Indelible Impressions of Women Scientists in India

Dr. K. Vijaya
Associate Professor & Head
PG & Research Department of Historical Studies
Quaid-E-Millath Government College for Women (Autonomous)
Chennai, Tamil Nadu
&
Dr. P. Maheswari
Former Assistant Professor
Department of History, Tourism & Travel Management
Ethiraj College for Women (Autonomous)
Chennai, Tamil Nadu

Abstract

Women in India have historically been excluded from knowledge generation and dissemination. Science has been especially considered as a masculine domain. In most patriarchal societies, formal education does not try to dispel myths about women being a subordinate part of society. Amongst practitioners of science and technology in India, women constitute a distinct minority. The apparent absence of women scientists in a specific culture does not necessarily mean that women are not engaged in scientific activities. Gross regional disparities and gender equity issues are evident in History. It is impossible to generalise the contributions of women in science and technology due to heterogeneous culture in India. This research work explores the significance of women's contribution to science and describes how women have challenged preconceived notions about their capabilities. The study attempts to identify the struggles of few women scientists in India who have made indelible mark to establish their identity and also analyse the reasons for their detrimental position in scientific arena. Despite the increasing recognition of the role of women in science and technology, women are still working under an environment dominated by men. Thus, for achieving sustainable development of India, a fair environment is essential, wherein both men and women can compete on an equal footing.

Keywords: Science, Technology, Gender Equity, Sustainable Development, Women Scientists.

Introduction

Women's empowerment through science and technology has all the components that enable them to comprehend their potential and shape their lives in accordance

with their aspirations besides strengthening the advancement of science and wealth accumulation. Their participation and commitment in the present day information society on an equal footing with that of men would directly contribute in improving the livelihood of people. However, realizing these potentials is certainly challenging with many variables and barriers. Indian women have historically been barred from knowledge generation and dissemination. Science has been especially considered as a masculine domain. In most patriarchal societies, formal education does not try to dispel myths about women being a subordinate part of society. Amongst practitioners of science and technology in India, women constitute a distinct minority. The challenge thus is to break gender inequality in all dimensions.

Review of Literature

Today, science is considered as an agent of social change, national restoration, economic resurrection and national security. The published literature on women in Science and Technology has also undergone an explosive expansion in the past years. Many studies reveal that Women in science consist of meager representation in all over the world even after the fruitful efforts have taken against the gender discrimination in access to education and employment opportunities. This also clearly indicates an increasing consciousness among men and women scholars to take up the cause of women as contributors to human development and as a collaborator of their male counterpart. Men of Science and Technology in India (1964), a directory published by Government of India contains comprehensive information of scientific and technical personnel with their achievements, who have specialized in their respective branches in India. Krishnaraj (1991) highlights the problems faced by women scientists. Deepak Kumar's, (1995) Science and the Raj – A study of British India, makes implicit and explicit distinctions between colonial and metropolitan sciences in terms of their aims, contents and the mentalities of their patrons and practitioners. Lilavati's Daughters: The Women Scientists of India by Godbole (2008) is a collection of (auto) biographical essays of about 100 women scientists. Kumar (2009) provides an overview of Indian Women engaged in science. The volume brings together the writings of prominent academics and researchers who discuss gender and science in the context of Indian culture and explores the relevance of gender theories.

Women and technology has not drawn enough attention of Indian scholars. Theoretical debate around gender and technology is almost lacking in the philosophy, history and sociology of science. There were debates on the masculine nature of technology, fundamental questions were raised; theories were developed on the mutual shaping of gender relations and technology; debates were framed on the gendered identities and technology. However, a precise attempt to focus on the women scientists in India from the historical perspective is crucial for a progressive state.

Objective

- To discuss and understand the struggles and contributions of women scientists in India

Struggle Against Orthodoxy

During 18th and 19th century, in traditional Indian society, women as daughters are kept under the restricted supervision and authority of their parent's right from their infancy to adulthood. Orthodox taboos are imposed on women, such as a daughter's role is very limited and restricted to certain level. The influences, attitudes and stereotyped beliefs by which women are hemmed by males, affect their development and personality in various ways. Their talents and abilities instead of being developed and cultivated, remain unexplored, unsounded and perhaps even undetected, besides being deliberately suppressed or ignored. Domestic sphere was the most important field in woman's activities. Thus, her whole day was occupied with the domestic affairs which formed the usual routine. As regards the education of common women, girls belonging to middle – class family did not receive much education. The subjects of studies were mainly domestic- science such as needle work, embroidery, cooking and household work. This deprivation had natural impact, unfortunate psychological repercussions and inflicted on them, the added burden of frustration, self – pity and inhibition. Increasingly, however, the prevailing view that woman should only fulfill their gendered roles as daughter, sister, wife and mother and should not trouble themselves with work for financial gain or with any other serious intellectual pursuits. Ideally, traditional law and custom struck a balance between the protection of women and respect for women.

Indian women wrote and spoke about women's condition, formed organizations to secure desired change and eventually had an impact on the institutions of their society. Education was foremost on their list, followed by child marriage and the problems of widows and dowry. As women became literate and found a "voice," they were able to express their own version of women's positions, grievances, and solutions.

Access to Science Education

Intellectuals debated the position of women in the 19^{th} century and first time, raised their voice against the inferior status of women in society. Raja Ram Mohan Roy, Ishwar Chandra Vidyasagar, M.G Ranade, Maharshi Karve, Jyotiba Phule, Dayanand Saraswati and many others were quite concerned with woman's subordinate position in the society. With the help of these social reformers, women of India slowly began to recognize their true potential. She therefore, started questioning the rules laid down for her by the society. The 19th century witnessed the consolidation of British power in India and the acceleration of western contact

which brought far -reaching changes in the social structure. The westernization involves certain values preferences. In this way several Christian missionaries played an important role in spreading the western education among women in several part of the country.

High schools for girls were established for imparting modern education, but initially very few girls enrolled. Despite socio-religious prejudices obstructing education to women, formal education for females gained popularity gradually. The issues of tertiary education and professional participation of women grew up which is resulting in breaking of barriers and earning a respectable position in society and the world. Female literacy crawled from 0.2 per cent in 1881 to 1.8 per cent in 1921. There are a quite number of broad stages in the development of higher education for women. Though some colleges were founded in different parts of British India, the Wood's Despatch of 1854 was the first major pronouncement on female education. In 1857, three universities came in the Presidencies and others came up after 1920.

Among the various sub – disciplines of science, medicine was the first to attract Indian women. The participation of women in engineering remained negligible till the early 1980s. It is only in the past fifteen years that their enrolment has increased. Unlike the medical profession, engineering did not establish exclusive colleges for females. In 1882, Pandita Ramabai persuaded the Hunter Commission for allowing women to become doctors and teachers. In 1883, Chandramukhi Basu and Kadambini Ganguly become the first female graduates of India. The conservative practice of segregation of Indian women necessitated the examination of female patients by women doctors. Hence, qualified women doctors were needed. 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, which helped to 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. Thus the field of medical education opened up for women of India.

Slowly universities in India allowed the admission of female students to the different courses in science. 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. It is only in the twentieth century that some women could get training in Physics and other basic sciences. Between 1935 -1947, the number of women's colleges totaled to 37. They were run by Christian missionaries and Hindu reform organizations. There were also women in co-educational institutions. The field of science has been considered "non – feminine" and therefore for a long time girls were not encouraged to take

science subjects. Science being the most advanced branch of knowledge, women were late entrants.

Since Independence, the Indian Parliament has adopted major policy statements relating to higher education and S&T development. Article 15(1), 16(1), 16(2) of our Constitution provide for equal rights and privileges for both men and women and guaranteed equality and liberty. Men and women were declared equal before law. With this constitutional safeguard, a feeling that the problems of inequality, inferiority and discrimination against women have been solved was generated. The Kothari Education Commission (1964-1966) emphasized that Mathematics and Science are important subjects and adequate preparation therein is essential to gain admission to significant courses at the university stage. It recommended that special efforts should, therefore, be made to encourage girls to study mathematics or science at the secondary stage and special efforts should be made to prepare women teachers in these subjects. To provide a nodal point for Science and Technology in the broadest sense, apart from specific areas such as atomic energy, space and electronics, The Prime Minister of India, Smt. Indira Gandhi has set up the Department of Science and Technology. This department has created the first effective institutional framework for advice to Government on matters relating to Science and Technology by setting up the National Committee on Science and Technology in 1971. The Department of Science and Technology began to coordinate science plans since 1974 and plays a unique role in promoting women in research and technology development in the country. The first data on Indian women scientists was collected in 1975 by Indian Women Scientists Association. IWSA mooted a small, explorative study in collaboration with SNDT Women's university and analyzed employment status, job satisfaction and obstacles to careers were examined.

Empowering women in science is a high priority for the Government of India, which is evident from various schemes and programmes that have been undertaken towards promoting science education and equalizing science-based professions. Commendable efforts have been made by government since the Sixth Five Year Plan period (1980-85). A shift in the approach from 'welfare' to 'development' is viewed with the vision and farsightedness of Dr.M.S. Swaminathan, a special chapter on 'Women and Development' and a section on 'Women in Science' were introduced in the Plan Document. This paved the way for blossoming of many women scientists in India. Women represent a wide range of scientific disciplines, besides physical, earth and life sciences. Amazing scientists like Anna Mani, Asima Chatterjee, E. K. Janaki Ammal, Kamala Sohonie, Rajammal, Girija Rajaram and Durga Krishnamoorti have profiled and described exciting vignettes in their works, their passions, struggles and accomplishments. Their contributions to society have been no less than that of men, though one has to search a little harder to discover it. Their achievements deserve special praise, because they often worked without the

societal support and faced the burden of family restrictions. These women have thus become role models for the future generations.

Painstaking Efforts of Pioneers

As science was professionalized and industrialized, moving from home to laboratory, women became the personal support structure for male scientists in home and then in the lab, a condition that persists till today in attenuated form. Women could be introduced to science for the purpose of fulfilling the role as assistants to husbands, father or brothers. However, the apparent absence of women scientists in this field does not necessarily mean that they did not engage in scientific activities.

Anandibai Joshi, the first Indian woman doctor went abroad to study Medicine. She was awarded an MD degree for her thesis 'Obstetrics among Aryan Hindoos'. Unfortunately, she contracted tuberculosis and western doctors refused to treat a brown woman and Indian doctors would not help her because she had broken societal rules. Joshi died in 1887 at 22 years of age. She was the first Indian woman to get a medical degree, in the Women's Medical College of Pennsylvania and first female of Indian origin to be graduated with a degree in medicine in the United States. She is also believed to be the first Hindu woman to set foot on an American soil. As one of the first proud Indian woman to be trained in western science, her story is iconic and inspirational.

Dr. Abha Sur who was a chemical physicist by profession, read out extracts from her book, 'Dispersed Radiance'. Her study on women scientists were based on extensive conversations with Professor Anna Mani, who not only provided biographical information of her but also of two of her female colleagues in Sir C. V. Raman's laboratory. Her book holds the lives and experiences of three renowned women scientists of India – Kamala Sohini, Sunanda Bai and Lalita Chandrashekhar. Dr. Anna Mani along with Sunanda Bai and Lalitha did their research under the Nobel Laureate physicist, Sir C V Raman. Anna Mani born in 1918 and grew up in a prosperous family in the state of Travancore, a former princely state in the Southern part of India, now part of Kerala. In 1940, she obtained a scholarship to do research in Physics at the Indian Institute of Science and was accepted in Sir C.V. Raman's laboratory as a graduate student. In Raman's laboratory, Anna Mani worked on the spectroscopy of diamonds and rubies and spent long hours, at times even working throughout the night. It is between 1942 and 1945 she had published five single authored research papers on the luminescence of diamonds and rubies. In laboratory, Raman maintained a strict separation of sexes, wherein the crucial practice of discussion and debate about scientific ideas among peers was denied to women, rendering them peripheral to the scientific enterprise. The casual, informal association with male colleagues was strictly out of bounds. Raman frowned upon any communication between men and

women. It is a reflection of the loneliness and professional seclusion forced upon the women.

In 1945, she submitted her PhD dissertation at Madras University and was awarded a government scholarship for an internship in England. However, Anna Mani was never accorded the Ph.D. degree. The Madras University during those times, formally granted degrees for work done at the Indian Institute of Science, claimed that Anna Mani did not have a M.Sc. degree and therefore she could not possibly be granted a PhD. She was not awarded a doctorate, despite her publishing several single-authored papers. In 1948, Anna Mani joined the Indian Meteorological Department at Pune where she was in charge of construction of radiation instrumentation. In her career of almost 30 years, she had published number of papers on topics ranging from atmospheric ozone to the need for international instrument comparisons and national standardization of meteorological instrumentation, before retiring as Deputy Director General of the Indian Meteorological Department in 1976. The success story of Anna Mani is one which few women could aspire.

Kamala Sohonie (1912-1998) was the first Indian woman to get a PhD in bio-chemistry. She was graduated from Bombay University in the faculty of Chemistry in 1933, topping the university merit list. She had applied for admission to the graduate studies programme at the Indian Institute of Science, which was dismissed by Raman, who repeatedly reiterated, 'I am not going to take any girls in my institute'. Sir C.V. Raman, the renowned physicist, denied her admission to postgraduate course in Chemistry at the Indian Institute of Science (IISC) on the ground that she was a woman. She refused to accept this refusal based on gender bias. A firm believer in Gandhian principles, she decided to do Satyagraha in Raman's office, till her admission. Accordingly, she was permitted to work but her research will be approved subject to the satisfaction of the Director. Kamala accepted these terms, and thus, crossed the first hurdle in her pursuit of science. At the Institute of Science, Bangalore, she worked with dedication under her teacher, Shri Sreenivasayya who was very strict and demanding. He was also eager to impart knowledge to deserving students. After observing Kamala for a year, Raman was satisfied with her sincerity and discipline. Thereafter, she was allowed to do regular research in Bio-chemistry. This was how Kamala Sohoine revolutionized IISC, Bangalore with her dedication because it was only after her behavior, Raman lifted the barrier and began to admit lady students to the institute. At the age of 82, she recounted this incident to the members of the Indian Women Scientists' Association (IWSA) who had gathered to felicitate her at the Bhabha Atomic Research Centre (BARC) in 1997. She recollected her memory and stated that, 'though Sir C. V. Raman was a great scientist, yet, he was very narrow-minded'. Also, Kamala recounted to the members of the IWSA, 'I can never forget the way he treated me just because I was a woman'. Dr. Kamala's life is a

perfect example that would suit heroic stories of valour and courage where defiant women triumph against all odds to gain acceptance in the male-dominated realm of science.

Lalitha Chandrasekhar, Raman's first woman student, hailed from a family, which had been especially influenced by social reforms. She wanted to pursue graduate research in physics from abroad but her family did not consider sending an unmarried girl to England for higher studies. She taught physics at a high school in Madras for a year and then went to Delhi to teach at Lady Harding Medical College, a women's medical school. She subsequently returned to South India and joined Raman's laboratory in 1935. In August 1936, Subrahmanyan Chandrasekhar, her classmate in Physics during her college days at Presidency College, returned from Cambridge for a brief visit. Lalitha and Chandrasekhar who had extended their college friendship through frequent correspondence and it was no surprise to anyone, within two months of his arrival, the duo had married and subsequently settled in America. Lalitha taught astrophysics and astronomy at the observatory in Williams Bay, Illinois, where Chandrasekhar taught, but she decided not to pursue her research. It is clear from accounts of Chandrasekhar's life that Lalitha gave up her aspirations of a career in science to support her husband. Chandrasekhar, as he was known, went on to become a renowned astrophysicist at the University of Chicago and won the Nobel Prize in1983.

The book 'Dispersed Radiance', also narrates the mysterious and controversial suicide of Sunanda Bai who along with Anna Mani was denied a Doctoral degree despite her immense hard work at the Raman Institute. Sunanda Bai, the second woman student in Raman's laboratory, who hailed from a Brahmin family in the province of Maharashtra, joined Raman's laboratory in 1939 as a graduate student in Physics at the Indian Institute of Science. It is regardless of her scientific achievements, something troubled Sunanda deeply just before her intended departure to Sweden for Postdoctoral work in experimental physics, Bai and her friend Sharada together attempted suicide. Sharda's brother was able to save his sister but evidently could do nothing to save Bai. She has done pioneering work in recording and analyzing the composite nature of the scattered spectrum of liquids. During her tenure of five years in Raman's laboratory, Bai had published ten single authored papers, which in itself is a remarkable achievement. The lives of these women scientists reveal the cracks that had begun to appear in the largely traditional 'embattled' family structures of the nineteenth century. Few of those who flourished were the first to break into male-dominated professions. Many of these women suffer lack of institutional support, double standards in measuring their achievements, social bias, negative stereotypes surrounding single women and the multiple roles that married women with families had to juggle. But besides all these odds, more had a passion for their work. In spite of these hurdles, women are now increasingly breaking the mould and demonstrating their true and hitherto under - estimated worth across scientific professions.

Discussion

In summary, the findings indicate that women scientists in India are obviously well aware of issues that affect them as women. They had less opportunity for education and therefore, the chances of entering into scientific fields were less. The participation of women in S&T has suffered from a seriously distorted perception. Kamala Sohonie's perseverance and academic success opened doors for Lalitha Chandrasekar, Anna Mani and Sunanda Bai. Neither kamala Sohine, Anna Mani nor Sunada Bai had to fight against male chauvinism. The earliest entry of women in scientific field observes immense attention because access to education and employment against social customs is a difficult task and they struggle to cross the barrier. The lives of these women scientists reveal the cracks that had begun to appear in the largely traditional 'embattled' family structures of the nineteenth century. Apart from these obstacles many women are still in the mainstream of science and have proved themselves as world's top scientists. In fact, the face of modern science would be incomplete without the major contributions made by earliest women scientists. Few of those who prospered were the first to break into male-dominated professions. The road leading to the top is never smooth where many of these women suffer lack of institutional support, gender bias, social bias, negative stereotypes surrounding single women and multiple roles that married women with families had to juggle. However, one can understand that besides all these odds, they had more passion for their work. Despite these hurdles, women are now increasingly breaking the mould and mark their imprints across scientific professions.

Suggestions

It is by utilizing women's fullest potential, the nation will march ahead in the arena of science. The achievements of women scientists and biographies of successful women scientists should be chronicled periodically. Moreover, the gender sensitization programmes should be initiated in all institutions. Furthermore, we should have a holistic view of the problems faced by women and initiate policy formulations and implementations with a view to ameliorate their present conditions and empowering them. A role-model programme, named after famous women scientists, should be initiated, involving special lectures, special workshops and mentoring for girl students in science. Also, initiatives should be taken to promote women achievers as mentors, supporters and collaborators in science for achieving high scientific accomplishment. In addition to this, creating opportunities in scientific research and increasing equality of opportunity in science professions are vital elements in the quest to empower Indian women. The mechanism for fostering motivation to forthcoming women's generation is by providing adequate support given for women to attain senior positions.

Conclusion

Today, more and more of women are stepping out of their homes to earn their living, choose a career and establish their own identity. The number of women scientists in National laboratories and research institutions has substantially increased. According to National survey 'Research and Development Statistics 2019-20', there were 56,747 women employed in R & D establishments which works out to be 16.6 percent of the total manpower employed in the country in R & D establishments. Women in India are now an integral part of every sphere of science be it research, trade, policy or education. Though this trend has witnessed lot of transformation in the last few years, the attitudes and perceptions have not yet changed and a lot more needs to be done in shaping and improving an environment of equity in science, education and employment for women in India. Scientific institutions in India carry essentially masculine ethos and exhibit vertical as well as hierarchical segregation in terms of gender. Women's participation has been limited and confined to comparatively junior positions. Major attitudinal and institutional changes are the need of the hour in the current scenario. Typically, women in science and technology resemble a pyramid where many women at the bottom live and a few occupy the top positions in various parts of the world, including India. Their roles have however been underplayed in the male prejudiced society and their achievements have not seen the light of the key. To bring about a radical change in the policies, the administrators should concentrate on Gender neutral approach, Women friendly approach and Gender sensitive approach.

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