

Gender Gap in STEM Education: Why is There a Decline in Women's Participation?

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Abstract

Although the Gender Gap in Education has been narrowed over the past decade, women are frequently under-represented in STEM (Science, Technology, Engineering, and Mathematics) fields in higher education and universities. The Women in Science report from UNESCO shows a significant gender gap in women representing STEM worldwide. This article aims to explore the reasons for such a decline in women representing STEM through an argumentative literature review. Findings from numerous studies denote that factors like variations in interests, enterprising and artistic, to work with people and materials, lesser awareness of STEM, spatial ability, and biases affect the enrollment of women in STEM. This review study can be used as an insight for stakeholders, policymakers, and educators to promote more Research towards making STEM attractive for both genders and providing early education that makes STEM attractive for both genders.

Keywords: *STEM education, Gender, Gender differences, Gender equality paradox*



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INTRODUCTION

The term "STEM Education" refers to teaching and learning in the field of Science, Technology, Engineering, and Mathematics" (Gonzalez & Kuenzi, 2012). It can be in all levels of education from K-12, doctoral, and post-doctoral. It is an approach based on an integrated, interdisciplinary approach; it is not a discipline-specific content but is treated as a single unit (Merrill, 2009). STEM started to gain much interest when students enrolled in STEM education were perceived to have an advantage in college while choosing to pursue STEM in post-secondary education (Butz *et al.*, 2004). It serves as a gateway for those interested in pursuing this field in their higher levels of education. It gives them a specialized knowledge of their subject and often brings about professional development; students interested in this field also get experience in this field at an early age and can make the best use of it. However, the underrepresentation of women in the field of STEM is observed worldwide (Burke & Mattis, 2007; Ceci & Williams, 2011; Ceci, Williams, & Barnett, 2009; Cheryan *et al.*, 2017). Even though there has been immense progress and subsequent empowerment of women in the education sector, participation in STEM education does not reflect so. However, women are well represented in the social and life sciences field (Ceci *et al.*, 2014; Su & Rounds, 2016). But underrepresented in Computer science, Engineering, Technology, and Mathematics. Despite efforts to bring about a change, this trend has been stable for decades, even in developed countries like the United States (National Science Foundation, 2013). Women are a minority in this field, and this under-representation of women in STEM is an obstacle to achieving

complete utility of the human capital. Overcoming such obstacles would certainly increase economic growth and boost a country's economy. This review article tries to address the following research questions:

Research Question 1: To what extent are women underrepresented in the field of STEM worldwide?

Research Question 2: Is the Gender Gap in STEM observed in countries with a higher gender equality index?

Research Question 2: What are the reasons for the under-representation of women in STEM?

LITERATURE REVIEW

STEM disciplines were defined as occupations that required education in streams like Science, Technology, Engineering, and Mathematics (Jang, 2016). Proper STEM education helps students to use and understand technology effectively in their day-to-day life (Bybee, 2010). Studies related to the gender gap in STEM are not new, considering the immense advancement of women in varied education streams. With the rise in women's empowerment, there is a growing concern about the minimal amount of participation of women in STEM. Parental support and perception also influence students to pursue STEM education (Kelly, 2016; Wang & Degol, 2013). Factors like gender stereotypes still affect students, and teachers, hampering and discouraging the prospects of women's workforce in STEM. According to the report from UNESCO Institute for Statistics (UIS) data, the representation of the world's women researchers is less than 30% (Women in Science 2019) refer figure 1.

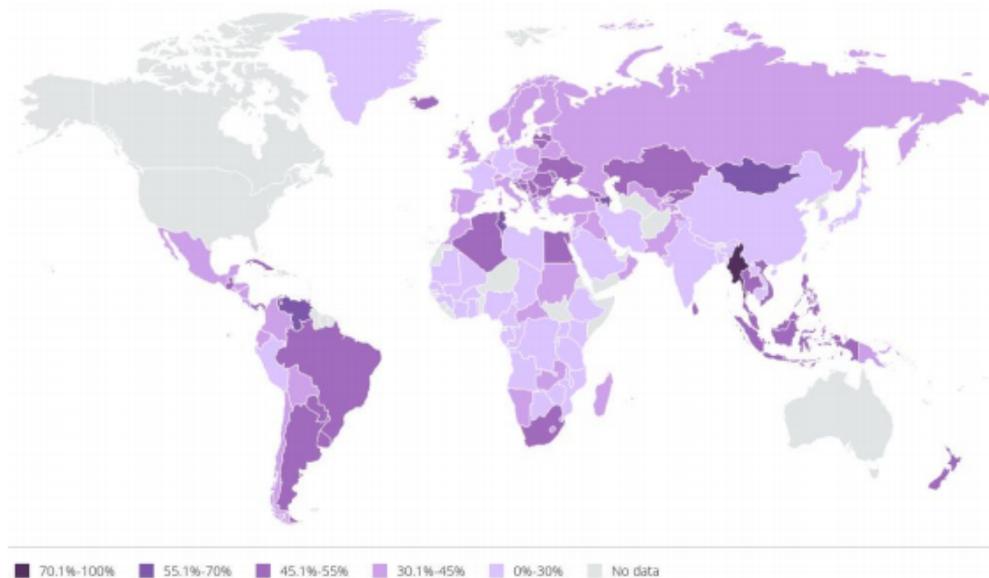


Figure 1: The representation of women in Research as of 2017 (*Women in Science, 2019*).

The gender gap can be observed in leadership positions and among female research leaders (García-Holgado *et al.*). Based on observations in the variation of participation in each sub-discipline of STEM, women have made more progress in the field of biomedical sciences and social sciences, constituting about 50% of participation. Whereas, in the field of engineering, it's only about 20% (National Science Foundation, 2013). The gender gap in STEM can also be observed in countries ranked highest on the Global Gender Gap Index, termed the "gender-

equality paradox.” This issue deals with countries that exhibit gender equity showing a large gender gap in STEM education (secondary and tertiary). One good example of this is Finland, ranked 3rd in the Global Gender Gap Index (*Global Gender Gap Report 2020*). The girls in Finland outperform boys in sciences during school, but Finland has one of the most massive STEM gaps in college degrees. This was also observed in countries like Norway and Sweden, which are again ranked 2nd and 4th in Global Gender Gap Index and emphasize gender equality. In these countries, statistically, there were differences in boys' and girls' intraindividual academic strengths (Stoet & Geary, 2015). In the PISA test conducted worldwide (2015), it was observed that boys scored more in mathematics in most countries than in reading, and girls scored more in reading than mathematics. When it was calculated for personal academic strengths on an average, it was seen that 24% of girls had the Sciences as their strength, 25% of girls had mathematics, and 51% of the girls had reading as their strength. Boys had 38% for science as their strength, 42% for mathematics, and 20% for reading. Boys had more aptitude for mathematics and sciences than in reading, but some girls did better than boys in science in egalitarian countries like Finland and Norway but had less female enrollment for STEM education in universities. Even though girls performed better than boys in mathematics and Sciences, girls performed much better in reading compared to math and sciences (Stoet & Geary, 2018), and students showing higher aptitude in language-related competencies prefer to major in humanities than opting for STEM (Park, Lubinski, & Benbow, 2007). Hence, most of them were seen opting for fields other than STEM.

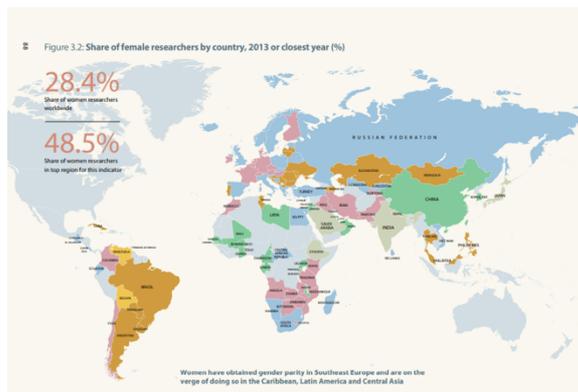


Figure 2: Representation of the share of female researchers country-wise as of 2013 (*Women in Science, 2013*)

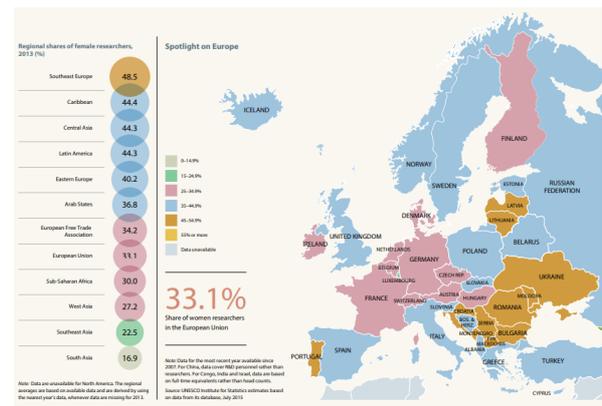


Figure 3: Representation of the share of female researchers European Union as of 2013 (*Women in Science, 2013*)

METHODOLOGY

In the present analysis, secondary data obtained from available literature on STEM education and the reasons for the existing gender gap was considered. The same was furnished from premier journals; additionally, the census data representing the worldwide gender gap was obtained from the report by UNESCO pertaining to women in science. After collective analysis, the data was compiled to provide a comprehensive understanding of the reasons for the underrepresentation of women in STEM, which is the core objective of this review article.

STEM education

STEM education is often misunderstood, and many reasons for this are the fact that it is not a mainstream form of education. Many were not aware of STEM and had a proper understanding

or can even explain it, and there can be a common misconception that it refers to the study of stem cells. STEM education originally began with the acronym "SMET," which on occasions sounded like "SMUT", due to which the acronym was eventually changed to "STEM" (Sanders, 2008). Even though the name sounded very intriguing and was expected to take the education system by storm, it is quite the contrary. The reason for this is the lack of several teacher educators available in STEM, and the teachers tend to employ conventional methods which demotivate the students, and quite often, many lose interest in the early ages of STEM and drop out. Also, environmental factors, the pedagogical, and the infrastructure that is involved in STEM are expensive to implement. Besides that, the employers hiring STEM graduates reported they struggled while working with teams (Prados *et al.*, 2005). Other skills include; communication skills, collaborative skills, management, problem-solving and critical thinking are often reported to be lacking among STEM graduates (Tang *et al.* 2000; Radermacher and Walia 2013).

However, one of the significant issues in STEM has been its Gender Gap; addressing this Gap is essential as, Research in science is more accurate with the inclusion of women; from designing a vehicle or a medication for the heart, women, and men process it differently. Women also bring about a unique perspective in Research. New ideas and research questions from different perspectives are possible in a gender-diverse environment (Bert, *3 reasons gender diversity is crucial to science* 2018). A gender-diverse individual in STEM can also result in equally talented individuals in the STEM workforce. Though some women pursue STEM in their bachelors and masters, it is drastically reduced in Ph.D.'s, a phenomenon known as the "pipeline problem" (Van den Hurk *et al.*, 2019)

Reason for the Gender gap

According to a study conducted by Swafford and Anderson, the domination of STEM careers by males, less awareness of the career and study opportunities, lesser female mentors, the duration to become an expert in STEM, lesser encouragement from the opposite sex have an impact on the number of females in STEM (Swafford & Anderson, 2020). Based on the report from Census Bureau's American Community Survey (ACS), women comprise 48 percent of the US workforce but just 24 percent of STEM workers. Although the women's share in college education has been enormous, their share in STEM work has been the same for decades. This stagnancy is seen in jobs related to computers and mathematics; a drop in the number of women is also seen in the field of engineering, and such stagnancy can create a gender gap in business and start-ups related to innovation resulting in fewer women entrepreneurs with STEM backgrounds (Kuschel *et al.*, 2020). Women are a minority in this field of STEM, and this under-representation of women in STEM keeps us from fully utilizing the human capital. Utilizing this would increase financial growth and boost a country's economy significantly.

Only one out of every seven engineers is female, and men were more likely than women to have a STEM job regardless of their qualifications (Beede *et al.*, 2011). Career choices are also seen to differ among college-educated men and women; it was observed that men are more likely to stay in a career path with respect to STEM after graduation. It was also observed that women are more likely to drop from this field than men (Miller & Wai, 2015). Studies have also shown that "Investigative interest" is also the most significant indicator of pursuing a STEM education or career (Su & Rounds, 2015). Gender differences are observed to be more prominent during middle school (Tracey & Ward, 1998). It was seen during their adolescent stage, and boys scored more compared to girls on "investigative interest" (Collier *et al.*, 1998; Hardin & Longhurst, 2016; Jacobs, 2005; Su *et al.*, 2009; Tracey & Ward, 1998). When their

“enterprising and artistic interests” are higher than Investigative interests, young women are more unlikely to pursue STEM fields (Cardador *et al.*, 2020). Being interested in other fields during college also is another reason for women diverting out of STEM majors (Seymour & Hewitt, 1997). Women are more likely to be seen as having more significant math and verbal skill (McCabe *et al.*, 2019). This combination is associated with lower enrolment into STEM compared to just having only higher mathematical skills (Wang *et al.*, 2013)

Women are likely to deviate from STEM, and about 40% of men with STEM degrees work in a STEM field. In comparison, only 26% of women with STEM degrees work in that field. Females with STEM majors are likely to work in education or healthcare, which is nearly one in five of every STEM-educated woman. Whereas the ratio of men working in education or healthcare is about one in every ten. 14% of women end up in the education occupations, but only 6% of men end up in the education occupation (Beede *et al.*, 2011). Men and women deviate in their career choices after STEM, with women showing less preference for pursuing a STEM career after graduation compared to men. Studies regarding this varied change and male dominance have suggested that this could be due to preferences among males to work “with things” and women “with the people” (Lubinski & Benbow, 1992; Ceci *et al.*, 2009; Su *et al.*, 2009). Women are interested in fields oriented towards “people” and men towards “things”.

It is very natural for an individual to perform better in an environment that is more suitable for them and has a scope for their progress. If one favors the work environment, they are likely to stay there for longer durations. This likability to a particular environment also influences career choice and performance. People choose to stay or leave based on these above factors, and it has numerous studies have shown that more than men, women have a stronger preference to work in environments that cater to people (Thorndike, 1911; Woodcock *et al.*, 2013), social interests (Su *et al.*, 2009; Robertson *et al.*, 2010), subjective task values (Meece *et al.*, 1982; Eccles, 2007), and communal goals (Diekman *et al.*, 2010; McCarty *et al.*, 2014). Women have consistently performed better than men in occupations that are people-orientated, and Men performed in occupations that are oriented toward things (Woodcock *et al.*, 2013). People-oriented career is contrary to engineering and Research. One has to spend hours together in labs, and it is likely to suit better for people who are oriented toward working with things. A study conducted with 47 interest inventories and 503,188 participants and was observed that males, on average, again scored more on a realistic scale that was based on things and gadgets. Females, on the contrary, scored more on the scale which measured helping people. (Su *et al.*, 2009). Also, a study conducted by (McCarty *et al.*, 2014) showed that the participants giving more preferences to communal goals showed deviance from the work environment that offered less scope for communal goals. It was observed that this communal goal adversely affected the person opting to pursue STEM careers. Since women scores have more interests in communal goals, there were unlikely to work in environments that offered less scope for the community, including the STEM field (Diekman *et al.*, 2010, 2011). This interest and preference towards the environment favoring communal goals affect the majority of women in STEM. Apart from interests, the difference in early childhood spatial ability can also contribute to the emergence of gender differences in mathematics and science later (Ceci *et al.*, 2009; Wai *et al.*, 2009). Sex hormones released further increase the spatial ability difference (Voyer *et al.*, 1995). The evolutionary reason that men had to cover the distance to hunt in the early day required spatial skills (Buss 1995, 2015).

FINDINGS AND DISCUSSION

The advancements in technology and progress made in education equity have still not seen a reduction in the Gender Gap in the fields of STEM over the past decades. The UNESCO reports from 2013 to 2017 have still shown a noticeable gender gap. Women are still underrepresented in the fields of Research and publications. The Gender Gap has been witnessed even in developed countries and in countries ranked highest in the world for gender equality. This is paradoxical because countries like Sweden, Finland, Switzerland, and the Netherlands are designing policies and reservations to create equal opportunities for both men and women. However, they also have noticeable gender gaps in STEM and Research. Well-developed countries like the USA are also seen as having such prominent gender gaps. Therefore, the problem must lie with the education policy rather than socio-economic status and gender inequality. Another question that can arise is, are women and men biologically attracted to individual career choices? If such is the case, then gender equality in some fields cannot be achieved and would instead be asking to deviate from their natural interest. However, stakeholders and policymakers must ensure that children are educated in a gender-neutral environment. The curriculum should not be gender-biased. The children should not experience any gender socialization towards a particular stream of study because of their Gender. The reasons derived from this article could also be used to provide solutions to create a non-biased curriculum. Students should be provided the necessary support at an early age from guidance on STEM, for example, familiarizing the use of technology amidst all Gender, stimulating the spatial memory, removing stereotypes within classrooms, and providing guidance to parents. Reducing the gender gap would create a larger workforce for women in STEM and increase the economy of a country and especially in the post-pandemic situation, since a greater demand for individuals in the field of STEM might arise soon.

CONCLUSION

There is a constant gender gap in the number of female students opting for STEM and choosing to work in this career. Even the countries ranked highest in the global equality index have shown some large gaps in STEM fields. Countries like Finland have girls performing better than boys in Science and Mathematics; however, they saw a large gender gap in STEM enrollment in Universities. Identifying these gaps is essential as working on these factors could provide us with the solution to make it attractive for the fall-out gender. Education systems should neutralize the gender gap; this can be implemented in early childhood education and schools; boys can be encouraged to read more. Girls can be encouraged to operate gadgets and technology, activities to improve spatial intelligence, and remove gender stereotypes. Students should be given equal opportunities to exercise their investigative interests and critical thinking skills. Workplaces also can be made more "people-oriented" with frequent peer interactions to make STEM careers attractive for a more significant number of females. Studies should be done to identify more reasons for the gender gap; these reasons can provide a solution for bridging the gender gaps in the field of STEM.

Conflict of Interest

The corresponding author states that there is no conflict of interest.

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