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RESEARCH ARTICLE

DISPARITY AND CAUSALITIES OF GENDER EQUITY IN STEM: AN INDIAN PERSPECTIVE

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ABSTRACT

Gender equality implies that men and women have equal opportunities in education, career growth, financial independence and political empowerment. Guaranteeing rights of women and providing avenues is critical for attaining equity. Major problems faced by them are security, motherhood, family responsibility and self-imposed gender subordination. Women have fewer opportunities for economic participation than men, less access to basic and higher education, greater health and safety risks, less visibility at the higher positions and less political representation/leadership. To increase participation and inculcate interest of females in Science, Technology, Engineering & Mathematics, conducting of women science congress and women centric programmes at regular intervals in routine required. Workshops, seminars for sharing career prospects, introduction/interaction with the successful leaders of excellence, networking between faculty and researchers, easy access to their icon & mentors is of great importance. At workplace having more female heads of organizations will provide a balanced safe & secured environment and inspiration to the young females. Substantial financial support will encourage tapping of scientific acumen for pursuing higher studies and research for financial independence. Offering lucrative leading position in the universities, research organizations and offices will attract talent and potential leaders to improve visibility and gender balance.

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INTRODUCTION

Gender disparity is partly due to the biological role & responsibilities of women as mothers, mostly influenced due to the traditional mind-set which visualises women as being child bearers & home-makers only, and men as bread earners/winners. Women's empowerment is a critical aspect of gender equality, which increases a woman's sense of self-worth, her decision-making power, her access to opportunities & resources, her power and control over her own life inside & outside the home, and her ability to affect changes. Guaranteeing the rights of women and giving them opportunities/representations to reach their full potential is critical for attaining gender equity for meeting a wide range of national & international development goals by involving the left out female force. Empowered women and girls contribute to the health and productivity of their families, communities, and countries, creating a ripple effect that benefits everyone. For shaping the future of society, various sectors like agriculture, housing, energy, environment, water, health care, security, communication etc. require female folk with knowledge of science & technology. Although, in many invisible, un-rewarded ways women contribute significantly to the economic well-being of the family and society, but by not allowing the creative talent of women from being expressed through their involvement in research and development, society is missing out a lot and concrete needs to be done to make scientific research more gender friendly. A final area of focus in attaining gender equity is by ensuring women's achievements in academic excellence & technical

advancement, economic/financial independence and political empowerment. Though women comprise more than 50% of the world's population, they only own 1% of the world's wealth. Throughout the world, women and girls perform long hours of unpaid domestic work. In some places, women still lack rights to own land or to inherit property (as in Jammu & Kashmir before abrogation of Article 35A), obtain access to earn income or job or move up in their workplace, free from job discrimination. At all levels in the society, including at home and in the public arena, women are widely underrepresented as decision-makers. In legislatures around the world, women are outnumbered 4 to 1, yet women's political participation is crucial for achieving gender equality and genuine democracy. Worldwide, women only make up about 15% of senior leadership positions. According to UNESCO Institute for Statistics (UIS) fact sheet 2017 on Women in Science [24], women account for 28.8% of the world's researchers. In other words, less than 30% of the world's researchers are women and UNESCO fact sheet [25] for 2018 reconfirms the same scenario. According to a pan India survey [1] on higher education 2017–2018 conducted by Ministry of Human Resource Development girls constituted 47.6 per cent of total number of enrolments in higher education in that academic year, but on breaking down the numbers according to field of study, the number of girls enrolling for STEM subjects was not impressive at all. As per the data depicted by Department of Science and Technology [20] women enrolment in science and technology disciplines in higher education sector is increasing.

RESEARCH METHODOLOGY

For the present study, we have collected secondary data comprising of books, e-journals, review of the studies conducted by various platforms of the Government of India and other international bodies.

Objectives: The purpose of this study is to present a list of causes, remedies and suggestions for gender equity in STEM.

LITERATURE REVIEW

There is progressive increase in the overall literacy rate of women in India every year. The literacy rate of women was 29.8 in the year 1981 and had increased to 65.5 in the year 2011 (Source: www.census.gov.in) [26]. The enrolment of women in higher education had increased from 17.9 in the year 2010-2011 to 26.4 in the year 2018-2019 (AISHE Report) [1]. The Gross Enrolment Ratio [GER] of Indian women has shown a steady rise in the past two decades. The GER of women has surpassed men in the age group of 18 to 23 in the year 2018-2019 (AISHE Report, 2019) [1]. In the year 2019, only 48.20 % of the Indian population are women. Therefore, the decrease in the number of women joining the workforce despite the increasing GER is a matter of great concern. The female workforce participation in India had fallen from 36.7 percent in 2008 to 26 percent in 2018 (The Hindu, March 8, 2019) [22]. In the Indian parliament, only 14.36 % of elected representatives in the lower house (The Lok Sabha) are women in the year 2020 (www.loksabha.nic.in) [27]. Women hold only a meagre 7% of the senior management roles in India which is much lower than the global average. (Grant Thornton press release, 2017) [10]. Women enrolling in (STEM) science, technology, engineering, and mathematics-related education stands at 39 percent (Source: Girlsintech.org) [28]. There is an analysis of the relationship between the enrolment of women in higher education and literacy level of women with their representation in governance and the workforce in India (Anita and Ravindran) [2]. Women have fewer opportunities for economic participation than men, less access to basic and higher education as mention by Chatterjee, Desai & Reeve [4].

Different reason for unequal ratio of girls' enrolment in the higher technical education as per Kesarwani and Komaraiah [13] which are as follows; Parents' low level of education, Early marriage, Financial crisis at home, Lack of parents' support, Male preference in the family, Backward thinking towards girls' education, Lack of girls' security, Traditional cultural practice, Poor schooling, Menstrual/health problems and other variables which are included in the analysis are socio-demographic characteristics of student such as age group, gender, marital status, region, residential status, religion and caste. However, rate of this growth is not as it should be for a densely populated country like India. AISHE report [1] of 2018-19 shows that gender gap is narrowing, there is more female population in two states Uttar Pradesh and Karnataka as compared to the male population, female enrolment improved from 47.6% in 2017-18 to 48.6% in 2018-19 and the gross enrolment ratio (GER) increased marginally from 25.8 in 2017-18 to 26.3 in 2018-19. According to a Belong report [29] which shows that women comprise a merely 26 per cent of the STEM workforce in India. As per facts, statistics of KGWI [14] and Belong report [29] came at the time when the state of women's education in India is significantly improving; though the last census revealed woman's literacy rate of 65.46 per cent in the country, significantly lower than the corresponding global figure of 79.7 per cent. IT-Business Process Management (IT-BPM) sector confirms this and states that women applicants have far higher success rates than men. But gender bias even affects the presence of women in seminars, workshops, conferences, academic councils and different head of boards. As per the UGC Annual Report 2016-17 data [23] about Ph. D degree recipients during 2015-16 reveals that in S&T faculties, out of total doctorate degrees awarded, 38.8% were women. According to UGC Annual Report 2017-18 data [23], during

the academic session 2017-2018, the total student enrolment in all courses and levels in regular and distance education programmes was 366.42 lakhs including 174.38 lakhs women students' constituting 47.59%. Only 15% of board seats and 6% of board chairs are held by women as per the report from (Catalyst, 2019) [3]. As per the global survey conducted by Grant Thornton, India [10] is ranked third lowest concerning women in leadership roles. As per the Only 17% of the senior management roles are occupied by women. Women as chief executive officers or managing directors form only 7% of the total numbers in such positions as per the analysis by Catalyst [3] This paper presents a list of causes and recommendations for gender equity in STEM. These findings will help in empowering the fellow women by inculcating scientific interest among them, mentoring the younger women concentrated at the bottom of the hierarchy, facilitating women's entry and continuation in science career.

Constraints for Women's Career path in STEM: The fields of STEM have remained male dominated with historically low participation among women since their origins during the age of enlightenment. As per ancient Hindu law giver Manu: "Women are supposed to be in the custody of their father when they are children, they must be under the custody of their husband when married and under the custody of her son in old age or as widows. In no circumstances she should be allowed to assert herself independently". Research and career in STEM in India have a 'diversity problem' with Indian women and minorities represented inadequately. Some of the factors influencing underrepresentation of women in STEM are:

- **Less support from family:** In India, there were a lot of societal pressures which prevented women from returning to higher studies or career after marriage and childbirth as it was difficult to maintain a balance between family and work. In later stage, problems related to health of parents or their other family members leave little time to develop and hone an ambitious career in STEM. So, women failed miserably to convert their scientific temper, degrees and talent into progressive careers mainly due to biological clock and family pressure, the child bearing age also clashes with career building period which is substantiated by the survey conducted by KGWI [14] for women in STEM in India. The "double-burden syndrome" which makes women quit jobs mid-career, especially in technical careers is still a big problem in India and needs to be tackled sooner than later. Although there has been lot of continued socio-cultural conditioning of women, still they have been accepting their subordinate position to men, and are part & parcel of same patriarchal system. In Indian culture, both men and women feel the family and household duties are primarily the woman's responsibility.
- **Lesser Opportunities:** Lack of higher/technical education is also one of the reasons for women's low status in society. Higher/technical/advanced education of girl child is still seen as a bad investment because she is bound to get married and leave her paternal home one day. Thus, without having good and professional/ skill-oriented education women are found lacking in present day's demanding job skills; whereas, each year's High School and 10+2 standard results show that girls are always doing better than boys consecutively. This shows that parents are not spending much after 10+2 standard on professional education of girl child and that's why they lack in job market. Even for families with greater resources, economic considerations affect the pursuit of science degree as a science or engineering degree is generally a more expensive option than humanity or a commerce degree.
- **Less Representation/ Less Role Models:** The women did not have much visibility on the national and international scene either in academic councils or in scientific bodies at the higher positions, which plans & takes policy decisions on science and education. India needs more women in top position/ leadership roles and Govt. /Corporates needs to change the perspective that women cannot be leaders, more

women going up corporate ladder will encourage women workforce and will encourage them not to give up mid-way.

- **Health problems, Healthy Environment and Safety Risks:** Lack of safe, secure & gender friendly environment in institutions, work places & in society and also improper, insecure transport for female (separate) are the main hazards for the overall growth of female career. Lack of medical facilities and no proper wash rooms for females' and unhygienic condition at some places are great obstacles in progress of females.

According to the latest KGWI survey on Women in STEM [14], women in India tend to drop out of workforce at key phases in their lives, most notably around childbearing years and later at mid-management levels and it is very unfortunate that 41 per cent of women in technology companies leave after 10 years of experience, compared to 17 per cent of men. While women represent 46 per cent of all enrolled undergraduate students in STEM, not many continue to pursue careers. Kumar ([15] & [16]) also discussed that 'why, despite the existence of legal and constitutional equalities, women are still subject to discrimination in science'.

Existing Scheme to Promote Female in STEM in India: India has launched many programmes through different departments and agencies like DST, UGC, DBT, INSA and many more who are working in earnest to attract girls to and retain women in science, amid a countrywide challenge to reduce a worrisome gender disparity in this area of human endeavour. INSA constituted a committee to investigate the issue of science career for women and suggest measures to increase women's participation in study and practice of science and presented a report [21] to get a picture of the status of Indian women in science, analysed the factors and constraints which influence science career for women. In 2002, DST launched Women Scientist Scheme (WOS) to address the challenges faced by women due to various reasons and in 2014; DST restructured all women specific programmes under one umbrella called Knowledge Involvement in Research Advancement through Nurturing (KIRAN). Different components of KIRAN deal with various crucial women-centric issues such as break in career, self-employment, part-time career, relocation, etc. faced by women in their career path. WOS (KIRAN) has three components: WOS-A (Fellowship for research in basic/applied science), WOS-B (Fellowship for research in S&T-based societal interventions), WOS-C (Internship for the self-employment).

Along with IT, even government and educational institutes, and technology firms are working to fill the gap and to make India's engineering workforce truly diverse. Technology giants such as Cadence, Qualcomm or Intel have their own platforms for empowering tech women in India. Over the past few years, government too has worked out solutions for retaining working women and launched initiatives such as Rajiv Gandhi National Crèche Scheme for children of working mothers and women in maternity benefit programs. The announcement was accompanied by a redesigning and renaming of a national programme called Innovation in Science Pursuit for Inspired Research (INSPIRE), changed to Inspire-MANAK (Million Minds Augmenting National Aspiration and Knowledge), to attract talented young boys and girls to study science and pursue research as a career. As per the latest Research and Development Statistics at a Glance 2017–18 brought out by DST, Government of India ([18] & [19]) women participation in extramural R&D projects supported by various central S&T agencies has been 29% in 2014–15. In absolute terms, 1301 women principal investigators (PIs) during 2014–15 availed extramural R&D support as against 232 in 2000–01. Gupta [11] has also discussed in detail about Government of India initiatives and policies to empower women and bring them back to mainstream science.

With representation of eminent Scientists/ Educators/Administrators, DST constituted 'Standing Committee for Promoting Women in Science' in 2016 to tackle the issue of low representation of women in planning and policy making. The Vigyan Jyoti scheme, advanced

by the Department of Science and Technology (DST), was announced in the 2017 budget allocation for the Ministry of Science and Technology and given a 2,000-crore-rupee purse. The scheme's aim to arrange for girl students of classes 9, 10 and 11 meet women scientists, with the IITs and the Indian Institutes of Science Education and Research serving as the nodal centres, at least at first. The 2030 Agenda for Sustainable Development includes 17 Sustainable Development Goals (SDGs) including SDG 4 on education and SDG 5 on gender equality.

Existing schemes for Women in Higher Education

- Higher education of women through Open and Distance Learning (ODL) Mode
- Post School Diploma (Polytechnics etc.): To provide financial assistance for the construction of women hostel in the existing polytechnics.
- The University Grants Commission (UGC) has launched a number of schemes to encourage the enrolment and promotion of girls in Higher Education.
- Day Care Centres in Universities and Colleges
- Post Graduate Indira Gandhi Scholarship for Single Girl Child for Pursuing Higher Studies.
- Higher and Technical Education. Construction of Women's Hostels for Colleges
- Development of Women's Studies in Universities and Colleges
- Scheme of Capacity Building of Women Managers in Higher Education
- Post-Doctoral Fellowships for Women

Recommendations for Facilitating Women's entry and Continuation in Science Career

The following simple and inexpensive steps could make a huge difference in gender imbalance in STEM:

- Sparking interest in STEM among female students at an early age, practical way to tackle this issue is timely intervention at the school level and interactive sessions or programs to help mitigate the gender parity. Once interest is sparked and kindled, the next step is getting schools to join in. The students from schools do focus on subjects that are crucial to the foundations of engineering, such as math and science, but there is a link between the core subjects and the exciting, creative, and diverse careers within engineering and applied sciences that may appeal to young women is made too late or not at all. All educational institutes must approach and mentor parents which will increase women enrolment in STEM fields. The primary focus would be instilling confidence in female students by exposing girls to STEM and introducing them to women in the STEM field who can serve as role models, and that shall go a long way in reducing the gender disparity in STEM education and professions.
- We should focus on new attractive teaching methods to be adopted by teachers. The innovative and interactive method involving students with new content will definitely be helpful in inculcating more interest and understanding of the subject.
- We should sensitize the society, especially the male counterparts whose co-operation is required. Each individual should be encouraged to focus in the direction of gender sensitivity. Getting more women into STEM careers will require a partnership among parents, educational institutions, government, industry, and organizations. An awareness, encouragement, safe and secure atmosphere must be provided to female in society as well as at workplace where they can explore their potential to work with full zeal.
- Awareness and mentorship programmes related to science and its applications in daily life for girls at school levels are the need of the hour. Women should be given proper access and necessary support to pursue a career in STEM in all walks of

life at each stage. We should work collectively as team irrespective of gender to create an environment where gender no longer plays a role in education, career, decision making and discussions.

- Our media can play a big role by quoting inspirational females, increasing visibility of great women scientists and achievers to create and enhance interest of young girls in STEM fields. By featuring documentary films about life, struggle and work of successful women will be a great initiative to attract female in STEM. Regular talk shows by senior scientists and STEM professionals, especially females, should become a routine telecast/broadcast.
- In a male dominated society woman who have reached the pinnacle of their career are exceptionally talented and have excelled by dint of their sustained efforts & hard work. Famous women scientist like Godbole ([5], [6] & [7]) actively involved in working for women in science, increasing women's participation in science in India, gave many popular talks about physics and about women in science to adult audiences as well. Godbole ([8] & [9]) co-edited books like 'Lilavati's Daughters: Women Scientists of India', containing (auto) biographical sketches of about 100 Women Scientists of India and also a book called 'A Girls' Guide to a Life in Science' containing material which we hope will inspire young girls to take up a career in Science. Godbole worked towards pioneering a variety of programs, at various forums, to raise awareness on the subject of women in science and members of various committees and associations. Her contribution for the concerned gender is highly appreciable. Work and life history of such successful women should be given due publicity and appreciation so that other can follow their footsteps
- Thrust Areas in STEM demonstrations comprising of science fairs & melas, exhibitions, mobile science exhibitions, lecture-demonstrations on different kinds of themes on STEM, visits to S&T establishments, Hands-on-STEM activities, interaction with the women luminaries and so on be made regular routine activities, which will serve to expose students to the scientific concepts at the cutting edge and their career choices, and motivate students to take up a career in science. Special scholarships and awards must be instituted to attract female students in science. More and more research projects (minor and major) for women in particular by different research departments should be given in different streams of science.
- Need of 4R's (Representation, Recognition, Retention, Rights) for women, getting more women to study science and technology; ensuring that those who study, are able to pursue a career in STEM successfully, facilitating women's entry and continuation in STEM career at all stages of service till retirement and due recognition & reward to female candidates at higher positions. It is most desirable to have Associations for Women headed by Women of repute for mentoring and promotion of women in STEM. Government must launch forum of women, for women, by women to address the issues of women in STEM at various levels.
- Organizing Women Science Congress/ Conferences / Workshops is a good initiative to fascinate women in STEM which must be a step towards the women to abridge the gender bias. For encouraging STEM at grassroots level, Women Science Congress is a unique movement popularising science among young women and arresting the persistence underrepresentation of women in this field towards national development to encourage students to communicate & share innovative concepts. Such activities will provide an open forum to students to interact with the leading women scientists and academician from different parts of country and to be a part of scientific community, hoping this initiative will also go a long way in attracting a large number of women scientists towards contributing to basic research and adopting a career in science. Such scientific activities will be a pathway to motivate and guide the girls to opt for science and choose STEM as a profession, to build self-confidence and boost the morale of women. Plenary Lectures by eminent scientists, academician

and scholars from within the state and other part of the country might be beneficial to female students. The speakers from within and outside the state in women science congress will refer & discuss female scientists who have won fame & glory worldwide by showing their affiliations and love for science and research. It will be of great boon for inculcating scientific temper, spirit of scientific inquisitiveness & research through systematic observation & analysis empowering women, assume leadership positions, enhance professionalism, enabling face challenging of life effectively.

- Organizing Panel Discussions on different topics like: Women in Science: Gender Equity / Why so Few Women in STEM or any topic related to unequal enrolment of female in STEM. Moreover, in this discussion forum the members of collegium will be themselves luminaries, women of high repute at top positions and they must introduce & interact with the young budding girl students to inspire & follow their foot prints by choosing higher studies & science as their carrier in life. Such activities will provide an open forum to students to interact with the leading women scientists and academician from different parts of country and to be a part of scientific community. It can be great initiative which will also go a long way in attracting a large number of women scientists towards contributing to basic research and adopting a career in science.

A fish will grow to the size of its aquarium; if it finds itself in the ocean then the growth can be exponential. If we work towards inspiring young minds and fuelling their curiosity in STEM by connecting them to renowned women scientists and exposing them to advanced research that can bring about desired sea change can be achieved, no matter if a small percentage of women get inspired, the effort will be worthwhile.

CONCLUSION

There's no reason for men to be better at any point/ subject than women – it's just about our perception. We have a fabulous list of greatest famous and established female scientists /mathematicians in National/International map, who have changed the world and everything they've brought us today with their inspiring and incredible work. We hope one can quote these inspirational females to showcase our society that higher study and research in science/mathematics is all about the interest, knowledge, passion and love for subject not the sex/gender of individual. India needs more women in leadership roles and policy makers needs to change the perception that women cannot be leaders. More women evolving in research will attract fellow women workforce and will encourage them not to give up mid-way creating secured environment. We have to give more and more opportunities and support to women as they will be good in governance position and decision making if given a chance as the experience empowers them. Mentoring programs, women associations, women science congress might be fostering linkage between successful/ established women and others. Provide a platform so that women can explore their inbuilt talent. Focus on developing qualities like leadership, resourcefulness, initiative's adaptability, seriousness, committed, adaptability to new situations, decision maker. For safety of female students, we have to consider unequal enrolment of female students seriously. Female should be considered as ambassador of change and development of society.

Women needs to come forward and make use of available opportunities and explore various avenues with full zeal and confidence. In corporate sectors and research institutes, employers must try to retain the women they hire, and should give them equal opportunity to advance, need to care about workplace bias, more steps to arrest mid-way drop out of women employees from leaving their carrier for unavoidable situations in life / social responsibilities of extended family care of elderly persons in the family in the later years of their life. Each one should be judged by their ability to do the job and not by their gender. We have to work to take a strategic, holistic approach to closing the gender gap and focus on Retention,

Recruitment & Representation of Women in STEM. "One must think hard on what one wants and follow his passion. If one(men) can do it, everyone(women) can do it too".

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