Analysing gender gap in science: Government of India initiatives

Namita Gupta

This article provides an overview on the status on the S&T qualified women in science in the country and gives a glimpse of how S&T qualified women are placed across science and technology disciplines. Analysis of gender gaps and biases, implementation of effective actions based on identified gaps and stepping up support to gender equality are discussed. Government of India initiatives and policies to empower women and bring them back to mainstream science are elaborated along with achievements.

Keywords: Gender gaps, KIRAN programme, women scientists, women education, women scientist scheme, women in S&T.

EDUCATION is the most powerful tool to empower the lives of women in today's society. Education systems and schools play a central role in determining the interest of girls in science, technology, engineering and mathematics (STEM) subjects and in providing equal opportunities to access and benefit from quality STEM education. Teachers, learning contents, materials and equipment, assessment methods and tools, and the overall learning environment in school, are all critical in ensuring the interest of girls in and engagement with STEM studies and, ultimately, STEM careers[1]. Getting more girls and women into STEM education and careers requires holistic and integrated responses that reach across various sectors.

Society has to understand that women as an important human resource have made important contributions in many areas like medicine, pure science, biotechnology and are venturing into new fields like information technology, engineering and space technology. The 2030 Agenda for Sustainable Development includes 17 Sustainable Development Goals (SDGs) including SDG 4 on education and SDG 5 on gender equality.

Status of women in higher education in science and technology in India

According to UNESCO Institute for Statistics (UIS) fact sheet 2017 on Women in Science, women account for 28.8% of the world's researchers. In other words, less than 30% of the world's researchers are women[2]. UIS fact sheet for 2018 reconfirms the same scenario[3]. In India, as on 1 April 2015, there were 39,388 (13.9%) women out of 2.82 lakh R&D personnel directly engaged in R&D activities. According to the latest *Research and Development Statistics at a Glance 2017–18* brought out by the Department of Science and Technology (DST), Government of India, 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 (ref. 4). Data on women enrolment in higher education institutions can be one of the parameters to assess the growth of S&T qualified women in the country[5]. There has been remarkable increase in the number of women enrolled in the institutions of higher education from 13.67 lakh in 1989–90 to 27.42 lakh in 1999–2000. In 2016–17, women enrolment shot up to 141.56 lakh in higher education institutions[6].

Table 1 shows that their percentage share in total enrolment has gone up from 32.3% in 1989–90 to 47.9% in 2016–17. We hope that in coming years, women enrolment may reach 50%, that is half of the total students enrolled in higher education institutions may be women. In absolute terms, the number of women in S&T faculties has increased from 3.4 lakh in 1989–90 to 46.34 lakh in 2016–17 (ref. 6). Among the women enrolled in S&T faculties, 53.3% belonged to pure science, 15.5% to medicine, 29.4% to engineering and technology and 1.5% to agriculture during 2016–17.

Table 2 indicates that women enrolment in science and technology disciplines in higher education sector is increasing. However, rate of this growth is not as it should be for a densely populated country like India. Doctorate degree holders are highly qualified personnel of the higher education system. Analysis of data of Ph D degree recipients during 2015–16 reveals that in S&T

Namita Gupta is in the Knowledge Involvement in Research Advancement through Nurturing (KIRAN) Division, Department of Science and Technology, Technology Bhavan, New Mehrauli Road, New Delhi 110 016, India.
e-mail: namita@nic.in

Table 1. Growth of women enrolment in higher education by various faculties (thousands)

	1989–1990		1999–2000		2009–2010		2016–2017	
Faculty	(000)	%	(000)	%	(000)	%	(000)	%
Science	275	6.5	520	6.7	1215	8.3	2474	8.4
Engineering and technology	16	0.4	63	0.8	468	3.2	1364	4.6
Medicine	45	1.1	91	1.2	235	1.6	717	2.4
Agriculture	3	0.1	16	0.2	16	0.1	68	0.2
Veterinary sciences	1	0.02	3	0.04	4	0.03	11	0.03
Total women enrolment in S&T faculties	340	8.1	693	8.94	1938	13.23	4634	15.63
Others	1027	24.2	2049	26.5	4142	28.3	9522	32.3
Total women enrolment	1367	32.3	2742	35.44	6080	41.53	14156	47.93
Total enrolment	4247	100.0	7733	100.0	14625	100.0	29427	100.0

Source: Research and Development Statistics, DST and UGC Annual Report.
Note: 1. Percentage has been worked out on total enrolment in respective years. 2. Science means pure or natural science throughout this paper.

Table 2. Enrolment of women in higher education in various science and technology disciplines (thousands)

Year	Science	Engineering	Medicine	Agriculture	Veterinary science	Total percentage share
2001–02	699.4 (19.9)	131.8 (3.8)	123.0 (3.5)	9.1 (0.3)	3.2 (0.1)	966.5 (27.6)
2002–03	736.9 (19.9)	154.0 (4.2)	134.4 (3.6)	9.3 (0.3)	3.0 (0.1)	1037.6 (28.1)
2003–04	809.0 (20.2)	165.3 (4.1)	145.3 (3.6)	9.9 (0.2)	3.0 (0.1)	1132.5 (28.2)
2004–05	850.2 (20.1)	175.7 (4.1)	153.7 (3.6)	10.6 (0.3)	3.4 (0.1)	1193.6 (28.2)
2005–06	901.3 (20.2)	185.8 (4.2)	162.6 (3.6)	10.7 (0.2)	3.6 (0.1)	1264.0 (28.3)
2006–07	901.3 (19.1)	185.8 (3.9)	162.6 (3.5)	10.7 (0.2)	3.6 (0.1)	1264.0 (26.8)
2007–08	1014.0 (20.2)	209.5 (4.2)	183.4 (3.6)	12.1 (0.2)	4.0 (0.1)	1423.0 (28.3)
2008–09	1129.3 (20.2)	276.8 (4.9)	202.8 (3.6)	15.3 (0.3)	4.5 (0.1)	1628.7 (29.1)
2009–10	1214.9 (20.0)	467.6 (7.7)	234.7 (3.9)	16.4 (0.3)	4.3 (0.1)	1937.9 (32.0)
2010–11	1349.2 (19.1)	800.7 (11.4)	330.0 (4.7)	25.2 (0.4)	6.9 (0.1)	2512.0 (35.7)
2011–12	1662.1 (19.2)	959.1 (11.1)	350.3 (4.0)	24.8 (0.3)	7.0 (0.1)	3003.3 (34.7)
2012–13	1175.3 (13.5)	982.3 (11.3)	391.1 (4.5)	27.8 (0.3)	8.1 (0.1)	2584.6 (29.7)
2013–14	1911.1 (18.1)	992.8 (9.4)	364.6 (4.4)	30.4 (0.3)	9.4 (0.1)	3408.3 (32.3)
2014–15	2320.9 (18.6)	1232.0 (9.9)	637.0 (5.1)	55.4 (0.4)	10.0 (0.1)	4255.3 (34.1)
2015–16*	2685.4 (19.9)	1360.0 (10.1)	676.2 (5.0)	65.6 (0.5)	9.9 (0.1)	4797.1 (35.6)

Source: Science and Technology indicators tables 2017–18, NSTMIS, DST[5].
Note: Figures in bracket indicate discipline-wise percentage share of women enrolment. *Provisional.

Table 3. Faculty-wise number of doctorate degree awarded, 2015–16

	Number of Ph D awarded		
Faculty	Total	Women	% Share of women Ph Ds
Science	7,636	3,377	44.2
Engineering and technology	4,772	1,528	32.0
Medicine	1,021	437	42.8
Agriculture	1,350	493	36.5
Veterinary science	283	65	23.0
Computer science/computer application	698	220	31.5
Total	15,760	6,120	38.8

Source: UGC Annual Report, 2016–17.

faculties, out of total doctorate degrees awarded, 38.8% were women. Out of total doctorates awarded in pure science, 44.2% were women, followed by medicine with 42.8% and agriculture with 36.5%. In engineering and technology, women took 32% of the total doctorates awarded (Table 3).

Gender gap in science

The above data shows that enrolment of women in science and technology disciplines has grown with time. While the number of women earning doctorate degrees in different fields of science and technology is growing

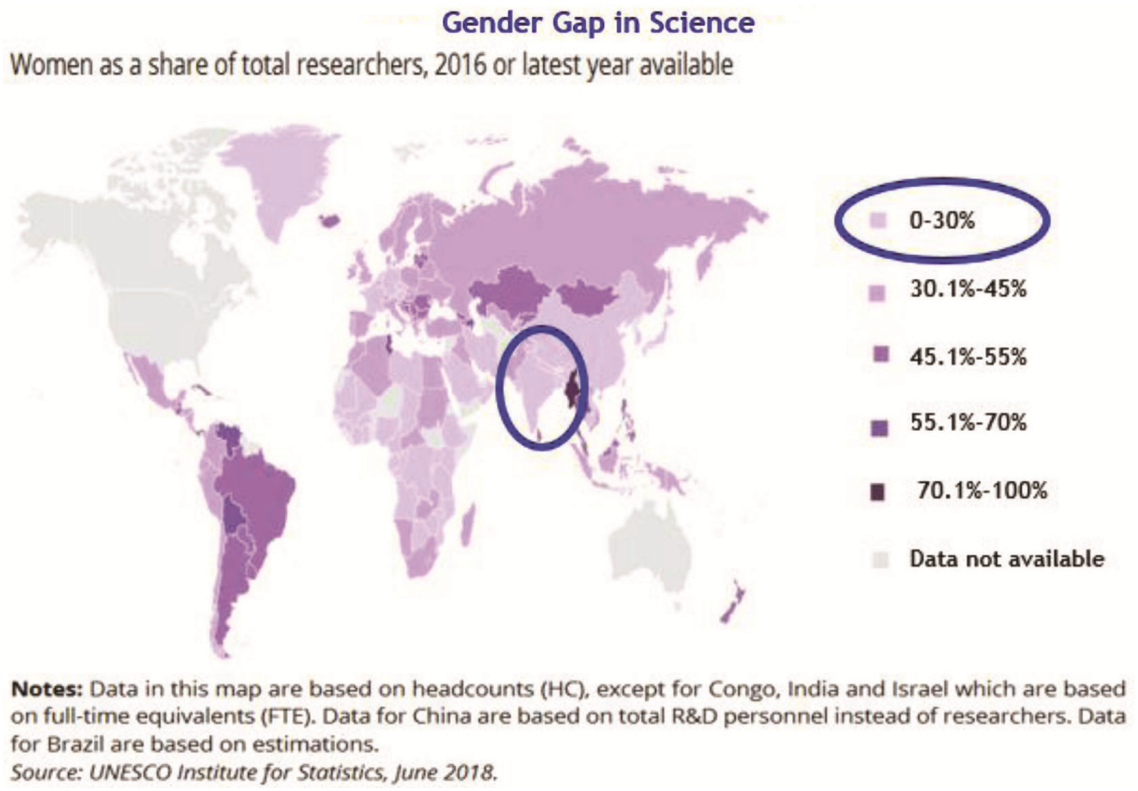

Figure 1. Percentage share of women researchers in the total number of researchers by country, 2016.

every year, number of women scientists entering the workforce is not growing at a similar pace[7]. It is important to understand and analyse the reasons for their fallout from entering the science and technology areas.

Analysing gender gaps and biases in science

Family support plays an important role in any woman's career and its growth. Achieving heights in a career generally begins with a successful personal life and good family support. Women fall out of science, technology, engineering and mathematics (STEM) areas because of variety of reasons, some known to society while others remain hidden but play an important role from beneath. Global map in Figure 1 shows the gender gap in science in terms of share of women in the total number of researchers by country. Women fall out of STEM pipeline and majority of them do so because of societal and cultural reasons[8]. Some of these are as follows.

Education is a family decision

Educational decisions in our country are generally family decisions and not individual choices, as education involves investment of collective family resources with collective impacts. Decisions are primarily based on projected impact on the collective family welfare. For parents, daughter's education involves family resources, status, marriage considerations and these become too important to leave choices in the hands of individual students. Family and social consequences become more significant in case of a girl child rather than her interest and will.

Economic factors

These play a major role in academic decisions and are major constraints for women in pursuing science. 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 an arts or a commerce degree.

Gender stereotypes and gender roles

Gendered family responsibilities and emphasis on homely traits for daughters makes the situation less favourable to study science. Widespread Indian cultural model of a family is patriarchal in which gender roles are differentiated and all household responsibilities lie with female members of a family. Individual women's goals and interests get merged for collective family welfare and smooth functioning of household activities.

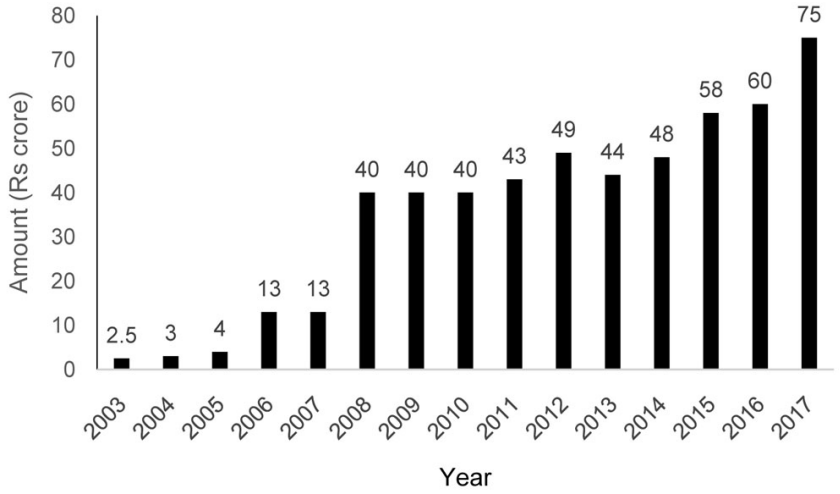

Figure 2. Trend of investment in Women Component Plan, 2003–2017.

Conformity to social expectations

Families expect daughters to marry and assume obligations to their husband's family. Many families think that a daughter's education would primarily benefit her in-laws rather than her natal family. Such families traditionally view boys' education differently from girls'.

Male-dominated environment

Women in STEM are highly visible minorities. Male-dominated social context of science and engineering is a major constraint on women's participation. Girls feel uncomfortable in a male-dominated environment while pursuing science but more and more women are catching up now.

Lack of role models

It is much easier for girls to pursue science and imagine a career there when they see more successful women examples. Lack of role models continue to hinder career choices of girls away from STEM subjects.

Government of India initiatives for promoting women in science

Government of India has been striving to empower women through various initiatives and programmes. Department of Science and Technology (DST), India, has been actively engaged in creating an ecosystem and enabling an environment for women in S&T domain. DST through its various schemes and programmes is working towards the cause of promoting women in science. Women Scientist Scheme (WOS) was launched in 2002, to address the challenges faced by women due to various reasons. In 2014, DST restructured all women specific programmes under one umbrella called Knowledge Involvement in Research Advancement through Nurturing (KIRAN). The mandate of KIRAN programme is to bring gender parity in S&T through gender mainstreaming. 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. KIRAN has the following components.

Women Scientist Scheme

Women Scientist Scheme (WOS) aims to provide opportunities to women scientists and technologists who desire to return to mainstream science after a break in career due to social responsibilities. Under this scheme, women with S&T qualifications are encouraged to pursue research in frontier areas of science and engineering, on problems of societal relevance, and to take up S&T-based internship followed by self-employment. Around 6000 women have been brought back to mainstream science through the scheme. Figure 2 gives the trend of investment in women component plan. Number of projects supported year-wise since the initiation of WOS is given in Table 4. WOS has three components: WOS-A, WOS-B and WOS-C.

WOS-A (Fellowship for research in basic/applied science): This component supports women scientists and technologists for pursuing research in basic or applied sciences. Women with a break in career after post-graduation are also encouraged to pursue Ph D with the support of WOS-A fellowship as the aim is to bring them back into mainstream science by providing fellowship to enhance qualification or research experience. Approximately 40% women were able to attain their Ph D

degree with the help of WOS-A fellowship during the tenancy of WOS-A research projects. It proves the relevance and popularity of the scheme.

WOS-B (Fellowship for research in S&T-based societal interventions): This fellowship focuses on S&T solutions of challenges/issues at grass root level for social benefit. Projects with specific location interventions addressing issues in rural/urban areas are invited from women scientists/technologists. They are required to work on development and adaptation of technology, transfer of technology from lab to field and its scaling up for improving quality of life and providing opportunities for income generation. Under the scheme, project development workshops are also organized to enable candidates to write viable proposals.

WOS-C (Internship for the self-employment): WOS-C, also known by name KIRAN-IPR, is a unique programme of its kind in the world imparting on-the-job training to highly S&T qualified women in the area of IPR. It provides opportunity to S&T qualified women for a sustainable career including self-employment or work from home options. Women can begin their career even at the age of 45 years. It is also a good example of public-private partnership and employment generation for women. In this, a year-long training in the domain of intellectual property rights (IPRs) is provided including one-month orientation programme followed by eleven months on-the-job training in law firms, IP divisions of CSIR, DRDO, ICMR, IP attorney firms, etc. More than 600 women in ten batches have been trained. The programme has earned widespread popularity in the country and trained women workforce in area of IPR. It has also inculcated the culture of patents handled by technical people in law firms, previously handled by lawyers.

Table 4. Number of projects supported under Women Scientist Scheme

Year	WOS-A	WOS-B
2003	145	31
2004	94	37
2005	73	22
2006	84	43
2007	131	42
2008	152	30
2009	174	40
2010	197	27
2011	250	35
2012	214	47
2013	222	65
2014	280	35
2015	261	36
2016	250	56
2017	302	50

Source: KIRAN Division, DST.

S&T for women

Science and Technology for women programme was initiated in 1981–82 with the mandate to promote gender equality and empower women at grass root level with inputs of S&T through development, adaptation, adoption, transfer, demonstration, replication of appropriate and successful technologies. More than 2000 projects have been supported. Around 500 technologies have been developed through individual projects, coordinated programmes and women technology parks.

Consolidation of university research for innovation and excellence in women universities'

KIRAN is involved in taking proactive measures through the component – Consolidation of University Research for Innovation and Excellence in Women Universities (CURIE) to develop state-of-the-art infrastructure in women universities to attract, train and retain promising girl students in S&T domains. Seven women universities have been supported based on their overall performance: (1) Avinashilingam Women University, Coimbatore, (2) Banasthali University, Banasthali, (3) SNDT Women University, Mumbai, (4) Sri Padmavati Mahila Visvavidyalayam, Tirupati, (5) Karnataka State Women University, Bijapur, (6) Mother Teresa Women's University, Kodaikanal and (7) Indira Gandhi Delhi Technical University for Women, New Delhi

After CURIE support, enrolment of girl students in undergraduate and postgraduate levels has enhanced by three fold. There is a boost in research culture evidenced by research projects and good publications. Extra-mural funding has also increased due to state-of-the-art laboratories developed through CURIE support.

Women technology parks

Women technology parks (WTPs) act as a single window hub for convergence of diversified technologies, leading to socio-economic development of women through capacity building and adoption of location-specific technologies. Diverse technology areas like agriculture, including fisheries, animal husbandry, horticulture, aromatic and medicinal plants, forestry, alternate livelihoods, post-harvest technologies, natural resource management, health and sanitation, occupational hazards, management of natural resources, sustainable agricultural practices, etc. form the core areas of interventions. Figure 3 shows WTPs developed in various states of the country.

Training and capacity building

Several training programmes specifically for capacity building of women scientists working in various sectors

Figure 3. WTPs at different locations act as single window for S&T interventions. (Source: SEED Division, DST.)

covering multifarious themes are conducted in partnership with premier institutions including the National Programme for Training of Women Scientists and Technologists in the Government that provided opportunity to over 1000 women scientists to upgrade their knowledge base and skills.

Indo-US fellowship for women in STEMM

Another new component, INDO-US Fellowship for Women in STEMM (WISTEMM) initiated in 2017–18 aims to provide opportunities to Indian women scientists, engineers and technologists to undertake international collaborative research in premier institutions in USA to enhance their research capacities and capabilities. Funding support extended includes stipend, airfare, health insurance, contingency and conference allowances. Under the first batch, twenty women have been awarded the fellowship.

Mobility

'Mobility' component aims to address relocation issues of women scientists working in regular positions in Government organizations. It will provide opportunities to women scientists who are facing difficulties in pursuing their present job due to relocation in a different city primarily due to family and social responsibilities.

Standing committee for promoting WoS

To address the issue of low representation of women in Science and Technology (S&T) domain, particularly in planning and policymaking, DST constituted 'Standing Committee for Promoting Women in Science' in March 2016 with representation of eminent Scientists/Educators/Administrators. The Standing Committee has met twice and made recommendations such as promoting women-specific technology business incubators, sensitization and women specific outreach programmes, mentorship workshops and leadership trainings to improve women participation in S&T domain. Implementation of these recommendations is under progress.

Vigyan Jyoti

To enhance participation of women in S&T domain, DST plans to introduce interventions right from Class VIII

onwards and then focused hand-holding after class X including coaching, mentorship, interaction with role models, and so on in order to stimulate equity and equality in participation of girls in higher education in S&T. The new initiative Vigyan Jyoti would address issues of women at every level and thus reduce chances of dropouts. Main highlight of Vigyan Jyoti would be to intervene at school level and enhance women participation in under-represented subject areas like physics, mathematics, earth and atmospheric sciences besides classical engineering subjects like mechanical, civil and electrical engineering. Vigyan Jyoti is being launched soon on a pilot scale in 5–7 districts covering different regions of the country.

In addition to major efforts by the DST, many other departments and agencies are also working to enhance participation of women in science. Department of Biotechnology (DBT) has a programme called BioCARE. It aims to promote women in biological sciences. BioCARE is supporting both employed and unemployed women scientists on their first grant. Support under BioCARE is available at different levels up to 55 years of age of the applicant. UGC has post-doctoral fellowship for women (UGC-PDF) which is a 5-year programme with 100 positions in which 50 are for science and 50 for humanities with upper age limit as 55 years. Then there is PG Indira Gandhi Scholarship for Single Girl Child under which support is provided for two years (10 months per year) with maximum age for the scholarship being 30 years.

Way forward

Despite many hindrances, women in India have made great strides over the years. It takes more than a policy to bring and retain more and more women in science. A strong commitment to gender mainstreaming is required. To achieve this we need to do the following.

Spread awareness: Awareness that pursuing science for girls is not as difficult as it is presumed, needs to be spread among parents. With family support and encouragement, girls can be high achievers in science.

Mentoring: Along with family support, having teachers who mentor and encourage girls in STEM subjects can have more impact. Mentorship programmes for girls at secondary and senior secondary levels are the need of the hour.

Make education gender sensitive: There is a need to promote positive stereotypes of roles of women in textbooks. It is important that when girls come out of school, they have the dream to carve a path for themselves. Education for boys at school level should be in the direction of making them gender sensitive.

Talks by senior scientists and STEM professionals: Schools should arrange talks by scientists, senior researchers and STEM professionals regularly to provide opportunities to students to learn and interact with them.

STEM scholarships to meritorious girls: Scholarships to meritorious girls at school levels can provide a boost to girls to pursue science at graduate and postgraduate levels and take up science as a career.

Media efforts to increase visibility of women in science: Many women feel isolated and dejected as they progress through the STEM pipeline. They lose self-confidence due to lack of support from peers, teachers and advisors. Motherhood also places risk on securing STEM career options. Our media can play a big role in bringing more girls into science by increasing visibility of great women scientists and achievers to create and enhance interest of young girls in STEM areas.

Some other interventions required at higher levels are: policy changes to guard against subtle bias, networking and internship opportunities for women in STEM, Government programmes to transform cultures of academic science, and, focus on retaining women employees in the workforce to maintain better gender ratios.

Women also need to come forward and make use of available opportunities and explore various avenues. A woman should try not to be self-conscious if she is the only woman in the class or meeting room. She should seek help from peers when needed and should never lose self-confidence. Mothers need to raise aspirations of daughters to expand their dreams.

Conclusion

There has been a change in women's attitudes towards scientific careers and personal life over the generations. India has come a long way as a society, but still has a long way to go before both women and men are granted equal opportunities from various fronts to become successful STEM professionals. Together we should find solutions that give both men and women proper access and necessary support to pursue a career in STEM.

Realizing the importance of women's education, Government of India is making all efforts to promote and retain women in science. KIRAN programme of DST encompasses women-exclusive schemes and encourages them to foster their career by not only undertaking research in science and technology (S&T) but also focusing on S&T solutions of issues and challenges at the grass root level for social benefits. KIRAN embraces women-exclusive schemes of DST with the mandate to bring gender parity in S&T through gender mainstreaming. Other departments and agencies such as DBT and UGC

are also stepping up support to promote and retain women in science. Special scholarships and awards have been instituted to attract students in science and women in particular.

Overall, sensitivity to women's issues among masses has increased; yet more needs to be done. Gender sensitivity has to be inculcated in the minds of young boys so that they understand and address gender issues with broader perspectives when they reach the positions to do so both at personal and professional fronts. Women should be judged by their ability to do the job and not by their gender.

1. UNESCO Open Access Repository. Cracking the Code: Girls' and Women's Education in Science, Technology, Engineering and Mathematics (STEM), UNESCO, 2017, ISBN-978-92-3-100233-5; http://unesdoc.unesco.org/images/0025/002534/253479e.pdf
2. UNESCO Institute for Statistics Fact Sheet No. 43, Women in Science, FS/2017/SCI/43, March 2017.
3. UNESCO Institute for Statistics Fact Sheet No. 51, Women in Science, FS/2018/SCI/51, June 2018.
4. Research and Development Statistics at a Glance 2017–18, Department of Science and Technology, India.
5. Science and Technology Indicators Tables 2017–18, Department of Science and Technology, India; https://www.nstmis-dst.org
6. Research and Development Statistics, Department of Science and Technology, India (various issues 1990–91, 2000–01, 2011–12).
7. Godbole, R. M. and Ramaswamy, R. (eds), *Women in Science and Technology in Asia: Women Scientists in India*, Indian Academy of Sciences, Bangalore, 2015, Annex 03, pp. 67–84.
8. Kumar, N. (ed.), *Women and Science in India – A Reader*, Oxford University Press, 2009.

ACKNOWLEDGEMENT. I thank the Department of Science & Technology for allowing me to write this paper.

Received 29 July 2018; revised accepted 8 March 2019

doi: 10.18520/cs/v116/i11/1797-1804