Closing the Gender Gap in STEM

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Abstract

Due to social and cultural constructions, young girls are discouraged from pursuing STEM (science, technology, engineering, and math) careers. Diversity within STEM is essential as it will lead to progress and unique solutions constructed with various backgrounds; hence, the massive gender-imbalance needs to be addressed extensively. This paper examines the development of the STEM gender gap and possible solutions. To close the persistent gender gap present in the STEM workforce, necessary changes should be implemented within the educational and social environment. To encourage young girls within STEM in acknowledgement of the stereotypes and difficulties present, young girls need to be encouraged to pursue a field of engineering through combating the portrayal of engineering as a masculine field, presenting role models for young girls to emulate, and developing their confidence in their skill sets for math and science. This paper also includes an Islamic perspective related to the topic discussed, with reference to the Quran and Sunnah. The resources of this paper include academic articles, published handouts, a textbook, and a video.

Keywords: social and cultural constructions, STEM, gender gap

Closing the Gender Gap in STEM

In January of 2005, the President of Harvard University, Lawrence H. Summers, offered his opinion as to why women have not made significant advancements in science, technology, math, and engineering (STEM) careers at a National Bureau of Economic Research conference. His first explanation pointed towards gender discrimination against women within the professional environment; this was later rejected when his logic led him to see that females are less present in STEM in stages prior to their professional careers, such as within high school and middle school. His second explanation offered his version of an excuse as to why women would not be able to pursue a STEM career by blaming possible lifestyle choices made, as children and family responsibility may come in the way of commitment to a STEM career. Still, this explanation was dismissed as women are present in other rigorous fields. His only "plausible" argument as to why the gender gap in STEM persists related to the supposed lack of intrinsic aptitude for science and mathematics (Dooe, 2015). Much to the misunderstanding of Dr. Summers, research shows that girls and boys do not significantly differ in their abilities for STEM subjects. Men and women share cognitive abilities; the perceived differences in cognitive performance between genders are socially and culturally constructed (Spelke, 2005). To fight these false constructions, steps need to be taken to encourage young girls within STEM and close the gender gap. The massive gender-imbalance that persists in the STEM workforce today will prove to be detrimental if it is not addressed and solved. In facing the stereotypes placed against women within STEM-related fields, young girls need to be encouraged to pursue a career in a field of engineering through combating the portrayal of engineering as a masculine field,

presenting role models for young girls to emulate, and developing their confidence in their skill sets for math and science.

Before solutions to the issue at hand can be found, the problem needs to be analyzed extensively. Despite the progress of women in the overall working class, “women remain underrepresented in the science and engineering workforce, with the greatest disparities occurring in engineering and computer sciences” (NGCP, 2018). This gender gap is significant as “women constitute 47% of the overall workforce and [only] 28% of the S&E [science and engineering] workforce” (NGCP, 2018). This disparity between the genders has defined trends as well when “female scientists and engineers are concentrated in different occupations than men, with relatively high shares of women in the social sciences (60%) and life sciences (48%) and relatively low shares in computer and mathematical sciences (26%) and engineering (15%)” (NGCP, 2018). As the following data contributes, men remain dominant within the STEM fields, an alarming trend as it takes away from a necessary diversity in ideas and backgrounds. Furthermore, as science and engineering focused fields are dominated by men, women have the upperhand in more humanitarian related fields. These disparities in representation do not only divide between genders, but on the basis of race as well when “black women, Latinas, and other women racially underrepresented in STEM comprise fewer than 1 in 20 employed scientists and engineers” (NGCP, 2018). Among certain high-tech jobs, there is an even bigger gender gap present as women in the United States consisted of less than 20% of those employed in high-tech positions in 2017; only 18.7% of software developers, 8.9% of aerospace engineers, and 4.2% of computer network architects are women (Catalyst, 2019). There are several movements and supportive resources with the goal of encouraging increased female participation in STEM;

however, these movements and resources may prove futile in significantly shaking the low statistics of women in STEM. Even out of the small population of women pursuing a STEM career, more tend to stray away from the field once they enter it:

> Unequal treatment at work is a leading reason women leave STEM careers. Work experiences impact women's decisions to leave. Isolation, male-dominated work environments, bias and a lack of effective women role models are other factors pushing women to leave STEM jobs. Once women enter the tech field, they are 45% more likely to leave than men. (Catalyst, 2019)

Several key issues arise due to the factors mentioned above. As the small amount of women that entered the STEM workforce leave, the chances of developing an effective female role model within STEM significantly decreases. The discouragingly low concentration of women in STEM fields leads to decreased female leaders in the STEM community, a necessary representation for women to acknowledge and observe their involvement in STEM progress. Unsurprisingly, "the information technology industry had the lowest representation of women. Just over a quarter (25.8%) of companies surveyed still had zero women on their boards in 2017 and only 18% had three or more women" (Catalyst, 2019). The lack of women in these influential positions produces unfavorable conditions for company progress for "in 2016, women on corporate boards (16%) were almost twice as likely as their male counterparts (9%) to have professional technology experience among 518 *Forbes* Global 2000 companies" (Catalyst, 2019). With the lack of representation and leadership for women, the STEM workforce remains dominated by men. This domination serves as wrongful support for the sexist stereotypes of women being intrinsically less skilled at math and science, as Dr. Summers proposed. The notion that the cause

of notably less female participation in STEM is due to biological shortcomings ignores the institutional prejudice that women face, leading to their decreased presence in the STEM workforce. The illogical superiority of men within STEM needs to be eradicated as it serves to support a cycle of female oppression, discouraging female participation among all ages.

The apparent gender gap in STEM perpetuates negative stereotypes pitted against women who enter the technical workforce. Gendered stereotypes presented throughout females' academic careers can heavily influence their decisions regarding their paths of higher education and roles in the workplace. When faced with these stereotypes, young girls beliefs in their mathematical and scientific abilities waiver, creating a detrimental and unnecessary effect on their actual performance. These stereotypes are built upon from an early age, negatively affecting the confidence of females in STEM subjects; as early as second grade, "both boys and girls had implicit and explicit stereotypes associating math with the category 'males'" (Kahn & Ginther, 2017). Furthermore, gender differences among STEM achievement may also be influenced by family contributions of pressure and bias. Gendered stereotypes held by the students' parents directly influence the student's perception and mindset regarding their performance and potential in math and science subjects:

> Eccles and Jacob (1986) and Eccles, Jacob, and Harold (1990) found that mothers' gendered stereotypes about math ability influences their perceptions of their children's abilities. If mothers held gendered stereotypes, their rating of their daughter's ability was lower than would have been predicted by the teacher's evaluation of ability (as cited in Kahn & Ginther, 2017).

Often yearning approval and pride from their parents, daughters grow less inclined to enjoy math and science as they see it does not impress and gain an appreciation of those whose opinions they hold dear. Furthermore, parental belief that math is a difficult subject for their child builds anxiety. The growth mindset of parents is crucial to their child's performance; Cheng, Kopotic, and Zamarro (2017) found that parents' math growth mindset increased children's growth mindset with the effect on girls twice as large as on boys. For parents that maintain gendered stereotypes when assessing their daughter's performance, their expectations can largely influence the mindset of their daughter negatively during the learning progress. It may cause the girl to be less inclined in developing a growth mindset when learning difficult concepts in math and science, negatively affecting her confidence and decreasing the chances of the female student positively engaging with STEM.

The contributions made to gender stereotypes outside of the home and within the classroom can play a significant role in the development of female students as well. Profound permanent changes can be made within the brain system of children by the way their teachers interact with them and present academic material (Kahn & Ginther, 2017). In a particular study measuring how teacher gender bias in early grades impacts test scores, "they found that girls with elementary and middle school teachers who were biased against girls in math ultimately took fewer high school math courses and were less likely to major in STEM fields and have STEM occupations" (Kahn & Ginther, 2017). These findings show how stereotypes are solidified from a young age within girls, affecting their development of a positive STEM outlook. Cultural stereotypes of female and male roles affect STEM achievement in addition to familial and educational contributions. Typically, a traditional female role encompasses the

responsibility of caring for the household, raising the children, and being supportive and loving for her husband (Desmond & Emirbayer, 2016). For men, the traditional role requires a hardened attitude and absence from chores related to the house or children; his responsibility is to work outside of the home and provide resources for his family (Desmond & Emirbayer, 2016). Due to these long established and limiting stereotypes, girls are averted from pursuing an academically involved career, particularly ones related to math and science subjects due to their incorrectly perceived masculine nature. A significant cause of the gender gap can be identified as sexist cultural attitudes present for they directly affect girls' STEM achievement. In 2003, Nosek et al. (2009) collected data of gendered stereotypes about science using the implicit association test (IAT). Using the results from nearly 300,000 individuals from 34 countries, the researchers concluded that the gender gap in math and science increased with the level of gendered science-stereotyping despite the country's gender-equality measures (Nosek et al., 2009). The environment that surrounds young females and its portrayal of girls and women plays a crucial role in the development of girls' views on what they can accomplish in correlation to what is considered socially acceptable. The status of an engineering or science career within their society, as well as who those careers are meant for, may work to dissuade girls from STEM. Even if the environment promotes gender equality, views of close family members on gender roles can affect a girl's confidence in math and science significantly as well. When considering math score differences on standardized tests among second-generation immigrants, two-thirds of the math gender gap is associated with parents' cultural attitudes (Nollenberger, Rodriguez-Planas, & Sevilla, 2016). These cultural attitudes were developed by the level of gender-equality present, both within the home country and the new institution, and heavily

influenced the positive or negative performance of their children (Nollenberger, Rodriguez-Planas, & Sevilla, 2016). With pressure to conform to the views of family and society, young girls stray away from STEM in an effort to feel further accepted and appreciated. In a repeated cycle of discouragement, young girls grow with an outlook of STEM as masculine, a helpless notion that suggests solidarity due to the lack of female involvement in STEM, and a broken confidence in their ability in math and science concepts. Due to the inimical social and cultural constructions present against females in STEM, the gender gap is present and persistent.

To make a large dent in the STEM gender gap, the portrayal of engineering as a masculine field needs to be combated. The role of engineering and science in society is heavily interconnected and impactful. Engineers and scientists work to make dreams the next reality. However, despite the advantages a STEM career offers both intellectually and pragmatically, the masculine stereotype of STEM workers diverts women from a young age. This bigoted stereotype asserts that females lack the intrinsic qualities imperative in becoming a successful worker in the STEM field. Women are often perceived as incompatible with STEM; research has shown that implicit stereotypes associating men with professions in science and engineering heavily correlated with an appreciation for STEM subjects and the desire to pursue a major or career in the STEM field (Carli et al., 2016). With STEM being associated with masculinity, women feel less inclined towards engineering and science fields due to the rightful fear of being less recognized than their male counterparts. This allocative discrimination against women in STEM works to undermine the skills and experience that women can offer to become accomplished scientists and engineers. Within their math and science classrooms, students are exposed to the masculine stereotype of STEM subjects constantly. The prevalence of the

disproportionate credit given to men in math and science history develops biases against possibilities of significant female achievement: comparatively few images of women could be found in depictions of scientists in sources of information, including secondary school textbooks and magazine advertisements (Carli et al., 2016). When asked to name individuals who made great impacts within the course of science and mathematical history, Albert Einstein, Neils Bohr, and Sigmund Freud come to mind with their much celebrated achievements and breakthroughs. Their work is widely recognized and deservedly considered essential to the foundation of math and science understanding in modern times; however, their names shadow over the forgotten names of women who made significant discoveries as well. The lesser known names of Hertha Ayrton (a British engineer, mathematician, physicist, and inventor), Sophie Germain (a French mathematician, physicist, and philosopher), and Lise Meitner (a Austrian-Swedish physicist and nuclear scientist) all conducted ground-breaking discoveries in their time; a time where engineering and science were considered unsuitable for women. A historic undervaluing of influential women in STEM works to preserve the perceived masculine stereotype. The contributions of these inspiring women were and are continuously undermined within classrooms by the works of their male counterparts due to the prejudice they faced as female scientists and mathematicians. Thus, female students are conditioned to observe that science and math are geared towards men, producing a negative effect on their confidence and perspective on careers within the STEM field. Diversity within the credit distributed in history will serve as the foundation in breaking down the masculine attachment to STEM. Furthermore, “successful scientists are presumed to be highly agentic because success in science, as in other fields, requires persistence, competence, competitiveness, and drive” (Carli et al., 2016). Women are

generally perceived to possess communal traits, making them kinder, warmer, and more understanding of their surrounding peers, whereas men are considered to be agentic, making them more independent, ambitious, and assertive (Carli et al., 2016). Hence, with these misconstrued perceptions, STEM is seen as a favorable field for male personality types, once again, discouraging girls from STEM. It is important to recognize that feminine and masculine traits are constructions of society, and the exaggerated masculinity of the STEM field is harmful to the industry itself. A successful engineer or scientist is not defined by traits belonging to a particular gender; there are a plethora of skills needed, honed by experience, to make the world a better place through STEM. Gendered stereotypes push women below, hiding their voices and lessening the value of their success and efforts. If the perceived masculine nature of STEM is not dismantled, the future of math and science will remain lagging and unexciting due to the lack of diversity, experience, and backgrounds. Women have the necessary skills and more to become extraordinary scientists, and when interested young girls are pushed back from STEM, the world loses the next Hertha Ayrton.

To further lessen the gender gap within STEM, the confidence of young girls in their skill sets for math and science needs to be supported through developing a growth mindset for STEM and presenting female role models for them to emulate. Resisting gender stereotypes, girls should be presented with a positive perspective of STEM within their early academic careers and throughout, because “when girls become aware through both subtle and overt cultural messages about male superiority in math, it makes each encounter with math and technology more fraught, triggering self-doubt in even the most studious young girls” (Berwick, 2019). With this self-doubt and the pressure girls receive to conform to traditional gender roles, the gender gap in

STEM grows. It is essential to bring forth changes in curriculum and teaching methods to prevent unwanted contributions to the development of discouraging mindsets within girls. To encourage girls to persist in STEM, "researchers say teachers can foster a growth mindset in students by emphasizing that practice rather than innate ability improves performance" (Berwick, 2019). As shown by multiple studies, girls are on par with boys when it comes to understanding math and science concepts (Berwick, 2019); hence, they should be presented with support to continue performing in compensation of the prejudice they face in those subjects. Developing a growth mindset by learning "that intelligence is not fixed but can be improved through training and hard work can help them persist through challenges, a trait that, in math and science, should be particularly advantageous for girls" (Berwick, 2019). It becomes increasingly important to consider the impression STEM places on girls with language used in the classroom and the confidence of female teachers during math and science class; "language that paints science as a male domain can steer young girls away from the discipline" such as calling a young boy a "future scientist" yet calling a young girl a "future woman scientist" (Edutopia, 2019). Presenting female figures of prominent mathematicians, engineers, or scientists belonging to the past or current time can help shift perceptions about who can succeed and make a difference with a STEM career (Berwick, 2019). To bring STEM closer to girls, "studies show that simple gestures of inclusion like having posters and books with diverse female STEM figures and inviting diverse female scientists to class as role models can create a lasting impression of scientific competency in girls" (Edutopia, 2019). The gender gap in STEM does not persist due to the lack of interested girls and their capabilities; girls are just as resilient, creative, innovative, assertive, and technical as boys, therefore, the gender disparities arise due to factors of

institutionalizaed or overt discrimination and prejudice against women in STEM. Through the current standard curriculum, girls are presented with the message that STEM careers are meant for boys, and math and science are difficult to achieve mastery in as boys will always perform exceedingly well do to inherent competency. However, by focusing on practice rather than innate ability in math and science and providing examples of remarkable female figures in STEM careers and history, the confidence in girls to face gender stereotypes and demolish them solidifies as they expand their horizons in STEM.

Islamic Perspective

The importance of education in Islam is persistent and compelling throughout religious teachings. Unfortunately, Islam can often be mistakenly seen as contradictory to mathematical and scientific findings even as Islam promotes knowledge extensively. Throughout the Quran, Allah (SWT) mentions the important and distinctive nature of human beings as having knowledge, a valuable trait as it places the human race among the highest of creation. The first revelation of the Quran took place during the month of Ramadan, 13 B.H, when the Prophet (PBUH) was in solitude in the cave of Hira and Angel Jibril (AS) came down and revealed the first five verses of Surah Al-'Alaq (Asad, 2007):

> Read. Read in the name of thy Lord who created; [He] created the human being from blood clot. Read in the name of thy Lord who taught by the pen: [He] taught the human being what he did not know. (96:1-5)

The emphasis placed on knowledge of the unknown in this revelation shows the value it holds in Islamic teachings. In the first five verses of the Quran revealed to mankind, the Lord shows that is He who has taught mankind all that they know; He is the establisher of all knowledge,

including proper mathematical and scientific findings. Furthermore, in Surah Az-Zumar, Verse 9, the Quran says, “Are those who have knowledge equal to those who do not have knowledge?” (39:9). This verse clearly proclaims the positive weight that knowledge has in a person’s character and values. Hence, Muslims should strive to seek knowledge with sincerity and earnest.

Moreover, the Prophet (PBUH) heavily encouraged Muslims to seek knowledge intently. It was narrated that Zirr bin Hubaish said: “I went to Safwan bin ‘Assal Al-Muradi and he said: ‘What brought you here?’ I said: ‘I am seeking knowledge.’ He said: ‘I heard the Messenger of Allah say: ‘There is no one who goes out of his house in order to seek knowledge, but the angels lower their wings in approval of his action.’” (Sunan Ibn Majah, Hadith 226). This hadith shows that believers are supposed to make a consistent effort in learning more about Islam and everything the Sunnah and Quran relates to. Hence, Muslims should strive to create an environment that fosters an optimistic attitude towards seeking knowledge. To support this strive to learn, negative stereotypes that inhibit certain individuals from seeking education regarding any positive topic should be disapproved of. The Muslim community, in accordance to the Quran and Sunnah, are responsible for promoting education for everyone, regardless of what race, gender, or socioeconmic class an individual identifies with.

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