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A Sociological Study of the Gender Gap in Stem (Science, Technology, Engineering, and Math) Jobs: Pertinent to Indian Society

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Abstract

Gender gap is one of the prominent issues in academics and society, it is in economy, politics, society, education, administration, i.e., it is everywhere it is in STEM field also. Women are underrepresented in STEM field in our society which create significant challenges as we enter the era of digital transformation. This article studies the gender gap in science, technology, engineering, and math (STEM) jobs in India and tries to examine its causes and its various aspects in Indian society. Paper presents a descriptive analysis the overall related to individual, social, and behavioral factors that pose individual barriers for women in STEM jobs. It also explains the government's efforts to promote women in science and technology. In this study, it is tried to find the glass ceiling effect that constant opposition against women's efforts to succeed at STEM work and advance to top positions within the organization they work for. The results write down that the typical cultural view of girl's education discourages families from making the same investment in it that they do for boys. Finding has shown that society still associates STEM professions with having more masculine characteristics, which contributes to stereotypes that may deter girls and women from pausing STEM education and carriers.

Keywords: Gender Gap, Women, STEM Jobs, Stereotype, Glass Ceiling, Digital transformation.

Introduction

Women have historically been underrepresented in STEM professions at the professional level., such as the IT industry, science, the environment, and the climate Act. Women's lack of access to technology and digital tools makes them less likely to be part of the wider dominance of science, technology, engineering, and mathematics (STEM). (Baruah, 2017). In the sphere of scientific research, there is an even bigger gender gap. Marie Curie is the only woman to have received the Nobel Prize in physics (1903) and the Nobel Prize in chemistry (1911) twice. In India, only 29% of women who enrolled in STEM courses for graduation which made up 52% of the total students, entered the STEM industry, and the other hand, 3% of women enroll in PhD programs in the sciences, while only 6% choose to peruse a PhD in engineering and technology, according to all India survey on higher education 2018-2019. The key to changing the existing academic orientation, which is necessary for countering new forms of gender inequality, we will remove the hurdles that prohibit women from accessing the scientific, research, and technology sectors (Shapiro at al.,2011). To achieve equal and long-lasting transformation, India aspires to transformation through women's development. India's G20 agenda continues to place a priority on women's economic empowerment. Despite requests to increase the presence of women in the economy, there has been a continuous problem with the underrepresentation of women in STEM positions (G20 Ministerial conference of WCD, 2023). More women are increasingly studying and succeeding in engineering and mathematics of the most profitable STEM areas, as they fight against gender inequality and prejudice. In India, women graduate from STEM at a rate of 43%, which is the highest rate in the world, but only 14% of them enter the workforce, leading to a gender gap in the workplace (Cheryan, Ziegler Montoya, & Jiang, 2017). In addition, women should not pass up the opportunity to pursue rewarding, successful and lucrative professions in the STEM field, where the employment growth rate is three times higher than those non–STEM jobs (Landon et al., 2011). According to the annual All-India Survey on Higher Education (AISHE), while tracks admission in undergraduate, masters, and PhD programs, the proportion of Indian women who choose STEM as a subject of study has climbed by 53,388 during the past three years. This pattern of female representation in STEM fields is also prevalent in many Western societies and European nations. It is possible that there are not enough applicants with

the necessary skills to fill leadership roles since there aren't enough girls choosing to major in science (Kanter, 1977). In the STEM industry, only 3% of CEO positions are held by women, even at the C- suite level. It is not as though ladies are not interested in these topics. According to World Bank data, women make up 14% of scientists, engineers and technicians employed in research, and development organizations and universities, although they account for approximately 43% of all graduates in India in the fields of STEM, one of the highest percentages in the world (Kalra, 2023). That is far more likely to choose, stick with, and graduate from STEM areas when success expectations and the value of STEM disciplines are high (Eccles and Winfield, 1995; Sainz and Eccles, 2009; Wang et al., 2015). We must investigate and confront the underlying institutions that support inequality, such as discriminatory employment practices and limited access to education and training opportunities, to create equality that is sustainable. We can make sure that leadership positions are available to all talented and deserving people, regardless of race, gender, or socioeconomic background, by putting structural solutions to these problems into place (United Nation's Agenda 2030, 2015).There is evidence that among STEM women, fallings of incompatibility between their gender and STEM identities (i.e., the degree to which people perceive their identity as a woman or man to fit with their identity as a STEM member) are associated with a lower sense of belonging, a greater sense of insecurity, a lower level of motivation in STEM, as well as a higher expectation of leaving STEM (London et al., 2011). Experts point out, that in four houses; Girls are encouraged to study social sciences, while boys are encouraged to study sciences and math. This bias later extends to the recruitment of the STEM workforce; men hold a disproportionate share of entry level positions, and when women are hired, they experience imposter syndrome (Hill, Corbett, & St Rose, 2010). When digital literacy levels are favorable to women the cause of gender equality and women's needs are effectively promoted, and technology gives women the tools they need to reach their greatest potential (Antonio, & Tuffley, 2014). Through programs like "Beti Bachao, Beti Padhao," India has highly identified women's education as essential to reducing poverty. However, statistics show that just 33% of women have ever accessed the internet, and this number fall to about 25% for rural women. Findings from scholars' beliefs of STEM competencies and the gendered motivators that affect their decision to pursue an education, or a job have been the focus of a great deal of research (Hackett and Betz, 1981). However, gender

disparities still exist, and many girls find it difficult to peruse and, education, even in the era of the digital revolution and STEM education, which enables students to use digital literacy to develop innovative technical solutions to pressing issues in the modern world (OECD, 2018).

Glass Ceiling Effect in STEM Fields

The underrepresent of women in scientific research has gained international attention in recent years. There is a need action for more women to work in science is widely acknowledged as a means of enhance the diversity and depth of human knowledge and comprehension (Helman, 2020). In addition, women's perspectives on scientific research are kinder and more compassionate, which is equally important for modern economy to experience sustainable growth. The term "glass ceiling" describes the symbolic barrier that, because of discriminatory attitudes towards women, keeps women from moving up the corporate ladder past a particular point (Isakova and Luna, 2021). For instance, a woman may work just as hard and have the same credentials as her male teammate, yet she will never advance to a senior position. Gay Bryant, who was leaving her position as editor of jobholder magazine to take a position as editor of family Circle, first used the phrase in March 1984. Bryant was quoted as remarking, "Women have reached a certain point – I call it the glass ceiling," in a Nora Frenkel Adweek piece. They are at the top of the middle management chain, and they are stalling out. There just isn't place at the top for all those ladies. A few are starting their own businesses. Some are leaving to start families. In a 1984 chapter of the working Report: succeeding in Business in the 1980s, Bryant also used the phrase (Gray, 2003). Different government organizations, including the department of science and technology, have been actively supporting women scientists through a variety of specially created programs in recognition of the difficulties they meet (Aiello, Awschalom, Bernien, Brower, Brun, & Zwickl, 2021). These have helped a lot of women scientists and would – be scientists, allowing them to enter the scientific industry even after taking career interruptions (Preston, 2004). India ranks last among the nations studied by UNESCO, with just 14% of its researchers being female and working in STEM fields. however, isn't far behind many developed nations in this regard. For instance, just 16% of research in Japan are women compared to 26% in the Netherlands, 27% in the United States, and 39% in the United Kingdom. South Africa, Egypt, and Cuba all have almost similar numbers of female and male researchers,

with 45% of each country's researchers being female (Standing, 1989). Africa's Tunisia has the greatest percentage of female researchers (55%) followed by Argentina (53%) and New Zealand (52%). But what is worrying is that as you move up the ladder, the proportion of women in academic posts starts to decline (Amruta, 2022). When it comes to the overall number of women fellows in India's three science academies – 7% for the Indian Science Academy (INSA), founded in 1935; and 8% for the National Academy of Science India (NASI), founded in 1930 – even recognition of merit for women is sluggish. In the 20th century, it was extremely typical for women to face widespread bias due to misperceptions about their intelligence and ability to oversee the challenging process of doing research. The glass ceiling has been smashed and things have altered (Herminia, Robin, & Deboreih, 2013).

Objectives

- To explore the Gender gap in STEM jobs in India in recent years and find major causes related to this problem.
- To explore the government policies and provision of bringing the gender gap in STEM jobs.

Methodology

It is a descriptive study as it involves the problem of the gender gap in STEM jobs in India. The research data obtained for the present research is secondary in nature. The aforementioned information was gathered from several sources. For calculating the percentage of gender gaps in STEM, empirical evidence from earlier research investigations has been used. The Report of United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Children's Fund (UNICEF), and National Sample Survey Office (NSSO), were referred to for learning distinct aspects of the gender gap in STEM jobs in India. Within qualitative analysis, the interpretative approach has been used during this research work.

Literature Review

Makarover, Aeschliman and Herzog (2019) studied how the perceived masculinity of three academic disciplines - chemistry, math, and physics - affects secondary pupils' desires for careers in STEM professions. The information was gathered from a cross - sectional study of 1364 Swiss secondary school pupils who were nearing graduation. Findings showed that female students attribute the same levels of masculinity to all three academic areas, showing that they all perceived men as being equally masculine. As a result, among the group of male students, the attribution of masculinity to math differs from that of chemistry and physics, while that of chemistry and physics does not.

Castro, Halgado, and Gonez (2022) investigated how roles and stereotypes affect decisions about higher Education in STEM fields, and the research is having been done on the gender gap in higher education choices in STEM fields. The findings showed that the leaky pipeline and stereotype threat, as well as the gender gap in general, are all strongly influenced by gender preconceptions. Focusing on impacts from the home, the school setting, and the peer group, as well as from the outside itself, must reduce the gender gap.

UN Women (2020) report investigates the challenges women face in traditionally male - dominated fields, the ages at which gender differences in educational and career preferences appear, and samples teaching staff to investigate gender stereotypes and the role they play in defining the educational and career goals of students. The findings showed male- like vocations that enable those to keep a financially secure status more than women do. Such socialization methods may have an impact on how spatial abilities develop cognitively.

Chcerlesworth and Banaji (2019) studied gender inequality in STEM and examined recent data on representation, pay, and recognition (awards, grots, publications) gaps, highlighting variations among subfields (such as computer science vs. biology) and career paths. According to the study's findings, leaving aside the moral concerns about equal access, it is crucial to comprehend and manage the complex challenges surrounding gender in STEM because of the potential

advantages for both STEM and society that can only be achieved when full participation of all talented and qualified individuals is ensured.

Ragoobeer and Gokulsing (2021) studied on potential gender differences in STEM enrollment in Mauritius the study investigated a variety of personal, environmental, and behavioral factors that may affect participation is STEM education and profession, as opposed to previous studies that employed chosen parameters to measure the gender gap in STEM education. The result showed that when young women have the support of their families, schools, and teachers, they are more likely than their male counterparts to seek STEM degrees. Findings showed more proof that women are underrepresented in STEM fields and then they suffer greater obstacles that their male counterparts in these fields.

Current Situation of Gender Gap in STEM Jobs in India

After COVID caused mayhem throughout the world, there were fewer women overall working in India. According to a study from the wire, women made up 19.4% of India's employment force in 2021 – 2022 compared to 29.8% the year before. Men made up 8.1 percent of the population in 2020-2021 and 80.7% in 2021-2022, clearly suggesting an improvement in the numbers. What is even more alarming is that women in STEM fields are chronically underrepresented in India, making up just 28% of the field, emphasizing significant gender parity. Engineering and technology currently account for 14.5%, natural sciences and agriculture for 22.5%, and health science for 24.5%. In organization like the Council of Scientific and Industrial Research, the Defense Research and Development Organization, and the Indian Space Research Organization, among others, women hold important leadership and research positions. This is due to individual initiative as well as the emphasis placed on gender diversity by succeeding governments through subsidies and the rewiring of infrastructure for more inclusion. Even though 43% of Indian women hold degrees in STEM fields, just 14% of women hold leadership positions in the core engineering field. Only 14% of the 28,000 research scientists in India are female. Women have allegedly made headway in the STEM fields, but there is still more to be done in terms of research.

STEM Gender Stereotype in Indian Society and Student' Academic Aspirations

In the domains of Science, Technology, Engineering, and Mathematics (STEM), bias and gender disparities are still pervasive. Women in STEM face barriers, and gender stereotypes contribute to persistent discrimination and underrepresentation of women in STEM fields (Bian et al., 2017; Cimpian et al., 2016), which compound throughout a female scientist's career. According to studies, it is untrue that boys are superior to girls in math and science, which is a common prejudice (O'D ea. et al., 2018). Recent studies have shown an in – group bias among boys between the ages of 5 and 8 when asked "who is usually good at STEM" (McGuire, Mulvey, et al., 2020), which is consistent with the assumptions of the social identity approach. Middle childhood showed a stronger propensity for belonging to an in- group than adolescence. While boys were more likely to report in – group favoring responses to this stereotype measure throughout early childhood, middle childhood, and adolescence, females were less likely to report such reactions. Soon after receiving a PhD, which for most Indian women corresponds with marriage and family responsibilities, a career in science can be pursued (Trepte, 2013) s. Women who take breaks or short – term research employment for three to five years to balance a dual function are frequently at a disadvantage later in their careers (Martucci,2023). The same findings are supported by more recent Kelly global workforce insights survey (KGWI), which found that Indian women in STEM leave the workforce at critical points in their lives, particularly around reproductive years and later at mind – management levels. India now boasts one of the youngest labor forces in the world, but the proportion of people who are knowledgeable and skilled in STEM subjects is still small (Kohler,2015). A serious demand – supply imbalance is developing for workers with technology skills as most industrial sectors experience rapid digital transformation. Women being excluded from technological fields will only make the issue worse. A statistical difference was discovered about the impact of gender stereotypes on men and women's beliefs of how they affect their career aspiration (Schwab 2017). The findings proven that people differ in terms of gender stereotypes and career preferences in the construction industry. Overall, this study supports prior research's findings that gender stereotypes have a varied impact on men's and women's job decisions in STEM. A strong masculine image of math and science significantly lowers the likelihood that a female

student will choose a STEM major, whereas only a strong masculine image of math significantly lowers the likelihood that a male student will enroll in a STEM subject, which is consistent with our findings that gender – science stereotypes have a stronger negative impact on the aspirations of female than male students (Makarova, 2019).

Governmental Initiative to Increase Women Ratio in Stem Fields

- **GATI (2020)** an innovative pilot project is gender advancement for transforming institutions (GATI). It introduces an innovative intervention strategy to advance gender parity in science and technology. Through an open call, institutions of higher learning and research were asked to write down their interest in taking part in the GATI pilot. They had to complete an expression of interest (EoI) application that had been professionally written. The call attracted a lot of interest, and top – tier universities applied. Thirty institutions have been chosen to take part in the GATI pilot after thorough consideration of the data presented. The GATI charter on gender equity has received the support of every pilot institution.
- **PRAGATI (2014)** "Pragati Scholarship" was introduced by the MHRD in 2014-2015 and is being conducted by the All-India Council for Technical Education (AICTE) to encourage and support girls to pursue technical education. AICTE's Pragati program aims to support the advancement of girl's involvement in technical education. One of the most crucial ways to equip women with the knowledge, skills, and confidence they need to fully engage in the development process is via education. This initiative, "Empowering women Through Technical Education," aims to provide every young woman with the chance to further her education and get ready for a Prosperous future.
- **VIGYAN JYOTI SCHEME (2020)** The Vigyan Jyoti program seeks to achieve gender equity in STEM fields. The Primary goals of this program are to enhance girl's participation in the fields like science and Technology from an early age. Also, this program tries to create an environment that encourages and supports girls to pursue science from Elementary school through college and from research to the workplace.
- **CURIE (Consolidation of University Research for Innovation and Excellence Initiative, 2008-09)** DST launched a unique initiative called "CURIE" in 2008-09 to

assist female universities in enhancing their research infrastructure, Eight women's Universities across the nation have received CURIE Support, including Avinashilingam women's University in Mumbai (Maharashtra), Shri Padmavati Mahila Visvavidhyalayam in Tirupati (Andhra Pradesh), Mather Teresa women's University in Kodaikanal (Tamilnadu), Karnataka State Women University in Bijopur The ninth women's University, Bhagat Phool Singh Mahilavishwavidhyalaya in Sonipat (Haryana), will be supported by CURIE.

- **SERB – POWER (Science and Engineering Research Board – Promoting Opportunities for women in Exploratron)** To address the gender gap in science and engineering research financing in various S&T Programmed in India academic institutions and R&D labs, the SERB – POWER was Developed. To offer equal access and weighted chance for Indian women scientist engaged in research and development activities, SERB-POWER was specially created to give structure effort towards greater diversity in Research.
- **Bio-CARE (Biotechnology Career Advancement & Re – Orientation Programmed)** The Program's major goal is to further the careers of female scientists who are up to 45-year-old and for whom this is their first external grant. Medical biotechnology, plant and agriculture biotechnology, compounds of industrial and medicinal utility, animal and marine bioinformatics/ computational biology and environmental biotechnology & bioenergy are the areas of focus for support.
- **Indo – U.S. Fellowship for Women in STEM** The Department of Science and Technology (DOST) and the Indo – U.S. Science and Technology forum (IUSSTF) have announced the "Indo – U.S. Fellowship for women in STEM" (Science, Technology, Engineering, Technology and Medicine) to give Indian women Scientists, engineers, and Technologist opportunities to conduct international collaborative research in Prestigious institutions in the U.S.A.
- **Women in Engineering, Science, and Technology (WEST)** This is a new I – STEM (Indian science Technology and Engineering Facilities Map) initiative called "women in Engineering, Science and Technology (WEST)" was launched by Dr Pervinder Maini, scientific secretary. The WEST Program will support women with STEM backgrounds

and give them the tools they need to Participation in the ecosystem of science, technology, and innovation. I – STEM is a national web platform for exchanging research resources, and it serves as the hub for numerous initiatives aimed at fostering R&D and technologies innovation Partnerships between academics an industry, particularly startups.

International and National Organizations Collaborations in the Gender Gap in STEM

- **The National Science and Technology Medals Foundation (NSTMF)** The National Science and Technology Medals Foundation's (NSTMF) goal is to create welcoming STEM communities around the American society. The crucial, inspirational relationship are set up between the people who have won awards for excellence in STEM fields nationally and the varied generation of college and high school students is fundamental to these communities. They will open the door for a future in science and technology that is more faire when they work together.
- **The National Girls Collaborative Project (NGCP)** Founded in 2002, has supplied a welcoming environment for those devoted to advancing gender parity in STEM fields. The NGCP has contributed to the current and developing environment for girls in STEM by Optimizing access to common resources across projects and by enhancing the ability of current and involving programs by sharing outstanding practices. The NGCP brings together groups from all around the country that are dedicated to educating and inspiring girls to pursue careers in mathematics, science, technology, engineering, and computer science. NGCP employs a collective impact method that increases the capacity of educational programs and supports more than 35,000 programs throughout 41 states.
- **National Math and Science Initiative (NMSI)** was founded in 2007; it is a nonprofit organization with headquarters in Dallas, Texas. This organization's goal is to raise American students' performance in the STEM fields. NMSI strives to better prepare students for challenging mathematics and science courses in college, so they are prepared for careers in STEM – related fields. This is done at school system level.
- **National Center for Women and Information Technology (NCWIT)** In order to advance its goals and effect long – lasting change, NCWIT makes use of the knowledge

and ability of experts from many backgrounds. People with doctorates in a range of disciplines, including Education, Sociology, Communications, and Psychology, make up the research and evolution team at NCWIT. This team contributes to the NCWIT purpose by performing original research and evolution, translating existing research into practical recommendation, and developing research-based materials to raise awareness and motivate systemic change.

- **Women in Engineering Proactive Network (WEPAN)** A nonprofit organization called WEPAN advocates targeted, practical actions to create long term, system level improvement in the engineering higher education to workplace system. It also mobilizes research in gender, diversity, and inclusion. WEPAN is motivated by the notion that, to satisfy the needs of today's innovation – and performance – driven business culture, engineering must completely embrace diversity and inclusion. It is crucial to develop academic and professional cultures for students, staff and faculty that support inclusion and diversity in higher education for engineering. By cooperating with WEPAN's dedicated network of knowledgeable leaders and advocates, everyone can help creates that embrace diversity.
- **Million Women Mentors** One million science, technology, engineering, and math (STEM) mentors are needed to enhance interest and involvement of girls and women in STEM programs and occupations, according to Million women Mentors, a partnership of organizations from across the country. The possibility exists for mentors to include EXISTING mentorships they have already formed with people they know (such as research assistants, mentees through organizations like GWIS, and student's mentees). Simply register on the Million Women Mentors portal and keep track of the pledge. A different alternative is for mentors to CONNETCT with mentees through the Million Women Mentors website portal with one of 58 partners.

Potential Suggestions for Minimizing Gender Gap STEM

The gender gap can be reduced, and women's financial security can be improved by providing women with equal opportunity to look for and succeed in STEM occupations, Government and

international organizations should make sure that the following conditions are met to promote women's equality in STEM field.

- Recognizing the issues and understanding the impact of unconscious bias is the first step in improving the environment for women in STEM. The disparities between the number of women entering STEM fields and unconscious bias that arise during the educational process are both factors.
- Along with the men, it is important to promote the women who work in STEM fields. While men, who are contributing to sciences and technological field, are discussed in textbook, students are less familiar with significant contributions that women have made to the STEM field.
- There is a need for more organizations that support women entering STEM disciplines. Employee Recourses Group (EGRs) that offer guidance and support to women currently working in the sector can be a useful tool for keeping women on board. According to research, women in STEM profession report felling alone, unpleasant work situations, and a lack of effective sponsors as reasons why they leave the field.
- Girl looking to pursue careers in math or science should look up to women who work in such fields or own degrees in those fields. Young girls can be kept interested and have a lasting impact on their professional trajectories by being exposed to positive role models who are also their own gender.
- By developing fair and open recruiting, salary, evolution, and promotion procedures, make a significant contribution to dropping the gender pay gap in companies.
- Scholarship and grants in education can support the inclusion of women in STEM fields. To increase retention rates, these departments must make every effort to drop sexism and discrimination.
- While giving a variety of chances for kids to explore their interests, including those linked to STEM, such as coding camps and scientific competitions, parents should be careful to remind their children that they can grow up to conduct anything that they desire.

- Girls are more likely to claim they will pursue STEM fields of study later in their schooling if they engage in STEM clubs and activities outside of school.

Conclusion

A diversified strategy is needed to address the complicated issue of minimizing and closing the gender gap in STEM, from fostering a sense of family confidence in girls to providing incentives for women to enter and remain in the field, by giving women the flexibility to choose their own educational paths and job paths. Girl's accomplishment in STEM is affected by the persistent misconception that STEM fields and jobs are better suited for boys, and this stereotype may also result in less funding for girls' education. Even though there have been many programmed and regulations promoting female's education and general well-being, closing the digital and STEM divide globally still needs more focus and funding. After the pandemic, the world's economy is rapidly becoming digital, and the workforce is becoming more reliant on being able to use technology. If the gender digital divide is not closed in such a setting, it may have an impact on the gender balance in society and young girls' potential will go unrealized and they will continue to be underrepresented in STEM fields and other carrier opportunities. Girl will have more career possibilities and will be able to overcome hurdles to labor participation with increased digital adaptation and use enhancing digital education and participation in these subjects can be achieved by creating STEM clubs for girls or providing community- based digital skills and training for out of school females via community groups. We live in a digital age, so girls need to have access to comprehensive, high-quality education as well as digital literacy and skills to close the gender gap in STEM. Young, educated girls in India have great hopes to peruse professions in the sciences, but putting those aspirations in to practice is difficult due to familial pressure, societal preconceptions, a lack of organizational support, and the disparity in skills. Since, Indian society was considered as one of the traditional and male dominated can which some were treated as secondary sex. In modern period specially after independence, women were given their due respect. Even today gender gap is visible everywhere, but it is more in STEM fields. Fulfilling gender gap is not a task of one day or year, it is a process of decades in which systematic strategies, and stanning and actions are needed. Vision and dedication of governments and involvement of civil society can faster the minimizing gender gap.

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All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publications.

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