, we find organizations like Girls Who Code, which runs summer programs that teach computing and programming skills to high school girls with the goal of supporting and increasing the number of women in computer science. Major corporations and nonprofits are even working together in some instances. The American Association of University Women and Verizon Wireless are in the process of expanding programming designed to teach coding and app development to middle school girls through the AAUW National Tech Trek Program. The expansion of this program indicates that girls are interested in STEM-related activities and willing to participate. Therefore, it is in our best interest to provide these girls with the resources necessary to cultivate a commitment to STEM.

In addition to outreach programs, personal encouragement from teachers and professors will enable girls and young women to see through and move beyond the myths that society constructs about what is gender-appropriate. The significance of face-to-face encouragement is supported by the response of female participants in the CalWomenTech Project, where, from 2006 to 2011, eight California community colleges received support and technical assistance to help recruit and retain women in underrepresented technology programs. The Institute for

Women in Trades, Technology, and Science (IWITTS) provided services and support for the project, which was funded by the program on Research on Gender in Science and Engineering from the National Science Foundation. Donna Milgram, Executive Director and founder of IWITTS, indicates, "[…] personal encouragement by a teacher was the top recruitment strategy that female students […] reported experiencing." The positive impact of personal encouragement on girls and women is most likely universal and not specific to the CalWomenTech Project. Genuine encouragement from educators, one of the constant authority figures in an individual's early life, validates one's existence and assists in conquering lingering, internalized uncertainties. Such support then frees up girls and women to explore their interests, unhindered.

Visibility and awareness will also play a critical role in altering hostile workplace climates. While the Internet and social media can perform wonders in increasing the visibility of role models, they are also platforms that could simultaneously expose the injustices that women in STEM experience. Publicly accessible accounts, posts, and articles explicitly calling out the failure of companies to address sexist practices and to offer support to affected female employees has the power to initiate change in the workplace by sparking public outrage at otherwise silenced female experiences. As a result, corporations, organizations, departments, etc. will be pressured to change their policies and, in order to avoid public criticism, will provide resources that counteract sexist practices and support women, or even men, subjected to gender bias. In turn, we can hope that fewer women will leave their STEM careers. Unfortunately, given the patriarchal society we live in, I suspect that it will be impossible to completely eradicate sexism and pervasive stereotypes. Nevertheless, increasing female representation in STEM is an attainable goal and it starts with visibility and providing women and girls with the proper

resources and tools to overcome the intersecting, ingrained societal norms and beliefs that otherwise limit their vast potential.

In conclusion, it is imperative to recognize female underrepresentation in STEM as a result of socially constructed gender norms, which, in turn, fuel persistent gender bias. The lack of women in STEM does not result from intrinsic, biological differences or mental capabilities. Attempting to counteract the gender myths and misogyny that limit female participation in STEM will benefit women in other industries by generating public awareness about the far-reaching consequences of patriarchy. Society as a whole can benefit from increased female participation in STEM because when women are allowed to reach their full potential, they contribute new ideas that can revolutionize the world. For future research, it is important to understand that race, class, sexual identity, and other factors present additional barriers to women's entrance into STEM and efforts to boost female representation in these fields should always be intersectional. Furthermore, researchers should examine how creating authentic choice for women and girls simultaneously frees men and boys of society's prescriptive gender roles.

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