

## Women and Science Education in India : A Saga of Marginalization

**ABSTRACT :** Science has traditionally been a male preserve. Socio-religious prejudices kept science education out of bounds for vast majority of women in India. Even today underrepresentation of women in science education is a stark reality. Physical, economic and psychosocial barriers restrict women's access. Flawed educational policies and plans (some of them vestiges of the colonial period) also hamper Indian women's engagement with science. Even the culture of science marginalizes women. The question now is how far the remedial measures will be effective in addressing the problem.

Underrepresentation of women in science in India is a persistent problem. If we turn back the pages of history we find the mention of only a few women who were famous for their erudition in science. In ancient India Gargi and Maitreyi were acknowledged as natural philosophers of repute. In the 12<sup>th</sup> century Leelavati, the daughter of the Indian mathematician Bhaskaracharya, was a mathematician and a natural philosopher in her own right. Bhaskara wrote a book on algebra and named it after his daughter<sup>1</sup>. One wonders why she did not follow her father's example and write books on mathematics and science herself. Indeed in the medieval period women's education in India took a backseat. There was little scope for women to engage with science during that period. Initiatives towards imparting formal education to females began during British rule in India. High schools for girls were established for imparting modern education. But initially very few girls enrolled. Socio-religious prejudices obstructed women's education. Gradually formal education for females gained popularity. The issues of tertiary education and professional participation of women came up. In 1882 Pandita Ramabai persuaded the Hunter Commission for allowing women to become doctors and teachers<sup>2</sup>. In 1883 Chandramukhi Basu and Kadambini Ganguly (née Basu) become the first female graduates of India<sup>3</sup>. The conservative practice of segregation of Indian women necessitated the examination of female patients by women doctors. So qualified women doctors were needed. The Madras Medical College admitted a few girls in 1875 for a certificate course in medicine so that they could treat female patients who were averse to being treated by male doctors<sup>4</sup>. In 1885 Lady Dufferin established the National Association for Supplying Female

Medical Aid to the Women of India. It was referred to as the Dufferin Fund. It helped start medical training programmes for women. It also sponsored women who intended to train as doctors, nurses and other medical personnel. The following year 1886 saw two Indian women Kadambini Ganguly and Anandi Gopal Joshi qualifying in western medicine<sup>5</sup>. Thus the field of medical education opened up for women of India. It is ironic that the social evil of segregation of women paved the way for their entry into medical education. Slowly and sometimes grudgingly the universities in India allowed the admission of female students to the different courses in science. In 1944 Asima Chatterjee became the first Indian woman to earn a doctorate degree in science awarded by an Indian university. In 1975 she was the first Indian woman to be elected as the General President of the Indian Science Congress<sup>6</sup>. It raises the question why it took so long for an Indian woman scientist to be elected to such a position. The list of names of Shanti Swarup Bhatnagar Prize (a coveted prize for scientific research in India) winners down the years shows very few names of women. In 2010 however three women were awarded the prize. But the problem of underrepresentation of females in science looms large.

Obviously the women in India continue to lag behind men in almost all the indices of education including science education even today. Among the university students, only about 40% are women. Table 1 shows the percentages of total enrolment and that of women's enrolment as students in the different faculties at the universities in India .

Table 1 shows that only around 39% of the seats in science faculty at the universities in India are occupied by female students. Women students are in minority in science-based courses like agriculture, veterinary science and engineering / technology. In the discipline of education women's enrolment surpass those of men. In liberal arts and medicine there are higher proportions of women than that in science. This reflects the greater social acceptability of some courses of study as being more appropriate for women. The reason is that education and medicine agree with the socially prescribed conventional roles of women as nurturers. Study of liberal arts is also deemed more suitable for women. It is argued that arts and humanities require attributes inherently possessed by women. It is therefore not surprising that about 44% of girl students were enrolled in the undergraduate arts courses as compared to about 39% in science in 2004-2005. Moreover, the

**TABLE 1. Percentage of Enrolment of Female Students in Different Faculties**

Faculty	Percentage of Total Enrolment	Percentage of Women
Arts	46.1	44.2
Science	19.8	39.4
Medicine	2.9	44.0
Agriculture	0.6	17.4
Veterinary Science	0.2	20.9
Engineering and Technology	6.9	21.5
Commerce/ Management	17.8	36.5
Law	4.0	20.0
Education	1.3	51.2
Others	0.9	37.7
<b>Total</b>	<b>100.5</b>	<b>39.4</b>

Source : Indian National Science Academy (2004). *Science career for Indian women: An examination of Indian women's access to and retention in scientific careers*. New Delhi : INSA.

percentage of women's enrolment in undergraduate science courses shows wide regional variation. For instance, about 64% female students were enrolled for B.Sc. course in the highly literate state of Kerala in the year 2000-2001 as compared to only 21% in Bihar<sup>7</sup>. The statistics regarding women's enrolment at the postgraduate level in science education and in research (Table – 2) also highlight their underrepresentation.

**TABLE 2. Percentages of Enrolment of Women at Different Educational Levels in Various Faculties of Universities of India in the Year 2000-2001.**

Faculties	Percentages of Women Enrolled at Different Levels		
	Undergraduate	Postgraduate	Ph. D
Arts	44.2	44.7	38.6
Science	39.0	42.5	37.2
Engineering / Technology	21.8	15.8	16.5
Medicine	45.5	34.4	29.3
Agriculture	17.2	18.8	14.6
Veterinary Science	21.6	18.6	14.5

Source : Indian National Science Academy (2004). *Science career for Indian women: An examination of Indian women's access to and retention in scientific careers*. New Delhi: INSA.

Table 2 presents an overall picture of underrepresentation. In science only about 42% of the postgraduate students and approximately 37% of the

doctoral candidates were female. The underrepresentation was particularly pronounced in engineering/ technology, agriculture and veterinary science.

**Obstacles in Women's Access to Science Education:**

The stumbling blocks can roughly be classified into the following categories: i) physical, ii) economic, iii) social, iv) Individual – level psychological, v) flawed educational policies and vi) masculine culture of science education. These categories of hurdles are distinct but interlinked as evident from the subsequent discussion.

**i) Physical Barriers in Women's Access to Science Education :**

The school or college offering science course may be physically distant. This problem is especially common in rural areas. Unavailability of transport or having to commute long distance by crowded public transport may act as deterrents. Non-availability of science stream/ courses in girls' schools/ colleges is also perceived as a hurdle. The prospect of having to stay at a hostel at a place distant from home for studying science courses may discourage the families of many female students. The living conditions at women's hostels in terms of cleanliness and security may be so unsatisfactory that a large number of students are put off. Limited number of hostel seats is also a big problem the female students from outside have to deal with.

**ii) Economic Barriers in Women's Access to Science Education :**

India being a developing country has to grapple with the problem of having millions of families with limited economic resources. Financial crunch forces many families to spend less money on the daughter's education than that of the son's. The rationale is that the son has the primary duty to support the family after he starts earning. So the money spent on the son's education will bring returns. But the daughter will be married off. Thus her education will not financially benefit her parental family<sup>8</sup>. Most families are therefore averse to fund the science education of their daughters because it is more expensive than one in arts or commerce.

**iii) Social Barriers in Women's Access to Science Education :**

Evidently gender stereotyping prevails in the Indian society. It prescribes distinct roles for the two genders. The society does not give much importance to women's education particularly their science education. In poorer families, the girls are involved in household work and sibling-care. It leaves them with little time or energy to devote to the serious study of science. Patriarchy supports those kinds of education for women which do not hamper their marriage prospects. Science education being more laborious is generally disapproved for girls belonging to conservative families. However, in some households

science education for females is encouraged simply because it is perceived to improve their marriage prospects. The patrifocal family structure in India does not allow freedom to girls to pursue the study of science in an unfettered manner. The issue of safety of girls is put forward. It is also argued that fostering the spirit of independence in girls may make them immoral and undermine the family values<sup>8</sup>. Early marriage, childbearing and childrearing come in the way of women hoping to receive tertiary education and conducting research in science. The society is however fast changing. Some educated, middle class and urban families in India genuinely support the science education of the daughters. But the phenomenon is not widespread.

**iv) Individual-Level Psychological Barriers in Women's Access to Science Education :** Psychological factors operating at the personal level also pose problems. Gender differential socialization practices make people view everybody and everything through the lens of gender. Science is construed as masculine. The internalization of such gendered perceptions make most individuals believe that science can only be mastered by men. The majority of women therefore believe that they are intellectually incapable of fathoming the intricacies of science. So they are unmotivated to study it. Having androgynous self-perception is conducive for studying science<sup>9</sup>. Androgynous self-perception is the perception of a combination of the conventionally masculine and feminine attributes in oneself<sup>10</sup>. The agents of socialization in India generally train girls in such a fashion that they generally lack assertiveness. They also learn to accept the stereotyped feminine role. Hence they do not feel the urge to study science.

**v) Flawed Educational Policies Blocking Women's Access to Science Education :** Gender bias in policies was evident during the colonial period. It continued even after independence.

a) *Gender Differentiation in Curricula*

British rulers had planned the education for males and females in India with distinct aims in mind. Indian men were educated to serve the colonial administration. Women were groomed to become western-influenced home makers. Female students were therefore encouraged to study less abstract subjects. This impeded women's engagement with science. Schoolgirls could study domestic science instead of mathematics. In the late nineteenth and the early twentieth centuries the women undergraduates of Calcutta University were allowed to study botany in place of physics<sup>11</sup>. Thus the intellect of females was undervalued.

Representations by women graduates to the Calcutta University Commission (1917) demanded the same curriculum for all pupils irrespective of gender. Women's organizations persisted for decades with this demand. Long after independence a Committee on the Differentiation of Curricula for boys and girls was constituted in 1961. The committee did not support the gender differentiation of school subjects. It proposed a common curriculum for all pupils in primary school. To break the moulds of gender stereotypes, it recommended the inclusion of home science as a compulsory subject both for all school students. The National Education Policy Resolution (1968) also disapproved of gender differentiation of curricular offerings. But it did not spell out the manner of implementation of the uniform curriculum. Thus many schools continued to offer female pupils home science and art instead of science and mathematics. Non-availability of women teachers in science and mathematics was the common excuse which was put forward. Finally the demand for a uniform curriculum for both genders was completely accepted in the National Education Policy of 1986<sup>12,13</sup>.

b) *Feminization of the Content of Science Education: The Case of Home Science*

The approach of the British administration in the matter of women's education in India was dictated by imperialist interests and patriarchy. The Indian social reform and nationalist movements were also patriarchal in this regard. The newly introduced subject – domestic science or home science fitted the bills of these three parties perfectly<sup>14</sup>. It was introduced in the high schools in India in the 1920s<sup>15</sup>. Later on it became a part of college education for women. The All India Women's Education Conference raised a fund to establish the first domestic science college for women in India – The Lady Irwin College<sup>16</sup> in 1932. Home science readily found social acceptance as a discipline suited for women. Conservative society argued that female students should be spared the rigours of studying intellectually demanding disciplines like mathematics, pure physics and chemistry. It was also opined that studying such subjects would be useless for women because they would inevitably become homemakers. The study of home science, it was iterated, would expose them to simple lessons of science and render them more efficient for domesticity. Thus initially the study of home science imparted simplified and fragmented knowledge of different branches of science and social science. It gave women the satisfaction of receiving education and enjoying social sanction for it. But it actually excluded many of them from the mainstream of science.

*c) Women's Science Education: Absent from the Agenda*

The policies and five-year plans of the government of India from independence till the mid 1980s did not address the issue of science education of women at all. A study of the policies and plans reveals a separation between "women's education" and "science education". The first (1951-56) and the second (1956-61) five-year plans focused simply on economic development. The third five-year plan (1961-66) emphasized scientific development. But the importance of inclusion of women in science was not specified. Similarly, the National Policy on Education (1964-66) highlighted the necessity of expansion of science education. But it did not clarify how more women could participate. The fourth plan (1969-74) aimed for equality and social justice. But women's underrepresentation in science apparently escaped attention. The Towards Equality Report (1974) in fact revealed how women had been bypassed by the planners. The need for adequate representation of females in science education was perhaps not realized because the traditional idea regarding women's education prevailed. For instance, The National Commission on Women's Education (1970) was aware of the need for greater participation of females in education. But it seemed to subscribe to the gender differentiated goals of education. The fifth (1974-79) and the sixth (1980-85) plans stressed on women's education in general but did not suggest how more women could be inducted to scientific and technological education<sup>17</sup>. Complete neglect of the cause of women's science education by the government for almost 40 years appears to have retarded its progress.

**vi) Masculine Culture of Science Education :**

Science continues to remain a male preserve. This is especially true in case of the physical sciences. The science curricula, textbooks, institutional policies, classroom environments, teaching – learning – evaluation styles etc. are biased in favour of males. A research on illustrations in science textbooks revealed that females are rarely depicted. If they are portrayed at all they appear in passive non-remunerative roles<sup>18</sup>. The institutional policies are not gender equitable. The enterprise of science demand so much of unrelenting involvement that women with household and childrearing responsibilities lose out<sup>19</sup>. The interactions in science classrooms generally favour the men. The teachers seem to pay more attention to them. There is covert discrimination against female students who feel marginalized<sup>20</sup>. A paucity of women teachers of science and mathematics especially at the tertiary level of education means that girls observe very few female role models. It

reinforces the erroneous notion that science is a masculine domain. The gendered culture of science mirrors the patriarchy prevalent in the larger society.

**Examining the Remedial Measures :** **i) Removing the Physical Barriers :** Distribution of bicycles to girl students under the Sarva Shiksha Abhiyan is aimed to help them attend educational institutions which are far from their homes. The female pupils of rural areas are likely to benefit more. It is an innovative step. But it remains to be seen whether it is backed by widespread social support. Otherwise it will not bring more girls to classrooms particularly science classrooms. To build more and better hostels for female students at the tertiary level, the University Grants Commission had issued guidelines on the special scheme for construction of such hostels during the tenth plan period<sup>21</sup>. It prompted the building of many women's hostels all over the country especially in the cities. But the demand for hostel seats still outstrips the supply.

**ii) Removing the Economic Barriers :** The government of India has announced either free or reduced cost of education for schoolgirls. Free textbooks and school uniforms are distributed by the government to girl students of poor families. The National Science Talent Search Scholarships are awarded to deserving students for pursuing courses in science and social science till the doctoral level. However, there is no quota for female applicants for award of the scholarships<sup>22</sup>. Girl students are exempted from payment of processing fee of applications for the Kishore Vaigyanik Protsahan Yojana. These fellowships are awarded to school and college students who are interested in conducting research<sup>23</sup>. There are some scholarships which are awarded only to female students. For example the Maulana Azad National Scholarship is awarded to meritorious girls belonging to the religious minority communities of India for pursuing higher secondary education including that in science. This scheme is significant because the education of women belonging to minority communities is a matter of priority<sup>24</sup>. The Post Graduate Indira Gandhi Scholarships are awarded to bright girls belonging to small families. These fund their postgraduate education including that in science<sup>25</sup>. Such schemes need wider publicity. Besides, the largesse will only be effective if these are accompanied by campaigns to generate more social support for the science education of girls.

**iii) Removing the Social Barriers :** Though gender discrimination continues to exist in our society yet some improvement in attitudes towards females is noticed. Recent legislations like The Pre-Conception and Pre-Natal Diagnostic Technique (Prohibition of Sex Selection) Act

(1994), The Commissions for Protection of Child Rights Act (2005), The Child Labour (Prohibition and Regulation) Act (1986), The Juvenile Justice (Care and Protection of Children) Act (2000), etc. have aided some girls and women of our country. The Right to Education (2010) has endowed every child (irrespective of gender) with the power to demand free elementary education. However, a lot more needs to be done to truly improve the social status of women. Meanwhile for making engagement with science more accessible for women several steps have been taken. In view of early marriage and childbearing of women an age relaxation of five years has been allowed to them for clearing the fellowship examination of the Council of Scientific and Industrial Research <sup>26</sup>. Many women are compelled to take a break from the pursuit of science to manage homes and raise children. The “Women Scientists Scheme” of the Department of Science and Technology, Government of India provides opportunities to such women to return to mainstream science after the hiatus. A National Task Force for Women in Science has been also set up in 2005 to inspire girls to take up science and to protect the interests of women scientists. A website and a directory of women scientists in the country have been prepared to facilitate their selection as examiners and conference speakers. Life histories of women scientists have been chronicled. Opinions have been elicited regarding ways of stress-reduction of female scientists <sup>27</sup>. However more initiatives are necessary to garner strong social support for nurturing the scientific potential of girls in the remote villages of the country.

**iv) Removing Individual – Level Psychological Barriers :** Merely offering incentives for women’s education in science will not work. The intrinsic motivation of females for participation in science must be developed. Confidence needs to be instilled in them that they can comprehend the complexities of science. Parent counselling may be made a part of the governmental programmes of education so that gender differentiated socialization is not practiced. A consistent provision of school guidance programme requires being implemented nationwide to nurture autonomy, self efficacy and achievement motivation among girls. It could become a component of the Kishori Shakti Yojana. At present the psychological aspects of women’s development are largely ignored.

**v) Government Policies and Plans Encouraging Women’s Participation in Science :** In the last twenty five years the policies and plans of the government reflect a trend towards promotion of women’s engagement with science. The seventh plan (1985-1990) emphasized science education at all educational levels. Accordingly the National

Policy on Education (1986) made science and mathematics compulsory for all schoolchildren. The New Education Policy (1990) stressed gender equality in education. But its impact was dampened by the non-expansion in tertiary education<sup>28</sup>. The eighth plan (1992-1997) advocated the use of science and technology to ease the workload of women. The plan noted that women are underrepresented in higher rungs of scientific research and management. The ninth plan (1997-2001) aimed at ensuring easy and equal access to education for girls and women. It intended to eliminate gender bias in all educational programmes<sup>29</sup>. The National Policy for the Empowerment of Women (2001) proclaimed that programmes will be made more effective to bring about greater involvement of women in science and technology <sup>30</sup>. The tenth plan (2002-2007) aimed to motivate girls to opt for the study of science and technology at the tertiary level. It also promised to ensure the involvement of women in developmental projects having aspects of science and technology <sup>31</sup>. Although these policies and plans appear gender equitable, a note of caution is necessary. The eighth, ninth and tenth plans aimed to use science and technology to reduce “women’s” household drudgery. This perhaps essentializes women as homemakers. However, special care was taken for engendering the eleventh plan (2007-2012). It aims to ensure good quality secondary education with focus on science, mathematics and english. It also intends to narrow the gender gap in student enrolment, dropout and retention rates <sup>32</sup>. But the effectiveness of these measures remains to be proven.

**vi) Making the Culture of Science Gender-Equitable :** Efforts are on to make the culture of science more women - friendly. The National Policy for the Empowerment of Women (2001) has mandated the development of gender sensitive curricula at all educational levels. The National Council of Educational Research and Training has taken the lead in making the science curriculum and textbooks gender equitable. It has also made the science teachers aware of the necessity of greater inclusion of girl students in class room interactions in co-educational institutions <sup>33</sup>. Despite these endeavours, biased institutional policies continue to obstruct women’s participation in science. Shortage of female science and mathematics teachers remains a problem. The National Policy on Education (1986) had recommended that at least 50% of teachers recruited in the future should be women <sup>34</sup>. But the Programme of Action (1992) mentioned the non-availability of mathematics and science teachers in girls’ schools <sup>35</sup>. The problem continues even today. It will be too much to expect that the culture of science which traditionally discriminates against females would be

transformed within a short period of time. However some signs of progress are noticeable. □

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Received : 13 April, 2011

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