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Women in STEM in India: Understanding Challenges through Social Constructionist Perspective

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Abstract

This article intends to understand the position of women in science, technology, engineering and mathematics (STEM) in India and to highlight the challenges faced by them through the perspective of gender as a social construct. It argues that the social constructionist perspective helps to focus on the specific socio-cultural context, and to deepen our understanding of the barriers in career advancement for women in STEM. Based on the governmental data and research studies, it demonstrates that these constraints occur at the intersection of Indian social, organizational and institutional contexts. This perspective helps to explore solutions unique to the specific national context.

Keywords

career, gender, higher education, India, social construction, science, technology, engineering and mathematics

Introduction

Women are under-represented in scientific careers in most countries (UIS, 2019). In India, there is a huge gap between the proportion of women doctorates and women in

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careers in science, technology, engineering and mathematics (STEM). While women constitute about 30–45% among the doctorates awarded in science and engineering (All India Survey of Higher Education (AISHE), 2020); their proportion as full-time equivalent of manpower employed in research establishments is 16.6% (R&D Statistics, 2020), which is much less than the world average of women's proportion as researchers at 29.3% (UIS, 2019). Women's proportion as researchers in India falls further to 13% in the higher educational sector (R&D Statistics, 2020).

Further, there is horizontal segregation with the proportion of women varying for different fields; for instance, women constitute half or more of the total doctorates awarded in bio-science and about 37% in physics (AISHE, 2020, table-36). However, compared to the proportion of doctorates, the proportion of women scientists employed is low for both fields. For instance, there are about 23% women scientists in the research institutes that mainly focus on biological sciences (Swarup & Dey, 2019); in physics, it is about 16% of the faculty/scientists at the physics departments of academic institutes and physics research laboratories (Dabas, 2021).

Academia with its hierarchy of institutions has the lowest proportion of women students and faculty in the elite central government-funded autonomous institutes (Gupta, 2020a; AISHE, 2020). There are only about 11% women faculty in STEM at the prestigious older Indian Institutes of Technology (IITs), about 27% on an average in top universities (Gupta, 2020a; Swarup & Dey, 2019), and a higher number of women teach science and mathematics in colleges than universities (Women in S&T: A vision document, 2016).

There is a vertical segregation within organizations and the scientific community in general, with few women in leadership positions. The ratio of women declines with the rise in academic position in STEM institutes (Kumar, 2001); more recent figures, but for all fields combined, show that the proportion falls from 75 females per 100 male assistant professors/lecturers to 38 females per 100 male professors (AISHE, 2020: p. 27). Women are seldom appointed as chairpersons of the institute-level committees or as the heads of departments; there are only 6% women vice-chancellors of government-run universities and these are mostly women universities (Women in S&T: A vision document, 2016). There have been no women chairpersons of examination bodies for entrance exams of bachelors (called JEE) and masters (or GATE) of the IITs. Women scientists lack recognition. For instance, women recipients of the prestigious Bhatnagar award[1] for young scientists are only 3.38% of the total (15/447) between 1958 and 2014; the proportion of women as Fellows of national science academies constitutes not more than 10% (Women in S&T: A vision document, 2016). Of the 820 Indian fellows of the Indian National Academy of Engineering, less than 2% are women (Gupta, 2020a).

The statistics above suggest a low position of women in STEM. To understand their constraints and challenges, this article examines the socio-cultural and institutional context of women in STEM education and careers. For this purpose, the article takes the social constructionist point of view. Unlike the feminist viewpoints considering either men and women as similar (as in the liberal feminist view) or different (as in the radical

feminist view), this view deals with how masculinity and femininity are constructed through 'doing gender'; how the categories of 'men' and 'women' are not merely biological, but are a product of socio-normative construction that define behaviour appropriate to the sexes (West & Zimmerman, 1987). Gender is constructed through upbringing and social interaction; cultural beliefs about gender impact behaviours, performances and evaluations; the biases accumulate over individuals' lives and have differential outcomes for men and women (Ridgeway & Correll, 2004). Using this post-structural perspective, the article analyses how social construction of gender impacts women in STEM education and careers in India with a focus on women in research careers. To comprehend the challenges derived from a social construction of gender in the Indian context, it is essential to understand the Indian socio-cultural milieu.

A Postcolonial Construction of Gender

Women's higher education and employment in the professional and technical sector is an urban middle-class[2] phenomenon. This is indicated in studies on women scientists (e.g. Gupta, 2016; 2017). In a survey of 568 women scientists (Kurup et al., 2010), about 80% of women in research belonged to the 'General Castes'[3], and those women in science not doing research also belonged to upper castes (79%); about 66% of women in research lived in cities. Most students qualifying the entrance exam of the elite IITs are from middle classes (JEE Report, 2018).

The educated middle class grew during the colonial period. The emphasis on family in this period portrayed middle-class women as a homemaker as a part of outer/inner, material/spiritual, West/East dichotomy so as to assert Indian superiority, which was a reaction to colonialism (Chatterjee, 1993). In the immediate post-Independence period, the Nehruvian idea of Indianness was defined in secular and socialist terms (Radhakrishnan, 2011) that stood in tense contradiction to Hindu rightist ideals. However, since the 1990s, liberalization and the growing Hindu nationalist forces have revitalized the ideas of Hindu piety and moralism, with the central role of family. The postcolonial notion of 'Indian culture' appears to be gendered.

'Middle class' is more of an ideological than an empirical category (Deshpande, 2003); it has dominated political and cultural imagination of the country (Radhakrishnan, 2009). In contrast to the view of an ideal Hindu woman as a homemaker until recently, the new view of Indian womanhood defines woman as being 'of substance', and includes greater visibility of women in workplaces. Yet, the middle-class construction of the cultural domain continues to construct the inner world, that is, home, as being woman-centred (Thapan, 2007). Studies of professional women in information technology (IT) (Radhakrishnan, 2009; Belliappa, 2013) found that middle-class women uphold family as a 'core value' of global Indian identity that helps enact 'respectable femininity'; that their narratives of self are often collective rather than individual projects.

Further, as a patriarchal society with family orientation (Mukhopadhyay, 1994), families traditionally took decisions on children's education and marriage. An

obsession with 'purity' (lineage purity was associated with control of female sexuality) amongst upper and middle castes/classes has been responsible for segregation of the 'public' (economic) and 'private' (domestic) sphere, which has implied a low priority for the higher education of women for professional employment (Dube, 2001; Mukhopadhyay, 1994). There are visible changes in the social milieu as marital decisions are increasingly taken with consent of the son/daughter (Desai & Andrist, 2010), and women enrol increasingly in professional courses. For example, their proportion in enrolments in engineering courses rose from 3.8% in 1980-81 to about 28% in 2019 (AISHE, 2020; Gupta, 2020a). Globalization and liberalization have enhanced job opportunities and women's participation in workforce, particularly in the IT sector (Gupta, 2012). The dual-earning couples are on rise in urban India and share household duties more (Ramadoss & Rajadhyaksha, 2012). The constraints for women in STEM in education and careers have to be viewed in the light of the above developments.

STEM Education: Cultural Context of Participation and Subject Choices

Family plays an important role in educational decisions (Mukhopadhyay, 1994) such as, what stream to opt for, and the father's role in such decisions is particularly significant (Gautam, 2015). Studies (Gupta, 2012; Varma, 2011) show considerable family support for the women that opt for the science stream (with physics, chemistry and math) in class XI, and for science/engineering later during higher education. While enhancement of women's participation in STEM fields in the recent decades reflects critical changes in the patriarchal system, considerations of parents in making educational decisions are often gendered (Gupta, 2012). For instance, in case of daughters, the subject to be chosen is related not only to the family decision of whether the daughter should have a career-oriented education but also to the marital obligations of the parents. A professional degree eases marital negotiations for the woman's parents apart from empowering the daughters (Gupta, 2012). A daughter's professional education brings prestige to the young woman and her family, and assures her a respectable job.

An engineering degree has become an attractive option for girls (and parents) due to its association with the computer-related branches. The latter are considered 'appropriate' for girls (Varma, 2010). Access to engineering education has become enhanced due to privatization of education and mushrooming of engineering colleges, and availability of jobs in the computer-related professions since liberalization (Gupta, 2012).

Contrary to the Western experience, the beliefs about women's incompetency in mathematics or notions of differences in intrinsic intellectual ability do not seem to occur in the Indian socio-cultural context (Mukhopadhyay, 2009). Mathematics does not appear as a male domain, and gender does not play any role in acquiring mathematical and problem-solving skills for education in computer-related fields (Varma, 2011). A study (Gupta, 2012) on women in a lower ranked state engineering college for

women, typically from middle class, found that parents of more than 90% respondents believed that women were no less capable than men in science and mathematics and hired tutors in these subjects for their daughters in class-12 (since coaching or tuitions are usually considered essential to boost class-12 performance and help clear engineering entrance exams).

However, there is evidence to the contrary also. For instance, according to Gautam (2015), the participants in their senior secondary school found that boys and teachers questioned mathematical ability of girls. Nevertheless, looking at the enrolments, with women constituting 64% in masters and 45% in Ph.D. in mathematics (AISHE, 2020), it is apparent that mathematical ability of girls is not a significant issue in the Indian context. The subject choice in tertiary (post-secondary) education reflects in the academic field, as for instance, in a higher female authorship in research publications in mathematics from India than from the United States (Thelwall et al., 2019).

The consideration of the mathematical ability of a son or daughter appears to be secondary to the gendered considerations in the family's subject-choice decisions. Subject-choice decisions are gendered for boys also. According to Gautam (2015, p. 37), in urban middle-class families, 'even if brothers were not considered "good students", they still had to take science. Male siblings were not given the option of pursuing arts and commerce'. Further, in such families, the decision to take science was made keeping in mind mainly two professions: medicine for girls and engineering for boys (Gautam, 2015). Although women's participation in engineering has increased, men still constitute two-thirds of the enrolments in under-graduation.

Also, it is perhaps more important to understand how the society views achievements of men and women than to analyse how society perceives women's mathematical abilities. Even among the well-off education-oriented families, educational achievement, especially in the scientific fields, is viewed differently for girls than for boys (Mukhopadhyay, 1994). Men's academic achievement is celebrated more than that of women, as male is viewed as an asset who will bring long-term economic and social benefits to the family, while the girl's achievement has little long-term value for the natal family. Further, even if there is parental support, women moving ahead of men in mathematics and science might not be looked upon favourably among the male peers and teachers (Gupta & Sharma, 2003).

The gendered participation in STEM is further exemplified through women's participation in professional coaching. Examinations for entry in the institutes of higher education in engineering are held in addition to the class XII exams. However, these entrance exams require coaching at the senior secondary school level to acquire training and skills of a higher level than those required for the class XII examinations. Studies show a lack of female students at the coaching centres for engineering entrance examinations (Singh & Pathak, 2010).

The situation for medical entrance is different for women. Unlike engineering entrance exams, girls' participation in medical entrance exams appears to exceed that of boys. For instance, in 2018, among the students registered for the national entrance examination (NEET-UG) for medical and dental courses, about 56.4% were girls

(Singh, 2018). The proportion of girls attending coaching for medicine does not lag behind that of boys (Gupta, 2020a).

This leads to the questioning of the hypothesis that parents are unwilling to spend on the coaching of girls, as found in case of women's coaching for engineering entrance (e.g. Mukhopadhyay, 1994). The monetary investment for girls' education seems to depend on the subject-choice decision. Engineering continues to be viewed less favourably than medicine for girls because medical career offers flexible working hours, independent work through private practice, social prestige and good earning (Chakrabarty, 2010). Historically, since the colonial period, when modern medicine was first introduced in India, medical science has been considered prestigious for women. Also, due to its association with biology, medical sciences appear to be 'suited' to women's aptitude. Women are high in proportion in gynaecology and nursing (AISHE, 2020, Table 13), which are typically associated with women.

The ideas of educating and empowering women versus placing traditional limitations on them coexist (Radhakrishnan, 2011). In effect, it implies, for instance, that a woman might become a doctor as it enables financial independence and status, but the practice, the level of education and the choice of specialization should allow her to meet domestic obligations. Women are clustered in dentistry, physiotherapy and pathology, while men are preponderant in the more prestigious and demanding branches such as cardiology, surgery and orthopaedics. In almost all fields, men are more than women at the doctoral level (AISHE, 2020, Table 13). Further, parents prefer to send their daughters to colleges nearby (Gupta, 2012), implying loss of opportunity to study in a reputed institute further away. This partly accounts for the lowest share of female students in the Institutes of National Importance (AISHE, 2020).

Defying the leaky pipeline in the engineering fields, the proportion of women in master of technology (M.Tech) enrolments (37%) was higher than that in bachelor of technology (B.Tech) (28.5%: p. 14) in 2019-20 (AISHE, 2020, p. 30). A study (Thakkar et al., 2018) found that M.Tech in computer science was encouraged by the families as it was a matter of honour and a boost to the marital profile of the participants. The increase could also be perhaps because teaching might be preferred for women. An M.Tech is essential to teach at the entry level in technical institutions (AICTE, 2012-13, p. 121). Further, more men tend to get jobs after B.Tech due to gender segregation in the job market (Gupta, 2015), and men are expected to start earning as soon as they graduate, and are under pressure to build successful careers (Mittal, 2013). However, the proportion of women in science enrolments in master's programme remains higher than that in engineering; for instance, it is above 55% in physics, chemistry and mathematics (AISHE, 2020), indicating 'feminization' of sciences, the latter having fewer job opportunities, and hence, a lower status than engineering (Gupta, 2007).

The proportion of women's enrolments fall from master's to doctoral studies in engineering and technology (from about 35% to 31%), suggesting that the proportion of men that move to Ph.D. after M.Tech is higher than that of women. There is a substantial variation in enrolments of women among engineering fields and between the institutes. They constitute about half of the total enrolments in Ph.D. in IT and computer

science (CS), but in mechanical engineering (ME), they are less than 10% (AISHE, 2020, p. 16), exemplifying again the social approval for women in computer-related courses; while ME is viewed as masculine because of its association with working with machines in industry among male members/workers and the perception of a biased labour market. There is a strong link between the job prospects and subject choices of both women and men (Nair, 2012).

Overall, the proportion of women in Ph.D. enrolment in STEM is lower than that in master's or bachelor's. The fall in women's enrolment from master's to the doctorate level in physics, chemistry and mathematics is about 20 percentage points, which is much sharper than in engineering (AISHE, 2020, Table 13). Their enrolment in Ph.D. (overall, at about 44%, including all branches) is about one-third of the total in the 'institutes of national importance' (AISHE, 2020, Table 26). A lesser proportion of women in STEM are sent abroad by their parents for higher studies. In a survey of Indian students who had studied abroad, it was found that those enrolled in STEM programmes exhibit maximum male bias with 69% males and 31% females (Sondhi, 2015).

Thus, there are less women than men in doctoral education in STEM and still fewer in quality doctorate programmes (of national institutes, for instance), owing to a sequence of socio-cultural normative decisions generated from the early socialization phase of daughters. These decisions construct an uneven road to a career that might be interrupted at the critical stage of transitioning from a doctoral student to a successful career. However, neither the parental decisions nor the centrality of domestic roles alone account for fewer women in STEM careers. Institutional and organizational factors are enmeshed with the socio-cultural context and play a significant role in constructing women's lower position in STEM careers. The sections below analyse women's challenges in STEM academic and research careers.

Gender and Contextual Construction of Scientific Merit

According to Merton (1942 1973), scientific norm of 'universalism' or objective criteria should be used to judge scientific contributions. However, various researchers have examined different elements of academic excellence, such as journal rankings, citation indexes and peer-review systems, in order to demonstrate that hegemonic structures of inequality based on gender, race and class are being reproduced in judging merit (e.g., Adler & Harzing, 2009; Hearn, 2004; Wenneras & Wold, 1997). Merit in India, as in the West, is believed to manifest early. This belief is exemplified in India in a low age of recruitment (maximum being 35 years) and of most awards/recognition (e.g., 45 years for the prestigious Bhatnagar award).

However, there is also a culture-specific context of constructing merit. In India, there is a notion of merit as an ascribed attribute. Subramanian (2007) found that scientists in India equate merit with talent for doing science that is believed to be inherent in a person and will manifest itself irrespective of the external conditions. However,

biological arguments cannot explain why for instance, there are about 40% women pursuing doctorate in STEM, while their proportion as researchers is only 16%.

The translation of doctoral degree to a successful career and the creation of 'merit' itself is actually a product of cultural and social capital accumulated on the basis of class, caste and gender. Among the advantages that accrete to men include a higher possibility for a man than a woman to gain opportunity to travel abroad for a prestigious Ph.D., construct networks through old boys' clubs (Gupta, 2007; Campion & Shrum, 2004) and find support through a cultural context that constructs advantage for men after marriage. Almost all the women scientists interviewed in a study (Gupta & Sharma, 2002) reported that merit (or talent) alone is insufficient for success in scientific career; that geographical mobility and contacts and networking with other scientists is important. Awards are recognition of 'merit'. However, greater informal contacts and networking with the seniors in the field and at the workplace help to garner visibility, and women scientists lack such contacts due to the Indian segregation norms, gender stereotyping, lack of mobility and a dual burden (Gupta & Sharma, 2003). Women-specific awards or science conferences (e.g., Women's Science Congress) seem to enhance sex-based categorization and hinders integration of women with the larger scientific community in India (Gupta, 2020a).

A negative evaluation of women during women's doctoral studies impacts their own evaluation of their 'merit' and thereby, self-esteem. A study of doctoral students showed that male scholars also have unpleasant interactions with their advisors; however, failings of women might be equated with their lack of competence and gender, affecting their self-esteem (Gupta, 2007). A dismissive and apathetic interaction with the advisor and blatant sexism has a similar effect (Subramanian, 2017). Women students from the scheduled castes or SCs (the lowest caste in Hindu social hierarchy, traditionally 'untouchable') and the scheduled tribes or STs (though not 'untouchable', are socio-economically marginalized groups) are even more vulnerable to an advisor's frustrations simply because they face more severe costs to speaking out (Kondaiah et al., 2017). The attrition of women Ph.D.s from science is about 11% in one survey (Kurup et al., 2010). It also found that inability to obtain an appropriate job was a significant factor for women who dropped out of careers after Ph.D. in STEM.

Workplace Biases

Workplace biases create gendered limitations on becoming meritorious for women scientists in research careers. Such limitations occur in two ways: (1) through gendered evaluation and (2) through inability of women to accumulate 'merit' due to gender.

Research elsewhere indicates that operationalization of what constitutes 'academic excellence' exhibits gendered practices by the evaluators (Van den Brink & Benschop, 2011; Moss-Racusin et al., 2012). A study of Indian women researchers show that women's gendered roles affect notions of competence while recruiting women. In a study on central government research labs (Gupta, 2016), a junior woman scientist (E1, CSIR2) said, 'awareness of a dual burden on women affects hiring. The woman has to

prove that she is better than a man for any job'. Interview committees for appointment of a faculty might ask gender-based questions, such as, 'how will you take care of your family?' (Gupta & Sharma, 2002) or 'you have applied for a job in this city, but your husband is in another city or country, so how will you manage?' (Gupta, 2020a, p. 178). The male heads of departments prefer male faculty for recruitment because he can work for longer hours compared to a female (Gupta, 2016).

The inability of women to accumulate merit occurs through day-to-day practices. Gender is constructed through performance of gender norms and through normative discourses at workplaces (Kelan, 2010). Best and Williams (1994) found gender roles more pronounced in countries that score higher on the cultural dimension of Hofstede's 'power distance' (the extent to which people in the society accept unequal distribution of power). India exhibits a high 'power distance' scoring high on this dimension, 77 (compared to the world average of 56.5). 'Hierarchy' has been a dominant feature of the traditional Indian social structure.

Although there are no formal rules that discriminate between men and women scientists in India, the workplace is affected by a hierarchical culture which translates into bias against women in junior positions (Gupta, 2016). The latter study on national research laboratories found that the culture of hierarchy adversely affects women more than men. This is because, unlike men, women are unable to counter systemic inefficiencies (e.g., the red-tape and lack of transparency). This affects various aspects ranging from purchase of materials to hiring students and promotions. Any such systemic issue could be easily manoeuvred through godfather and networking with those in leadership positions. However, apart from homophily (that occurs worldwide), Indian gendered norms of sex segregation usually hamper interaction with incumbents in leadership positions (usually men). In the absence of such interaction, a junior scientist is vulnerable to the 'politics' of those in higher positions. Lacking mentors and socialized in patriarchal norms (such as being docile and less aggressive), women scientists are often reluctant and diffident about reacting against such politics.

Gender schemas and stereotypes at workplace are prevalent with regard to women and are stronger in the male-dominated professions, such as science (Valian, 1999); the stereotypical image of a scientist is male (Schiebinger, 1999) and a 'male model' of full-time devotion to science tend to disadvantage women (and men) seeking work-life balance (Etzkowitz et al., 2000). However, placed in specific national contexts, these stereotypes also reveal specific challenges. Indian studies indicate that the belief that a woman has a primary domestic duty creates two critical disadvantages for a woman scientist at the workplace: (1) The notion of 'full-time' devotion of a scientist implies that women cannot do 'good' science since it is assumed that they are unable to devote 'full-time' to science and (2) the concept of women's domestic duties denies them several professional opportunities, affirming Holmes's (2005) finding that workplace interaction is a function of both gender and power.

Women's family roles are identified with 'Indian culture' which masks the glass-ceiling effects (Gupta, 2020b). Thus, 'long hours' of a woman as a scientist are assumedly untenable due to her gendered role for which she has to 'sacrifice' her work/

research; this is exemplified through a statement of a male scientist: 'The research of women is mediocre; you need to be immersed in research….Women are family oriented because in India it's a given that women sacrifice more' (Gupta, 2016, p. 453).

The statement shows that male colleagues often underestimate women's research, which verifies an earlier study on women faculty in prestigious institutes (Gupta & Sharma, 2002). The men colleagues' stereotype assumption that the dual burden renders women unavailable for significant tasks denies opportunities, such as committee headships, participation in seminars and consultancy, in going abroad or taking part in decisions, exemplifying Ridgeway's (2009) 'framed before we know it' (Gupta, 2020b). There is an overlap between the notion of 'an ideal worker' (Acker, 1990) who is a committed employee unencumbered by familial duties and a 'scientist' in public science institutes. This overlap is even more salient in private research labs (Gupta, 2017). Thus, a masculine discourse constrains accumulation of merit by women through negatively impacting the perception of quality of women's research and the opportunities available to women.

The masculine discourse is further strengthened by a lack of structural provisions of childcare and elderly care centres. The institutes of learning/research and the public spaces, in general, are severely lacking in such facilities. An access to domestic servants enables middle-class women to cushion a dual burden, but not entirely (e.g. infant care or sick elderly needing greater/professional supervision); campus living creates greater flexibility in work-home management; however, women shoulder greater domestic responsibilities than men. The masculine culture at the workplace and domestic duties create stress and delays career peak (Gupta & Sharma, 2002). The government has a liberal maternity leave (26 weeks) policy. However, paternity leave (of only 15 days) is seldom availed by men, inadvertently upholding the masculine culture of full-time devotion to science.

Women are further affected in STEM education and careers by social and economic inequality that is integrated into the unique caste system in India (and some other South Asian countries). This is evident in the position of women of lower classes and castes in STEM.

Beyond the Middle-Class, Upper Caste Conundrum

The growth of lower class women's participation in STEM is stymied by various factors. A report found that girls (classes 6–9) from lower classes are not fearful of science and mathematics compared to boys; but there is a sexist behaviour on part of students and teachers; discouragement also arises from socio-cultural factors that focus on the son's education due to his earning capacity and parental care obligations on the one hand and the daughter's engagement with household tasks on the other (FAT STEM Report, 2014). These factors hamper such girls from opting for STEM courses in higher education.

Class and caste roughly correspond, and those belonging to the lowest 'untouchable' caste, the SCs/Dalits, and the STs are at the bottom of the social, economic and

educational ladder (Bharti, 2018). Although there is an expansion of the lower castes in the 'middle class', there is a predominance of the upper castes in this category (Krishnan & Hatekar, 2017). Science has remained a domain of the upper castes, and the culture at the elite institutes, such as Indian Institute of Sciences (IISc), is Brahmanical (Thomas, 2020).

Caste is traditional (delineated in classical Hindu texts), is linked to power politics (formation of caste associations) and, more importantly, to humiliation (Jodhka, 2015). Caste and patriarchy are inextricably linked through the concept of 'honor' that emphasises the woman's chastity and male control over her sexuality; higher the 'purity', higher the caste (Chakravarti, 1993). Upper caste male advances/violence against Dalit women reinforces caste hierarchy and patriarchy (Gorringe, 2018). Inter-caste marriages continue to be frowned upon. A liberalization of the Indian economy since the year 2000 has had little impact on the SCs and STs; and although a few groups among these castes/tribes have improved their economic position, an overall economic inequality continues (Bharti, 2018).

Even more significant is the educational inequality. Privatization has increased the cost of education, and demand for new skills is rising. The SC proportion in education is lower than their proportion in population at all levels, and that of female SC falls even lower than their male counterparts. Thus, though the proportion of the SC females is about 16% of the female population in the country (97.8/586.4 million as per the 2011 Census), SC women constitute only 8.5% of women enrolled in doctoral studies in all branches, and 10% of women enrolled in B.Tech and Bachelor's of Science-Honours (AISHE, 2020, Tables 11 and 11a). SC women lag behind their male counterparts. While the all-India level of female teachers per 100 males is 74, there are only 58 SC female teachers per 100 male SCs (AISHE, 2020, p. 27). In the top engineering institutes, such as the IITs, the proportion of SC/ST remains small despite the quota system, with only about 2.5% of the faculty from SC and 0.34% from ST communities (Ministerial Response, 2018). At IIT Kanpur, there are at present 23 reserved category faculty, and none are female (Gupta, 2021).

Caste discrimination in academia could be structural, inadvertently constructed in policies and practices through caste-based categorizations (Rao, 2013). The caste bias is cultural as was recently exemplified[4] in the casteist abuses hurled by a female upper caste professor in an IIT at her students, suggesting an intersectionality of caste, gender and organizational position. It created huge furore leading to her suspension, indicating institutional and social responsiveness. A study on the students of an IIT found that SC/ST women are the most alienated and score lowest on self-efficacy (Gupta, 2019). Extreme vulnerability of the SC women doctoral students has been noted earlier in the article. A male faculty at an IIT recently resigned alleging caste discrimination.[5] Needless to say, due to a coalesce of gender and caste, of patriarchy and a lower caste position (with the stigma of untouchability), SC women face disadvantages and constraints higher in magnitude than the women of upper castes in rising from STEM education to careers.

A chilling letter by 30 women SC engineers of Silicon Valley in the United States that details the biases faced by the Dalit women in STEM in India and the carry-over of the casteist attitudes of the Indian managers in the U.S. gives an idea of the extent of casteism in 'modern' India:

"Being women in STEM is even harder when you have the added component of caste. We are also discouraged by the level of misogyny present in these schools, due to the incessant passing of inappropriate comments and the overly forward way in which dominant caste men would approach us. They have grown up abusing us and they expected to continue this shameful behavior in schools. We survived this only to be hurled into the casteist networks of Silicon Valley Tech" (Tiku, 2020).

It might not be an exaggeration to assume that for the women academics of SC/ST categories, the floor is extra sticky (fewer women moving forward), and the glass ceiling is thicker (more difficult to crack) compared to the women of upper castes, owing to structural and cultural biases arising out of the caste and gender hierarchy. Such biases imply loss of potential and an inability of the nation to use its human resources to the full.

Policies

The constitution of India provides the right to equality to all citizens irrespective of gender or caste. It also allows the State to make special provisions for the weaker sections such as the women, SC and ST to protect their interests. After Independence, India has implemented affirmative action for the SC/ST and more recently, for women in higher education and jobs.

The Government of India is also committed to enhancing women's participation in STEM. This is evident in several policies such as KIRAN for addressing issues such as break in career, relocation, training and infrastructure of women's universities. A pilot project of the GATI scheme was announced in 2020, on the lines of Athena SWAN in the U.K. Further, there are post-doctoral fellowships for women under various government departments and agencies. The recently launched Indo-U.S. Fellowship for Women in STEMM (the extra 'M' is for Medicine) is recognition of the fact that it is essential to provide opportunity to the talented women in STEMM to enhance their research capability. A doctorate from a reputed institute, and particularly from the developed countries according to some surveys (e.g. Pushkar, 2015), enhances prospects of a faculty position in the elite institutes in India.

However, as this article shows, gender is constructed in everyday practices; merit is constructed based on the opportunities arising from one's caste and gender position in society. Hence, there is a need to have an over-arching perspective which could provide a direction to the various existing policies and the new ones could be thought of. Although well-intentioned, the philosophy underlying many policies seems to reproduce gendered notions of a woman's primary domestic role. For instance, the Mobility Scheme for the women who had to relocate due to marriage, or transfer of husband or moving to take care of children or ailing parents, providing a filler while she

looks for other career options. The two-year childcare leave for a woman and single male parent government employee has similar underlying stereotypical assumptions. Further, most measures such as awards, fellowships and schemes are led by the government of India and therefore reflect a top-down approach. However, there is a need to connect this approach with a bottom-up approach through institutional reforms and talking to junior and senior researchers/academics and scientists' networks.

While there is an urgent need for gender equity measures in the short-term, the focus should be on achieving gender equality. Gender equity measures aim to overcome specific constraints for women, but they risk strengthening stereotypes as noted by European Institute for Gender Equality in its definition of 'gender equity'.[6] It is now increasingly recognized that gender inequality cannot be tackled by focusing solely on women. For instance, a UN document (UN, 2002, p. 9) reflected that 'more attention needed to be brought to the relations between women and men… there was a need to move away from "women" as a target group, to gender equality as a development goal'. An example here could be the childcare leave that should target the couple instead of a woman as the assumed primary caregiver. The message from the leadership that a couple and not a woman alone are responsible for the family is likely to have a powerful effect on the society.

Based on this article, it might be pertinent to note the chief aspects that need consideration: (a) biased organizational practices, (b) work-life balance structures, (c) work climate and (d) tapping the lower caste/class women's talent. Biased practices, such as those during recruitment and denial of opportunities due to stereotypes, require gender sensitization, transparency during selection procedures and a greater involvement of women in such procedures.

Lack of institutionalized care structure within institutes and in public spaces has a significant negative effect on women's careers. Such structures are required for two reasons: (1) for a better work-life balance for women (and men) and (2) for creating a socio-psychological climate in which it might be assumed by the recruiters and senior colleagues that women *can* take care of family (since gendered role assumptions will not change easily). A study using fictitious CVs in two industry sectors in Delhi found that indicating access to childcare in job applications partially reduces motherhood penalty (Bedi et al., 2021).

Structural changes that reduce hierarchy and improve informal interaction could improve the gendered work climate (Gupta, 2016). Large hierarchical structures are detrimental to gender equity climate (Smith-Doerr, 2004; Ridgeway, 2009). Studies show that the reservation policy for SC/ST in education and public jobs has created positive impact (Mosse, 2018). However, there is a need to devise policies specifically for the women of SC/ST in STEM education and careers to enhance their participation and integration in the knowledge economy.

Conclusions

This article began with an elucidation of a low numbers of women scientists in elite institutes, few women in leadership positions and lack of recognition for women scientists. While these are extremely useful parameters to judge women's position in science, the article attempts to use a social constructionist perspective to analyse the processes, structures and behaviours that constrain women scientists' position and their integration with the scientific community so as to understand the rationale behind the numbers. This article shows that the middle-class/upper caste background of most women scientists does not provide the cultural and social capital that is available to the men of their social background; the masculine hegemonic discourse at the workplace fails to create 'merit' for women.

Attaining numbers alone cannot prevent the reproduction of traditionally masculine cultures (Chesterman et al., 2005). To decipher such cultures, India needs more research on women in STEM, both qualitative and quantitative. There are no studies in India that examine, for instance, candidates' applications and procedures for recruitment to faculty positions (the procedures are 'confidential' and beyond the scope of an individual researcher), or those that extensively analyse women's and men's experiences at various institutes to understand the critical issues needing consideration or those that trace career paths of doctorate holders from various types of institutes. In the absence of such studies, the discourse on enhancing participation and the need for policies lack conviction even for the women scientists.

Until recently, the sociologists in India had taken little cognizance of the subject of women in science (Gupta, 2020a) or the middle-class professional women in general (Belliappa, 2013), perhaps because they are a well-off group, while the focus has been on the less privileged sections of the society. Despite workplace biases, most men and women in scientific research believe that inequality in numbers and position are not due to a systemic failure but due to the social structure that places dual burden on women or due to failure of women to avail opportunities (Gupta, 2020b). Individual incidents of discrimination are seen as unrelated to the system. Thus, unlike in the West, inequalities are rationalized not as an organizational issue, but as a problem of the social structure. As a result, there is a 'denial' of any gender discrimination in organizations (Gupta, 2020b), along with 'exhaustion' and 'scepticism' (Arora, 2021) about the entire discourse on 'women in science'.

Further, there is a near absence of studies and public discourse on the caste question in science (Thomas, 2020). The story behind a low participation of women in STEM in India is riddled not only with patriarchy and a hierarchical culture, but also with poverty and extreme exclusion (due to ascribed position) of a substantial population, leading to a loss of talent. Although there is an increasing recognition by the government of the need to tap women scientists' potential for gender equality and for boosting knowledge economy, the policies need to be backed by studies that aid in explaining and resolving the gender issue in science.

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Notes

1. Bhatnagar (or the Shanti Swarup Bhatnagar) award is the country's highest award for excellence in science and technology given annually by the Council for Scientific and Industrial Research, Government of India.
2. There is a considerable variation in middle-class income ranging from 250,000 per annum to about 2,750,000 per annum based on 2017-18 prices (WEF, 2020: p. 10). A large proportion of this class is salaried and rural (Aslany, 2019). The white collar educated professionals, including S&T personnel, constitute an urban middle class. Multiple identities within this broad 'middle class' exist; but there is a certain 'middleclassness' that defines the attitudes and values of this section due to common patterns of formal education, consumption and lifestyle aspirations (Capelos and Basu, 2021). One significant aspect of middleclassness is the expression of Indianness through focus on family (Radhakrishnan, 2011).
3. General' caste refers to upper castes who do not qualify for any reservations in government institutions. Scheduled Castes are 'untouchables' and are at the bottom of the caste hierarchy in the traditional Indian social system.
4. The media reports: https://qz.com/india/2001747/iit-kharagpur-professor-abusing-sc-st-students-is-not-a-one-off/; https://thewire.in/caste/iit-alumni-kharagpur-professor-caste-sc-st-students
5. Media report: https://www.thehindu.com/news/national/tamil-nadu/iit-professor-resigns-alleges-caste-discrimination/article35089086.ece
6. For definition of 'gender equity', see https://eige.europa.eu/thesaurus/terms/1175. It states: The term 'gender equity' has sometimes been used in a way that perpetuates stereotypes about women's role in society, suggesting that women should be treated 'fairly' in accordance with the roles that they carry out. This understanding risks perpetuating unequal gender relations and solidifying gender stereotypes that are detrimental to women.

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