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## Gendered Pathways In Stem: Barriers And Opportunities For Women

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**Abstract:** *The ongoing gender-based restrictions that exist in STEM (Science, Technology, Engineering, and Mathematics) sectors continue to create a situation in which women are underrepresented. In this study, the problems and possibilities that shape women's participation in STEM fields are investigated. Systemic hurdles such as social prejudices, unconscious biases, a lack of mentoring, and discrimination in the workplace are highlighted as examples of these obstacles. In spite of these obstacles, a number of efforts, including as legislative interventions, educational reforms, and programs driven by business, have opened up new doors of opportunity for women. Particular attention is paid to the role that inclusive policies, mentorship networks, and institutional support have in the process of developing equal possibilities. According to the findings, there is a pressing requirement for ongoing efforts to eliminate gendered obstacles and establish a STEM environment that is more diverse and encouraging of inclusion.*

**Key words:** STEM, Pathways, Gendered, Barriers, Opportunities, women's participation, inclusive policies

**Introduction-** STEM, an abbreviation denoting Science, Technology, Engineering, and Mathematics, comprises a diverse array of essential disciplines that are instrumental in shaping contemporary society and delineating the future trajectory of national advancement. The promotion of STEM education cultivates critical thinking, logical and analytical reasoning, as well as problem-solving competencies, thereby laying the groundwork for innovative and sustainable solutions.

The areas of science, technology, engineering, and mathematics (STEM) continue to present substantial challenges for women, despite the enormous progress that has been made in the context of gender equality. The fields of science, technology, engineering, and mathematics (STEM) have traditionally been dominated by men. Due to cultural norms, institutional biases, and structural barriers, women's involvement and career development have been restricted. Despite the fact that there have been attempts made to encourage women to seek professions and study in STEM fields, the gender gap continues to exist, particularly in positions of leadership and fields that need a significant amount of research. The traditional limits on women continue to coexist with aspirations of empowering and educating them (Radhakrishnan, 2011). The study investigates the intricate relationship between social, cultural, and institutional elements that play a role in determining the career paths that women choose in STEM fields. The preconceptions that hinder young girls from interacting with STEM subjects, the absence of role models and mentors, and the issues of workplace discrimination, gender pay discrepancies, and work-life balance are all topics that are discussed in this article. This paper also addresses growing opportunities, such as regulatory efforts, corporate diversity programs, and the importance of mentorship in boosting women's careers in STEM fields. Specifically, this article focuses on female STEM professionals. The purpose of this research is to give a complete knowledge of the gendered paths in STEM fields for the purpose of providing practical measures to bridge the gender gap. The creation of a STEM environment that is more diverse and inclusive is crucial for the advancement of social development, economic growth, and innovation efforts.

**Methodology and Approach-** An all-encompassing perspective on women's engagement in STEM fields is presented in this article through the utilization of a qualitative research approach, which involves the synthesis of insights from academic literature, industry reports, and case studies. The study makes use of papers published in journals that have been subjected to peer review, reports such as AISHE, JEE report and from organizations such as UNESCO, and data from projects that promote gender equality in STEM fields. An approach known as thematic analysis is utilized in order to identify and classify the obstacles that women encounter in the STEM fields. These topics, which provide a structured framework for debate, encompass difficulties that are specific to individuals, institutions, and society as a whole. In addition to this, the research investigates various programs and initiatives that have been successful in reducing gender disparities. For instance, case studies from businesses that have successfully implemented mentoring programs and policy reforms are given in order to highlight successfully implemented techniques. In addition to this, the essay makes use of both historical and current data in order to investigate patterns of male and female engagement in STEM disciplines. As an additional feature, it contains accounts of



pioneering women in STEM fields, both from the past and the present, in order to contextualize the progress that has been done and to highlight areas that require further attention. Using a combination of historical research, thematic classification, and case studies, the purpose of this page is to provide a complete resource for understanding the obstacles, progress, and future prospects for women in STEM fields.

**Pioneering Women in STEM-**Among the pioneers who have forged a path for future women scientists are Kadambini Ganguly, recognized as India's first female physician and practitioner (1886) of Western medicine in South Asia; Rupa Bai Furdoonji is acknowledged as the world's first female anesthetist (1888). Bibha Chowdhary is honored as India's first woman high-energy physicist and the first woman scientist at the Tata Institute of Fundamental Research (TIFR) in 1948; the illustrious botanist and plant cytologist Janaki Ammal served as the first Director of the Central Botanical Laboratory at Allahabad in 1952 and was the first Indian scientist to receive the Padma Shri award in 1977; Kamala Sohonie, the first Indian woman to earn a Ph.D. in a scientific discipline; Debala Mitra, the first Indian archaeologist to assume the role of Director General of the Archaeological Survey of India in 1981.

Rajeshwari Chatterjee, was instrumental in advancing research within the domain of microwave engineering, became the first female engineer at the Indian Institute of Science (IISc), joining the Department of Electrical Communication Engineering in 1952; Anna Mani, recognized as the first woman to be inducted into the Meteorological Department in Pune in 1948, made substantial contributions in the areas of solar radiation, ozone, and wind energy instrumentation. Archana Sharma became the first female recipient of the esteemed Shanti Swarup Bhatnagar Prize in the Biological Sciences category in 1975. Tessy Thomas famously called as missile woman of India is the first woman scientist to lead a missile project in India; Sanghamitra Bandopadhyay holds the distinction of being the nation's first female Computer Scientist and the Director of the Indian Statistical Institute as of 2015; Soumya Swaminathan became the first Indian to assume the position of Deputy Director General at the World Health Organization (WHO) and also its inaugural chief scientist; GC Anupama is celebrated as the first woman to serve as the President of the Astronomical Society of India in 2019. ("Indian Women Scientists"). Minnie Vaid's publication, *Those Magnificent Women and Their Flying Machines*, underscores the significant contributions made by women scientists towards the successful execution of Mangalyaan. Among the scientists entrusted with critical responsibilities during the mission's implementation were Ritu Karidhal, Nandini Harinath, Anuradha TK, Moumita Dutta, and Minal Rohit. In the realm of Mathematics, Shakuntala Devi emerged as an internationally acclaimed mathematical prodigy, endowed with an extraordinary capability to perform highly intricate mathematical calculations mentally at a velocity surpassing that of contemporary computers, thereby earning the epithet of Human-Computer. Sudha Murthy achieved the distinction of being the first woman engineer recruited by India's largest automobile manufacturer, TATA Engineering and Locomotive Company (TELCO). She commenced her role as a Development Engineer in Pune during a period when female employment in such positions was virtually nonexistent. Upon discovering that the job vacancy was exclusively open to male candidates, she proactively reached out to JRD Tata through a postcard, articulating her concerns regarding gender discrimination at TELCO. Sunita Sarawagi, professor at IIT Bombay is celebrated for her groundbreaking research in databases and data mining. Her work focuses on extracting valuable insights from large datasets, revolutionizing and contributing to data management systems. Sudha Bhattacharya is renowned for her contributions to molecular parasitology. Her work has led to groundbreaking discoveries in gene regulation and parasite biology.

However, despite the fact that women have made significant contributions to the fields of science, technology, engineering, and mathematics (STEM) throughout history, their efforts have frequently been overlooked owing to gender prejudices and cultural conventions. The tight gender roles that were enforced by societal standards frequently restricted the chances available to women in terms of education and professional advancement. These pioneers were not deterred by the difficulties associated with their work; rather, they cleared the path for subsequent generations. It is because of their resiliency that there is a pressing need for structural adjustments to acknowledge and promote the contributions that women make in STEM fields, therefore eliminating prejudices that continue to exist to this day.

**Persistent Gender Gaps-** In spite of advances, gender disparities in STEM fields continue to exist, which is a reflection of institutionalized problems. It is clear from present data that there is a significant gender gap in the participation rates of women in STEM fields.

Women's involvement in professional coaching is an example of gendered STEM participation. In addition to the class XII exams, there are entrance tests for engineering colleges and universities. Research indicates that female students are underrepresented in engineering entrance test tutoring centers (Singh &



Pathak, 2010). For women, the circumstances surrounding medical admission are different. Girls seem to take more medical entrance examinations than boys do, in contrast to engineering entrance tests. For example, approximately 56.4% of students enrolled in medical and dentistry programs who took the national entrance test (NEET-UG) in 2018 were female (Singh, 2018). According to Gupta (2020a), the percentage of girls enrolled in medical coaching does not fall below that of boys.

The All India Survey on Higher Education (AISHE) for the academic year 2021-22 provides an in-depth analysis of the higher education landscape within the nation, wherein data is gathered from various Higher Education Institutions via online platform. The report indicates that the total enrolment in STEM disciplines (at undergraduate, postgraduate, M.Phil., and Ph.D. levels) amounts to 98,49,488, comprising 56,56,488 male students and 41,93,000 female students. In the Engineering and Technology sector, there are 34.71 lakh enrolled students. The data reveals that 71.2% of the enrolled students in Engineering are male, while the participation of female students remains disproportionately low. The enrolment figures in the Science stream stand at 25.33 lakh, with male students constituting 51.7% and female students making up 48.3%. The context appears marginally improved for Science degrees, where the female enrolment, although less than that of male students, does not exhibit a substantial discrepancy. The representation of women within Engineering disciplines has witnessed minimal enhancement, rising from 28.8% in 2012-13 (as reported by AISHE 2012-13) to 29.14% in 2021-22 (as per AISHE 2021-22). ("Department of Higher Education")

**Barriers faced by women in STEM-** Women in STEM fields face a variety of obstacles that have a negative impact on their advancement, ranging from the expectations of society to the obstacles imposed by institutions. Perceptions of women's roles in Science, Technology, Engineering, and Mathematics (STEM) disciplines have been impacted by cultural and social prejudices for a long time. These biases have contributed to the perpetuation of gender stereotypes that may discourage women from pursuing jobs in technical professions. The assumption that men are more suited to logical and technical fields is frequently reinforced by society standards at a young age. On the other hand, women are encouraged to pursue positions that are viewed as caring or artistic (Dasgupta and Stout, 2014). Because of these prejudices, educational choices are influenced, and as a result, fewer females choose to major in topics such as mathematics and physics (Sttefens et al., 2010). This cultural reinforcement frequently takes the form of subtle manifestations, such as instructors and parents unknowingly discouraging females from pursuing technical interests or portraying STEM disciplines as "male-dominated" subjects. These prejudices are further compounded by the depiction in the media. In popular culture, women who work in STEM fields are underrepresented, and when they are shown, they frequently play supporting or secondary roles. Women in STEM fields have additional obstacles in the workplace as a result of cultural prejudices. These problems include "double bind" circumstances, in which women are required to reconcile opposing expectations, such as trying to be strong enough to lead without being so aggressive that they are perceived as unlikable. These obstacles not only make it more difficult for women to develop in their careers, but they also lead to greater rates of disengagement among women working in technical disciplines.

**Educational Barriers-** Girls are influenced by gender stereotypes from a young age, which might have an effect on how they view their capabilities in STEM fields. Several studies have shown that cultural standards frequently prevent females from pursuing careers in science and mathematics, which results in a gender gap in education related to STEM fields. The option to attend a reputable institution farther away is lost when parents choose to send their girls to nearer institutions (Gupta, 2012). Another factor that contributes to the severity of this problem is the dearth of female role models, which makes it challenging for young women to see themselves achieving success in these disciplines (Goodman and Damour, 2011). There is also the possibility that their self-confidence and academic performance might be negatively impacted by unconscious biases in the teaching techniques and evaluation standards, which would discourage them from continuing higher education in STEM fields.

**Workplace Barriers-** Even if women are successful in overcoming educational obstacles, they still face barriers in the job. A significant contributor to the discrepancies in professional progress is the presence of gender prejudice in the recruiting process, promotions, and pay negotiations. 'Awareness of a dual burden on women affects hiring', a junior female scientist stated in a study (Gupta, 2016) on central government research labs. For any position, the woman must demonstrate her superiority over a man. Due to their ability to work longer hours than women, male department heads prefer hiring male faculty. A phenomena known as the 'leaky pipeline' occurs often among women working in STEM fields. This phenomenon delineates a clear disparity between female student enrolment, their subsequent employment rates, and the attainment of



leadership positions. In addition, cultures in the workplace that are not inclusive can provide an atmosphere that is unwelcoming, which makes it harder for women to succeed.

**Structural and Institutional Challenges-** It is still difficult for women to advance in STEM fields because of the institutional restrictions that exist inside both academia and industry. Policies and institutional structures frequently fail to provide sufficient support for women who pursue jobs in STEM fields. Nearly all of the female scientists surveyed for a study (Gupta & Sharma, 2002), agreed that regional mobility and connections and networking with other scientists are crucial for achieving success in a scientific career; merit alone is not enough. Systemic hurdles are created by problems such as inadequate policies around parental leave, restricted access to leadership posts, and uneven financing for research. Women who work in academic and research disciplines typically face challenges while attempting to get grants and financing, which hinders their capacity to carry out independent research and achieve reputation in their particular professions. Furthermore, women working in STEM professions report greater incidents of harassment in the workplace, which further contributes to the high rates of employee turnover.

**Personal and Psychological Hurdles-** Personal and psychological obstacles, such as impostor syndrome and a dearth of role models, have a substantial influence on the experiences that women have and their ability to remain in STEM professions. Despite their apparent accomplishments, women in STEM fields are disproportionately more likely to report experiencing impostor syndrome, which is characterized by feelings of self-doubt and inadequacy. According to studies, as many as seventy percent of women working in STEM fields have encountered impostor syndrome at some time in their professional lives. At times, women may impose self-inflicted limitations and engage in potentially detrimental behaviors on a daily basis from a professional standpoint, such as occupying the rear seats in meetings, refraining from volunteering for assignments, and withholding suggestions, among other actions. Women often evaluate their professional aspirations in relation to prospective life events that have yet to materialize—such as the prospect of marriage or childbirth (Sandberg, 2013). For instance, women may decline promotional opportunities due to concerns about being relocated away from their preferred work environment. Throughout their careers, if domestic and familial obligations appear to be overlooked, women typically prioritize these responsibilities, occasionally at the expense of their professional advancement. Women frequently restrict their career progression due to familial and societal pressures, as well as the expectations imposed by others. Additionally, these psychological obstacles have an impact on one's confidence when it comes to applying for leadership posts or initiatives with high risks. Research has indicated that female leaders are assessed with a degree of negativity that is somewhat more pronounced than that directed towards their male peers (Eagly, 1992). According to research, women are less inclined to apply for employment unless they satisfy all of the requirements, but men are more likely to apply even if they only meet sixty percent of the requirements. Unfortunately, this reluctance frequently leads to the loss of possibilities for professional progress. For women working in STEM fields, the establishment of supporting networks and opportunities for mentorship is necessary in order to address these issues. It is possible to lessen the impact of impostor syndrome by the implementation of programs and initiatives such as peer groups, sponsorship programs, and leadership training. Furthermore, raising the visibility of women in STEM disciplines through the media, conferences, and academic forums may instill confidence in the next generation of women and encourage them to pursue and succeed in these professions.

**Opportunities for Women in STEM-** Various measures have been put into place to enhance gender diversity and inclusion in STEM fields, despite the obstacles that have been presented below. Policy-level interventions, mentoring programs, and business efforts are the categories that may be used to classify among these options.

**Policy Interventions-** There is a growing awareness among governments and international organizations of the need of addressing gender imbalances in STEM fields. Some of the factors that have contributed to the progressive growth in female involvement include affirmative action initiatives, policies that promote equal access to STEM education, and scholarships for women who are pursuing careers in science. The Indian government is likewise dedicated to increasing the number of women in STEM fields. This is demonstrated by a number of initiatives, including KIRAN, which addresses concerns like career breaks, relocation, training, and women's university infrastructure. The Indo-U.S. Fellowship for Women in STEM is another project that acknowledges the need of giving bright women in STEM the chance to advance their research skills. In addition, organizations such as the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the United Nations Women's Organization (UN Women) promote for gender-inclusive policies in order to cultivate a more equitable STEM landscape.





**Mentorship and Networking Programs-** When it comes to directing and maintaining women in STEM professions, mentoring is an extremely important strategy. Support, advice, and chances for professional advancement are provided by programs such as Women in Engineering (WIE), the Association for Women in Science (AWIS), Vigyan Jyoti scheme and mentorship efforts funded by corporations. These programs are extremely beneficial. These networks assist women in overcoming obstacles, enhancing their self-confidence, and establishing connections with influential figures in their field who can advocate for their success.

**Corporate and Institutional Initiatives-** An increasing number of organizations and businesses are making concerted efforts to establish inclusive working environments. It is becoming increasingly popular for organizations to implement diversity and inclusion initiatives, flexible work practices, and leadership training for women. GOAL (going online as leaders) initiative of Meta is a success story of such affirmative actions. Biocoin Limited, a biopharmaceutical firm offers maternity leave beyond timeline set by the government. After the allotted period, women may continue to take unpaid leave after speaking with their superiors. Non-profit organizations that place a priority on gender diversity not only cultivate an atmosphere that is welcoming, but they also reap the benefits of improved innovation and production. Companies in the technology sector, research institutes, and educational institutions have started establishing systematic diversity initiatives with the goal of reducing the gender gap in STEM career fields.

**Digital Platforms for STEM Education-** A revolution in science, technology, engineering, and mathematics (STEM) education has been ushered in by digital platforms, which have democratized access to learning materials and encouraged worldwide collaboration. Because of these innovations, formerly insurmountable obstacles like distance, cost, and lack of institutional support are now much easier to surmount. Coursera, edX, and Khan Academy are just a few of the many online resources where students may get STEM classes at no cost or a very little cost. Everything from elementary computer science to advanced data science is covered in these classes. Regardless of their location, students may receive high-quality knowledge from prestigious colleges through these channels. This type of program may be seen, for instance, in Coursera's "Women in STEM" project, which provides targeted education to encourage more women to enter STEM occupations and further their careers in these areas.

Labster and similar virtual labs allow students to practice doing experiments in simulated settings with limited resources, which is a great way to enhance STEM teaching. A global learning community has also emerged as a result of Massive Open Online Courses (MOOCs). Programmes like IBM's Skills Build and Google's Computer Science First aim to increase participation from traditionally underserved demographics, such as women. Digital platforms also play a crucial role in providing opportunities for mentorship and networking. Virtual events, webinars, and discussion forums bring students together with experts in the area and their peers, creating a space that is welcoming to women in STEM careers. Platforms like SheCanSTEM that combine education and coaching help women keep their jobs and advance in their professions. Digital platforms are crucial for closing the global STEM education achievement gap. These platforms are vital in advancing gender equality and expanding opportunities for women in technical fields because they remove barriers to entry and make knowledge widely accessible.

**The Ripple Effect-** Currently, women working in STEM fields are at the forefront of innovative initiatives that are addressing some of the most important problems facing the world today. As a result of their work, which encompasses a wide range of sectors, from artificial intelligence to renewable energy, they demonstrate the revolutionary influence that female leadership in science and technology can have. The achievements of trailblazing and modern-day women in STEM fields have set off a chain reaction, encouraging and enabling subsequent generations to seek employment in these fields. In order to combat prejudices and promote diversity, it is essential that female role models be visible in STEM fields. For instance, a research discovered that females are more likely to pursue jobs in STEM fields when they are exposed to female role models in science and engineering. Media and educational resources also have a significant impact. Role models have an effect that goes beyond the classroom. A strong network of female role models for aspiring STEM workers is fostered by the mentorship and outreach efforts of successful women in the field. For example, programs such as Women in Tech provide an environment that supports and encourages growth by offering mentorship, networking, and skill-building opportunities. The diversity of the workforce is another area that feels the effects of the ripple effect. Because diverse teams contribute fresh viewpoints to problem-solving, companies that aggressively seek to increase the number of women in STEM see an uptick in retention and creativity. These pioneers are influencing the future of science,



technology, engineering, and mathematics (STEM) and social justice by serving as role models for younger generations.

**Conclusion-** The persisting gender disparity in STEM areas underlines the necessity of continuing efforts to overcome structural barriers and develop opportunities that are inclusive of women while also addressing the gender imbalance. Despite the fact that women's involvement has traditionally been restricted due to obstacles such as gender prejudice, cultural preconceptions, and institutional restraints, focused interventions such as mentoring programs, regulatory changes, and awareness campaigns are helping to bridge the gap between the two groups. The promotion of gender diversity in STEM fields is not only necessary for the achievement of social fairness, but it is also critical for the advancement of scientific innovation and the expansion of the economy. It is possible for society to realize the full potential of varied talent if they create an atmosphere that fosters women's participation in STEM fields through education, career assistance, and legislative measures. A concerted effort from governments, educational institutions, corporations, and communities is required in order to address gendered paths in the STEM fields. It is only through a long-term commitment and inclusive tactics that we will be able to establish a future in which women have equal opportunity to excel in STEM fields, so contributing to a world that is more inventive and egalitarian..

### REFERENCE

1. AISHE (2020). All India survey of higher education 2019-20. MHRD. Government of India. [https://www.education.gov.in/sites/upload\\_files/mhrd/files/statistics-new/aishe\\_eng.pdf](https://www.education.gov.in/sites/upload_files/mhrd/files/statistics-new/aishe_eng.pdf)
2. Amirtham S, N., & Kumar, A. (2023). The underrepresentation of women in STEM disciplines in India: a secondary analysis. *International Journal of Science Education*, 45(12), 1008-1031.
3. Bhowmik, D. (2023). Gender inequality in higher education and research.
4. Borkar, S., & Kumar, N. A. Indian Women in Science. *Transforming India 2030: Strategies for Sustainable*, 123.
5. Chakrabarty, B. (2010). Some additional aspects of gender asymmetry. *Current Science*, 99(4), 420.
6. Chaubey, P. Industrial Revolution 4 and Indian Women in STEM: Challenges and Prospects. *National Development*, 9.
7. Committee on Science, Public Policy, Committee on Maximizing the Potential of Women in Academic Science. *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering*. National Academies Press; 2007 May 4.
8. Dabas, B. (2021). Publication productivity of women physicists in India: A scientometrics study. *Library Philosophy and Practice*. (e-journal). 5624 <https://digitalcommons.unl.edu/libphilprac/5624>.
9. Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences*, 1(1), 21-29.
10. "Department of Higher Education." Aishe.Gov.In, [aishe.gov.in/aishe/gotoAisheReports](https://aishe.gov.in/aishe/gotoAisheReports). Accessed 8 Mar. 2024.
11. Eagly, A. H., Makhijani, M. G., & Klonsky, B. G. (1992). Gender and the evaluation of leaders: A meta-analysis. *Psychological Bulletin*, 111, 3-22.
12. Gupta, N. (2012). Women undergraduates in engineering education in India, A study of growing women's participation. *Gender, Technology and Development*, 62(2), 153–176. <https://doi.org/10.1177/097185241201600202>
13. Gupta, N. (2016). Perceptions of the work environment, the issue of gender in Indian scientific research institutes. *Indian Journal of Gender Studies*, 23(3), 437–466. <https://doi.org/10.1177/0971521516656079>
14. Gupta, N. (2020a). *Women in science and technology, confronting inequalities*. SAGE.
15. Gupta, N. (2023). Women in STEM in India: Understanding challenges through social constructionist perspective. *American Behavioral Scientist*, 67(9), 1084-1103.
16. Gupta, N., & Sharma, A. K. (2002). Women academic scientists in India. *Social Studies of Science*, 32(6), 901–915. <https://doi.org/10.1177/030631270203200505>
17. Jean G. The Role of STEM Education in Breaking Gender Barriers: Strategies for Enhancing Female Representation in Technology and Innovation.
18. JEE Report (2018). JEE advanced report 2018. Joint implementation committee report (Volume I). IIT Kanpur. [https://www.iitk.ac.in/new/data/jee-report/1\\_JEE\\_2018\\_Vol\\_1.1\\_1.2-28-2-19.pdf](https://www.iitk.ac.in/new/data/jee-report/1_JEE_2018_Vol_1.1_1.2-28-2-19.pdf)
19. Kumar, N. (2001). Gender stratification in science, An empirical study in the Indian setting. *Indian Journal of Gender Studies*, 8(1), 51–67. <https://doi.org/10.1177/097152150100800103>