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Women's Participation in Stem – Challenges and Recommendations

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Abstract

STEM education aims to create and offer original answers to international problems, particularly those directly connected to the 2030 Sustainable Development Goals. It is already common knowledge that the connections between the fields of science, technology, engineering, and mathematics are growing stronger, penetrating the workplace, and posing new challenges for resolving everyday work-related issues. Many academics and decision-makers have remarked that historically few women have entered the fields of science, technology, engineering, and mathematics (STEM), which have remained dominated by men. Since women and girls make up half of the global population, it is essential to advance gender equality in STEM fields in order to meet the Sustainable Development Goals and provide a better future for all. Researchers are looking into the numerous causes of the persistent gender gap in STEM disciplines. Those who think that discriminatory pressures are to blame for this gap are also looking for strategies to close it in STEM professions. This paper analyses the current situation of women in the STEM field in India and tries to find out the reasons behind their low participation like prejudices and biases, college curricula, and the work environment which are some of the causes of the underrepresentation of women in these sectors. This paper also suggests strategies for overcoming the challenges of lower participation of women in the STEM field.

Keywords: *STEM, Sustainable Development Goals (SDGs), Stereotypes, GATI Scheme, and KIRAN scheme.*

Introduction

In order to address the growing concern that many students wouldn't be capable of keeping pace with, and might be left behind, in the worldwide competitive economy driven by an increase in demand for STEM-related skills and competencies, the US National Science Foundation first proposed STEM in the 1990s. An integrated or interdisciplinary approach to STEM education seeks to advance and coordinate efforts to give students a solid theoretical grounding that will enable them to come up with novel solutions to societal and global issues.

The *U.S. National Science Foundation's* scientific administrators first used the abbreviation *STEM in 2001.* (NSF). When referring to the job fields in those disciplines or a curriculum that incorporated knowledge and abilities from those subjects, the organization previously used the acronym SMET. It is a curriculum built on the idea of teaching students in 4

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distinct subjects - science, technology, engineering, and math — using an applied, interdisciplinary approach.

History of STEM

The acronym STEM is not wholly new. Science was created as a result of the exploration of the study of objects in their environs by early Greeks like Hippocrates and Aristotle. The Pythagoreans introduced the study of mathematics as a demonstrative subject in the sixth century BC. Since the beginning of time, when people created innovations like wedges and pulleys, engineering has involved the design, building, and use of devices, systems, and processes based on scientific and mathematical principles. The history of technology began with stone tools and practices that date back millions of years.

The four Industrial Revolutions (IRs) have led to enormous advances in industrial technology, which have had a profound effect on human civilization and daily life. The steam engine was initially invented in the 18th century, totally revolutionizing the manufacturing and transportation industries. The second Industrial Revolution (IR) in the 19th century saw the advent of electricity and mass production. The third industrial revolution of the 20th century brought with it semiconductors, computing, and internet use, all of which have contributed to the globalization of communication and trade.

The fourth industrial revolution (4th IR) is currently in full swing, and it is a time of unheard-of invention and quickly developing technological breakthroughs that have accelerated the digitalization and the amalgamation of technologies that transform and smudge the limitations between the physical, digital, and biological spheres. Numerous 'unthinkable' developing technologies, such as those in the fields of robotics, artificial intelligence, the Internet of Things, 3D printing, autonomous cars, quantum computing, and nanotechnology, are altering our daily life. Our understanding of the creation of goods and services as well as corporate management is already evolving as a result of the 4th IR. Together, these developments have repositioned the value of STEM and the contribution that STEM competencies make to productivity, economic growth, and satisfying future demand.

STEM and the world

The basic aspect of STEM is the application of information from the fields of science, mathematics, technology, and engineering to everyday or societal issues. This makes the study of STEM subjects more relevant and meaningful. STEM literacy is described as having the knowledge, attitudes, skills, and values necessary to

recognize issues and challenges in real-world scenarios.

- Understanding of the distinctive characteristics of STEM disciplines as forms of human knowledge, inquiry, and design;
- Awareness of how STEM disciplines shape our material, intellectual, and cultural environments;
- Willingness to participate in STEM-related concerns with the concepts of science, technology, engineering, and mathematics as a productive, concerned, and insightful citizen.

In order to address global issues like poverty, climate change, food shortages, and the protection of the environment, the *United Nations' 2030 Agenda* for Sustainable Development, titled *"Transforming our World," established 17 Sustainable Development Goals (SDGs).* These goals also work to ensure that everyone has access to peace, prosperity, and a high standard of living.

The SDGs can only be achieved with the help of education, especially STEM (Science, Technology, Engineering, and Mathematics) education. SDG 2 (Zero Hunger); SDG 3 (Good Health and Well-Being); SDG 6 (Clean Water and Sanitation); SDG 7 (Affordable and Clean Energy); SDG 9 (Industry, Innovation and Infrastructure); SDG 12 (Responsible Consumption and Production); SDG 13 (Climate Action); SDG 14 (Life Below Water); and SDG 15 are among the specific global issues that STEM education aims to elaborate on and offer creative solutions to (Life on Land). Moreover, advancements in the STEM domains are crucial for achieving SDGs 8 (Decent Work and Economic Growth) and 11 (Sustainable Cities and Communities). The contribution of STEM to achieving the SDGs in the context of Industry 4.0 is essential. (UNDP, 2019).

It has been noted that *Women,* who make up *half of the global population,* are essential for sustainable development. Despite having severe restrictions on access to and control over these resources, women play a critical role in their management, conservation, exploitation, and consumption as consumers and educators.

One of the key issues for sustainable development is the empowerment of women. While many nations have achieved gender parity in primary education, there is still a sizable gender difference in higher education. Women are graduating from colleges and universities in greater numbers, but they still make up a disproportionately small portion of the STEM (Science, Technology, Engineering, and Mathematics) workforce (STEM). In addition to gender inequities in

employment, academic promotions or seniorship, funding possibilities, and publications, systemic hurdles prohibit women from pursuing careers in research. Additionally, most women put in more time and effort than males do while earning less money in teaching, mentoring, partnerships, and other academic activities.

Significance of the Study

This study tackles this perplexing subject and paints a picture of what we know about girls and women in scientific fields—and what needs to be learned. The paper focuses on realistic ways that communities, schools, and families may foster an environment of support and dispel myths about women's ability to succeed in these hard industries. This study fosters interest in these subjects by encouraging girls' confidence in their capacity to learn math and science.

Objectives

- The main goal of this investigation is to examine and determine the difficulties that women encounter in their careers and the coping strategies they can employ.
- This paper analyses the current situation of women in the STEM field in India and tries to find out the reasons behind their low participation like prejudices and biases, college curricula, and the work environment which are some of the causes of the underrepresentation of women in these sectors.
- This study highlights the various Government initiatives to promote women's participation in India.
- This paper also suggests strategies for overcoming the challenges of lower participation of women in the STEM field.

Methodology

This exploration is a descriptive study. The necessary secondary data was collected from assorted websites including those of the Government of India, magazines, journals, other publications, etc. A large number of academic articles on the subject of women in science and engineering were reviewed using a variety of databases, including Web of Science, ProQuest, Social Science Citation Index, and J-STOR. This data was analysed and reviewed to arrive at the consequences and conclusions.

Indian Women's Participation in STEM

One of the nations that produce the most scientists and engineers in India, and during the past several years, STEM has seen substantial growth. A symposium on women in science, technology, engineering, and mathematics (STEM) was held on November 24, 2021, jointly organized by the Department of Science & Technology (DST) Govt. of India and the Ministry of Innovation, Science and Technology

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(MOIST), Israel. It was noted that in order to increase the participation of women in STEM fields, flexible work schedules and gender-neutral compensation must be implemented. ((DST), 2021)

According to Article 51A of the Indian Constitution, every citizen of India has a responsibility to cultivate a scientific temperament, humanism, and the spirit of inquiry and reform.

Critical thinkers, problem solvers, and innovators for the future generation are produced through a strong STEM education. The National Science Foundation predicts that 80% of the occupations that are produced in the upcoming ten years will require some level of math and science expertise. *India has the largest percentage of female STEM graduates (43%), however just 14% of STEM positions there are held by women. (Times, 2022) In Indian* STEM, the fraction of graduates who finally secure STEM jobs has always been of more concern than the overall number of female graduates.

By offering flexible work schedules and gender-neutral compensation to increase women's engagement in STEM, Science & Technology (S&T) might become a changemaker in society. S&T has transposed into the economic sphere and institutions are constructed in this way. Women will become stronger and more influential as they participate more in the tech industry, which will improve their socioeconomic standing in society. It is impossible to disregard or minimize the institutional, familial, social, and cultural variables that contribute to the gender gap in STEM in developing nations. In the end, there are fewer female role models for girls and fewer mentoring possibilities as a result of the lower number of female scientists in STEM subjects. Studies on the proportion of women holding senior positions in academic institutions indicate that unconscious and unintentional gender bias is widespread and that it can make it difficult for women to advance in their careers, receive recognition for their accomplishments, be nominated for leadership roles, or be perceived as leaders.

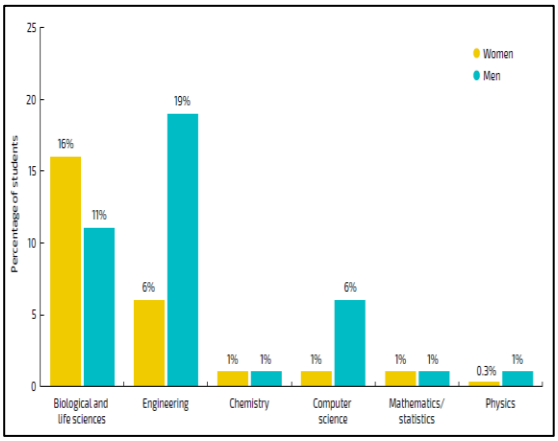

Fig.1: Intent of First-Year College Students to Major in Stem Fields, By Gender, 2014
Source: AAUW Analysis of Eagan Et Al. (2014).

According to World Bank data, there are fewer female STEM graduates than male STEM graduates in 107 of 114 economies.

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In postsecondary education around the world, 18% of girls choose STEM majors compared to 35% of guys. Women tend to major in the living sciences, even in STEM subjects, and are underrepresented in fields like computer science and mechanical and electrical engineering. Only 33% of researchers worldwide are female. Only 22% of artificial intelligence experts and 28% of engineering students are women.

The situation is significantly better in India, where women make up roughly 43% of all STEM graduates. Despite the fact that just 14% of scientists, engineers, and technologists work in research development institutions and universities, it is one of the highest in the world. (Times, 2022)

Despite the enormous achievements that women have made in recent years, the evidence shows that they are still underrepresented in academics. Particularly among individuals who pursue higher education and progress in their research careers, there is a gender disparity.

Challenges faced by women in STEM

There are many different reasons put forth as to why there are so few women working in STEM disciplines. These can be broadly categorized into innate, social, and psychological explanations. The prominent reason reported experiencing stress at work. Females may experience greater stress as a result of harassment, biased peer and student evaluation, and familial duties in addition to gender bias experienced during appointments, promotions, and career growth chances. Females can achieve work-life balance with the help of their family's financial support, household management, secure childcare facilities, flexible work hours to suit family responsibilities and the support of their female research colleagues.

Nearly 50% of females did not achieve a work-life balance. (Farah Naaz Fathima, 2020) This might be brought on by a lack of a welcoming environment for women, a lack of childcare services at the workplace, lengthy workdays, and inadequate family support. The other often mentioned difficulties include discrimination, harassment, a lack of leadership opportunities, professional resources, low salary, difficulties with career choice, time management, and low motivation.

- *Stereotypes:* Assigned stereotyped gender roles have contributed to the lack of women in STEM fields, in addition to ability deficiencies.
- *Patriarchy:* There are patriarchal attitudes present in employment procedures, the distribution of grants and fellowships, etc.

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- *Society:* A lack of positive role models, social pressure to fit in, and domesticity's constraints.
- *Stress:* marital, childbearing, and other stressors.
- Household management responsibilities include taking elderly people's care.
- *Physical Security:* Maintaining physical security while travelling to work.
- Harassment includes sexual harassment as well as other sorts in the job.

Structural and Cultural barriers

The underrepresentation of women in engineering and computer areas may be influenced by institutional structures and practices, more general cultural influences, and workplace and college contexts. Narrow focus, isolation, stereotypical surroundings, work-life balance, and social network less helpful for women, challenging academic workplaces, Biases can be either explicit (self-reported, conscious, and on surveys or in interviews) or implicit (automatic, generally occurring without an individual's conscious awareness), In-group favoritism, etc.

According to experts, societal stigma, prejudice, biases, social norms, and expectations play a significant role in the quality of education women receive as well as the disciplines they choose to study, which contributes to the underrepresentation and discrepancy of women in STEM.

This disparity in career choices not only emphasizes a lost opportunity but also the imbalance in a society where one gender is held back by constraints and limits.

Initiatives to Promote Women's Participation in India

- *Vigyan Jyoti Scheme:* This program was introduced by the Department of Science & Technology as one of the initiatives to encourage women's participation in INDIA (DST). It aims to level the playing field for deserving high school girls who want to major in science, technology, engineering, and mathematics (STEM) in college. It also provides exposure for female students from rural backgrounds to support the planning of their route from school to a career in science.
- *GATI Program:* The GATI Program will create a thorough Charter and a framework for evaluating gender equality in STEM.
- *Knowledge Involvement Research Advancement through Nurturing (KIRAN):* The program, which was introduced in 2014–15, offers female scientists the chance to advance their careers in academia and administration.

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Recommendations

The issue needs to be resolved on two levels: the social level, which calls for sustained effort, and the institutional and policy level, where action can be taken right away. The following are some ways that parents, teachers, and especially engineering educators can assist children, especially girls, in developing their spatial abilities:

- Make clear to young people that spatial abilities must be learned.
- Encourage kids and students to play with construction toys, disassemble and reassemble objects, play games that require them to position objects in certain locations, sketch, and use their hands.
- To assist students to visualise what they see on the page in front of them, use portable models whenever practical (rather than computer simulations).

1. *Make people aware about the successes of women and girls in science and math* - It will dispel the myth by introducing young girls and boys to female role models who are succeeding in STEM disciplines, discussing the rising numbers of girls and women who are excelling in STEM professions, and emphasising the lack of gender differences in performance across nearly all STEM fields.
2. *Teach females that cognitive abilities, such as spatial abilities, are acquired* - Teach girls that their brains make new connections every time they work hard and learn something new, which makes them smarter over time. Teach girls that the path to success and contribution is paved with passion, perseverance, and self-improvement, not just natural talent. Encourage girls to put forth effort rather than intelligence.
3. *Encourage girls to take on challenges*, to work hard, and to learn from their failures. These messages will impart to girls the virtues that lie at the core of contributions to science and mathematics: a love of challenges, a love of effort, and the capacity to accept and learn from mistakes that are unavoidable.

Inform pupils about the dangers of stereotypes and encourage a growth-mindset culture.

4. *Educate girls on their employable skills* - Girls are less likely than boys to believe that their achievements in math and science classes prove they have the qualifications to succeed as engineers, physicists, or computer scientists. Encourage females to see their achievement in high school math and science for what it is: a sign that they have the abilities to excel in a variety of

science and engineering occupations in addition to being a requirement for attending college.

5. *Encourage high school girls to enrol in* engineering, computer science, physics, chemistry, calculus, and other related courses when they are accessible.
6. *Proactively assist female students majoring in STEM fields* - To assist in integrating women into the department- sponsor lunches, lectures, and other social gatherings.

- Make sure that no student group takes control of a STEM major or establishes itself as the ideal way to "be."
- To promote connection outside of the classroom, provide a warm, friendly student lounge that is accessible to everybody.
- Sponsor a group called "women in (STEM major)".

7. Confront the prejudice against women in STEM disciplines- If engineers and scientists are aware that there is gender prejudice in STEM disciplines, they can function to halt the unconsciously biased mental processes. If women, especially those working in engineering and science, are aware of the fact that there is gender bias in these sectors may give them an advantage. When it may be beneficial to know that they are not alone if they experience hostility from their peers alone. The societal rejection is not personal, despite how it may seem, and women might be contrary to that perception.

8. *Evaluate the environment for female faculty by conducting departmental reviews* - Both male and female faculty members value the departmental culture, although it seems that female faculty members value it more in terms of their overall satisfaction. When there is a hostile environment, female faculty members report less job satisfaction and are more likely to consider leaving their jobs.

Conclusion

The paper focuses on realistic ways that communities, schools, and families may foster an environment of support and dispel myths about women's ability to succeed in these hard industries. We foster interest in these subjects by encouraging girls' confidence in their capacity to learn math and science. While the advancement of women in education is to be commended, more has to be done to guarantee that women and girls have full access to educational possibilities and career prospects in the fields of science, technology, engineering, and mathematics. As a result, it would not only encourage women to follow their goals, but science would also benefit from their inclusion. Strong STEM education produces next-generation innovators, problem-solvers,

and critical thinkers. With more women in STEM, the future is promising.

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