ICSSR-SRC

Azadi Ka Amrit Mahotsav

ICSSR Sponsored Two-Day National Seminar

On

SOCIAL INNOVATION & ENTREPRENEURSHIP IN INDIA

(In collaboration with Krishna University, Machilipatnam)

25th & 26th February, 2022

ISBN: 978-81-947453-1-0

Editors

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Organized by

DEPARTMENT OF COMMERCE & MANAGEMENT

K. B. N. COLLEGE (AUTONOMOUS)

ISO 9001:2015 NAAC "A" Grade (Cycle: 3)

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All India 92nd Rank in NIRF by MHRD (2017)

BAND PERFORMER IN ARIIA

VOLUME - IV

INDEX

ISBN: 978-81-947453-1-0

Role of Women in science and technology in India – An Overview

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Abstract

Historically, the presence of women in the fields of science, technology, engineering and mathematics remains mainly trivial. Despite the infrastructural and financial support availed from the government and non-governmental bodies, under-representation of women in the field of education has not changed over the years. Also, no information about the current status of women in these fields is available in the public domain. In this paper, we address this lack of information by collecting data from renowned institutions throughout India. The under-representation of women in the science and technology community is depicted, primarily highlighting the male-dominated technology-driven Indian institutions. The probable causes for such inequality need to be analysed and addressed for remedial purposes.

Keywords: Gender inequality, higher education, science and technology, women's participation

Introduction

With the emergence of 'rational thinking', ideas like 'freedom from religion', 'abolition of slavery', 'constitutional government' and 'equal rights to women' become central to the political debates during the "Age of Enlightenment". The era also known as the "Century of Philosophy" starts loosely in 1620s with the scientific revolution in Europe and paved the way for different political revolutions of the 18th and 19th centuries (1). India granted voting rights to women immediately after its freedom in 1947. The right to vote was quickly followed by the rights to equal employment and education, to provide better opportunities and social acceptance to women workforce. However, a brief glance of higher education and employment history shows very marginal participation of women, not just in India but also in the world. As a prompt example, the percentage of women Nobel laureates (2.94%) in the fields of Science and Technology along with the Field's medal (1.66%) in mathematics gives us a brief idea. Such evident inequity can be explained by many social prejudices and stereotypes towards women counterpart, questioning their intellectual and leadership ability. The age old concept of 'women being the intellectually weaker section' is often professed by many socioeconomical factors along with psychological stereotypes, such as.

a) Gender stereotypes: A stereotype of men being better at math and science is inculcated from childhood itself (2, 3). These preconceived notions might discourage female students to pursue their career in science or technology.

b) Gender stereotyping of subjects: There is also the longstanding belief that science and technology are masculine subjects, since they deals with the technical aspects of nature (4, 5). A recent study tried to explain the role of society and psychological impression over the masculinity of "physics" and thus highlighted the role of symbolic hegemony which perpetuated this idea (6).

c) Social stereotypes: Historically, the female intelligence was always believed to be inferior to male, fuelled by Eugenics and Genetics (7). The hypothetical relationship between skull size and intellect supports the concept of intellectual inferiority of women (2). This school of thought persisted through time, and still does, despite several successful attempts to debunk it (2, 8).

d) Role of women in family: Gender stereotypes that depict female workers in every sphere of life as the expectation to be the primary caregiver of the family.

e) Lack of role models: Lack of strong and intellectual women characters, their negligible role in science and technology based popular culture media and literature might have played an important role in modulating the minds of girl children restraining them to follow such career paths.

Historically, the discourse concept of assuming women as the intellectually inferior class was profoundly fostered throughout the world(9). However, a brief analysis of the Indian history indicates that in early Vedic period (2000-1000 BC), women used to enjoy a prestigious status in science and education. For example, Lilavati(10), Maitreyi(11) were mentioned as experts in their respective fields. The trend of women suppression in India started with the onset of the late Vedic period (1000-600 BC) (12) and continued during the Mughal era and British rule. The World War I changed the scene for women in scientific research and a small, but substantial number of women joined the laboratories and engaged in science (13). India, however, under the rule of the East India Company, witnessed several social reformers such as Raja Ram Mohan Roy, Ishwarchandra Vidyasagar, Jyotiba Phule and his wife Savitribai Phule, struggling to propagate literacy of women. Inclusion of women in the mainstream education and workforce became more visible after independence.

The concept of women empowerment had materialized in post-independent India. However, the complete absence of any substantial data in the public domain except a few lone observations(14), provides no support regarding the 'actual empowerment' of women in India. The present study was undertaken to understand the real scenario in terms of women's representation in eminent educational institutions throughout the country.

Methodology

In the present study, we observed the recruitment pattern of various prestigious and prominent Indian institutions/universities over the years. A comparative analysis of male and female faculty in the various science-related streams taking into account the major institute types in India was done to show the disparity in the numbers. These categories include – institutes of national importance (IITs, NITs, IISERs), universities and colleges (top 20 colleges of India according to NIRF rankings and the top 10 universities in the world according to the Times Higher Education Rankings), Council of Scientific and Industrial Research (CSIR) institutions such as Advanced Materials and Processes Research Institute (AMPRI), Centre for Cellular and Molecular Biology (CCMB), etc. The reason for categorizing them in this manner is due to their different mandates. Assuming that a complete and successful scientific career might span over 25-30 years, we considered a group of faculty who had been recruited in 1988-2018. Analysis of IITs, the most prominent engineering colleges in the country, showed the wide gap in gender equality with the average number of women faculty being 11.24% (n=[illegible]).

Table 1

Name of the Institution	% of Women Faculties
IITs established between 1951 and 2001	[illegible]
IITs established between 2008 and 2009	[illegible]
IITs established between 2012-2016	[illegible]
Top 20 Universities of India	[illegible]
IISc	[illegible]
Amrita Vishwa Vidyapeetham	[illegible]
Savitribai Phule Pune University, Pune	[illegible]
NIT average	[illegible]

ISBN: 978-81-947453-1-0

VII Uttarakhand	6.67
VII Manipur	29.41
CNR	18.48
IISER	15.47

Discussion

From the table it can be assumed that the dearth of qualified women candidates remained the same from 1951 to 2018. However, the profile of faculty in the top 20 universities of the country differed significantly, may be the fact that these universities handle teaching and research mostly related to basic sciences rather than technical subjects. Among the universities, Indian Institute of Sciences, Bangalore was mostly male-dominated while Amritha Vishwa Vidyapeetham and Savitribai Phule Pune University, Pune stood out with most balanced distribution of gender within India.

When studied, it became clear that irrespective of the year of establishment, eminence and geographical distribution, all the research and teaching institutes in India exhibited a similar pattern in employing female faculty/researcher (merely 10-20% of the total strength) with very few exceptions. Lastly, the distribution of female scientists/faculties amongst the top ten ranked Institutes throughout World showed an average participation of 20.34% (± 3.45) females which is marginally better than the Indian scenario (18.86%).

Such a huge gap between the male and female faculty distribution in the STEM cannot be reasoned only by not having enough female student to start with. The minimal number of female candidates pursuing a career in STEM can be explained by a model, called the "leaky pipeline effect, (15,16) where the leaking happens at primary school, secondary school, undergraduate, postgraduate, doctorate, post-doctorate and faculty level positions. The two of the greatest leaks in this system are transitions from secondary school to college and from post-doc to faculty positions due to familial and societal constraints (17). This phenomenon is further supported from the data where different research/Re-entry Fellowships/faculty positions, awarded in India over last 5 years, showed comparatively better female representation (21.88%) than the Institutes/Universities. However, the continuous loss of female workforce can be assumed to be a cumulative effect of the many factors (2) such as the followings.

a) Social responsibility: The absence of women both in primary and higher ranks of scientific community could be reasoned primarily by the family responsibility (18).

b) Glass ceiling at work place: Furthermore, due to these ingrained stereotypes supported by society and other scientists, women in science became a victim of self inflicted inferiority complex 18 and reduced presentation in senior authorship (19).

c) Lack of recognition and Matilda effect: The "Matilda effect" which refers to the prejudice against crediting women scientists for their work, and attributing the said work to their male colleagues might also have negative impacts (20). Multiple examples of this effect include renowned female scientists not duly credited for their ground breaking experiments such as Agnes Pockels, Nettie Stevens (21, 22), Frieda Robscit-Robbins (23), Rosalind Franklin (24), C.S. Wu, Jocelyn Bell, and Lise Meitner (20).

d) Less participation in networking: It is observed that during scientific conferences, male researchers ask 1.8 times the number of questions asked by the same number of female researchers, which might impact the scientific networking negatively (25).

Probable solutions: General improvement in social and financial front especially in developing countries like India is paramount for more inclusion of women in main stream education which can be expected to trickle

[illegible] Science, Technology, Engineering and Mathematics (STEM) [illegible] of women role model specifically those [illegible] more in popular media and scientific literature particularly in school textbooks might have positive impact [illegible] comfortable work place, flexible work hours, creches and daycare facilities can be included in the current infrastructure to support the existing women workforce. In spite of such hardships and obstacles, the scenario is changing worldwide, as 130% increase in enrolment of girl students was observed in male dominated subjects such as physics, technology, engineering, mathematics, statistics and computer science over the period 1990-2013 in the United States [26]. In India, long term analysis is needed to understand the repercussions of previous policy changes and its impact on social structure.

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