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Transforming the Backdrop: Women's Ascension in Indian STEM

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Abstract: In India, women are going through a prominent ascension in the STEM fields, breaking the barricades and are contributing considerably to the nation's technical progression. Their growing existence reflects a transformative change which is apparently authorizing women to prosper in male-dominated domains. The recent times have witnessed a significant progress towards attaining gender equality in the STEM fields. Yet, a there are various challenges that force a women to leave STEM careers at different points during their professional journey. In this study we present an overview of the policies and initiatives for the empowerment of women in STEM in India. We have used the NLP-based content analysis to identify the barriers and challenges rooted in the literature review on women's empowerment in STEM in India. The research findings help us toformulate the recommendations that determine the explicit research areas and guide our imminent research actions that demand further investigation. The NLP techniques help us to systematically analyze and summarize our literature content to get a better understanding of the women empowerment and thus provide valued insights for the academic and policy-oriented contexts.

Keywords: Women Empowerment; STEM; NLP; Content Analysis; Gender Bias; Women's Rights

1. Introduction

Innovation works as the driving force behind progress in the continuously evolving territory of science and technology. It pushes us onwards and shapes our standard of living, work and understanding of the world around us. Nevertheless, our capability for innovation has been constantly under-exploited for a long time [1] [2]. Though women constitute half of the world's population, they have often remained behind because their talents have not been fully used in science and technological influential fields. The equity remains the first principle while empowering the women in the domains of science and technology [3]. In achieving gender equality in Science, Technology, Engineering, and Mathematics (STEM) fields, noteworthy progress has been made in recent times. Within the workplaces as well as educational institutions, the discrimination in addition to the gender bias aid as an unfavorable factors for women who desire to pursue STEM careers [4]. There are a wide spectrum of challenges including everything from climate change and healthcare discrepancies to the cyber-security threats and the ethical deliberations neighboring artificial intelligence. These challenges play an important role in framing the factors that force the women to opt out of the STEM careers [5] [6]at different points in their professional journey laterally.

In today's context within India, the concern of women's empowerment in the realms of science and technology holds noteworthy importance [7]. In India, the female scientists and technologists have reached astonishing achievements thereby breaking down barriers and becoming the inspiring figures for future generations [8]. The government is playing an upright role to encourage the participation of the women in STEM fields by providing the initiatives, scholarships, and awareness campaigns.

In this paper, we explore the multifacetedcharacteristics of empowering women as well as the obstacles that have delayed the transformative power of representation and the crucialrole of education and policies in STEM. In our research work, the Natural Language Processing (NLP) [9] [10] [11] based content analysis [12][13] identifies the barriers and challenges rooted in the literature review on women's empowerment in STEM in India. The research findings help us tounderstand the issues that support for the change that can cooperatively strive for a future where technology is accessible and boundless. The rest of the paper is structured as: Section 2 provide the significance of this study, Section 3 provide the literature review, Section 4 gives the proposed methodology and experimental setup of the research study, Section 5 provides theresults and Section

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6 provides theconclusion on the basis of the results gained from the proposed method.

2. Significance of the Study

The study thoroughly analyzes the women empowerment in the fields of STEM within India by not just providing actions and hindrances but as wellas fetchingthoughtfulness to numerous strategies that work in the direction of the main goal of achieving gender impartiality in STEM disciplines which benefits the social order as a whole.The objectives of this research study include a brief awareness regarding the initiatives and strategies for women's empowerment in STEM fields. The study helps to bring into view the various barriers and challenges that are present in the literature concerning the empowerment and women in STEM by utilizing the NLP based content analysis. The findings provide the endorsements for future research directions possibly recognizing the regions where further examination is necessary. The research study rationally observes and reviews the prevailing literature using NLP techniques to improve the whole understanding of the research matter.

3. Literature Review

We divide our literature studies about women empowerment in science and technology into three parts - gender inequalities in science and technological fields, data and statistical indicators on women in STEM fields in India in addition to the features that add to the underrepresentation.[14] [5] [7] deliberatedupon the factors such as gender bias, family responsibilities, educational inequalities, networking barriers, absence of female role models, networking challenges, social standards, work-life balance matters, unconscious unfairness in employment and cultural biasesresponsible for the under representation of women in STEM in India. [15] [16][17] put forward that there is an inconsistent progress in improvement of racial, gender and ethnic diversity in STEM jobs. [18] [19] [20] [21] emphasizes on the fact that there is still a significant passage ahead to accomplish better diversity in the higher education pipeline, predominantly in fields such as engineering, computing etc.

The latest Department of Science and Technology (DST) report [22] specifies that women researchers encompass 16.6% of the personnel in Indian Research & Development (R&D) [23] [24]. Inadequate representation, spouse-related transfers, supremacy of males, deprived working settings besides family responsibilities cause women to take a break from their education or from their careers and sooner or later leave their jobs can be well-thought-out as the barriers. Regardless of challenges for example patriarchy and adversative working conditions, women contribution has raised from 13% to 28% in science related projects [25].56,747 are women scientists out of 3.42 lakh R&D employees. Nevertheless, there is a slighterexistence of women in engineering and technology spots [26]. Despite the fact, between 2014 and 2022, in India, the total of science researchers has doubled over from 30,000 to 60,000 [27].

The initiatives and strategies for empowerment of women in STEM can be either at government level or Non - Government Organization (NGO) level or private sector level. In India emphasis on authorizing women in science and technology, government efforts via initiatives such as Knowledge Involvement in Research Advancement through Nurturing (KIRAN) [28] and Women Scientists Scheme (WOS) [29] offer research funding and career support. UDAAN [30] inspires entrepreneurship of female in technology. Campaigns like BetiBachaoBetiPadhao (Save Girl Child, Educate Girl Child) [31] congruently support girl education in STEM. Gender-Budgeting [32] guarantees funding for women enrolled in various STEM programs. Some policies like the National Skill Development Policy (NSDP) provide training opportunities to females. Moreover, gender sensitization [33], workplace regulations and scholarships [34] strengthen women's involvement in STEM.

In India, NGOs and private enterprises are vigorously involved in women empowerment across various sectors, lining up with government policies and initiatives. SEWA, Pratham, and Mann Deshi Foundation [35] [36] are prominent examples. They emphasize on financial empowerment, education, and private enterprise. Breakthrough [37] is an initiative that addresses gender-associated trials. Another initiative namely Make a Difference [38] provides support to the girls in shelter homes. As far as private sector effort are concerned, Indian companies are supporting the women-owned commerce and headship. Many international companies are offering variety of initiatives. In the private sector partnerships with NGOsare offering the skill development and focusing on women's empowerment. Secure transportation by firms such a Ride-Sharing; customized financial services by private banks for women are greatly strengthening the women's empowerment in India [39].

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4. Proposed Methodology

For conducting the research we have used a secondary research method wherein we perform the content analysis of the literature using the NLP techniques. We used the secondary data from formerly available literature and designed an NLP method in Python to produceclusters on feature vectors that help in grouping the related topics together based upon their themes.NLP is used for the text analysis and document categorization. The task, technique and the description of each task is given in Table 1.

Table 1: Experimental Setup for Content Analysis using NLP

Task	Technique/Method	Depiction
Collection of Data	Simple Download, Web Scraping	We assemble the research papers and web-blogs to be analyzed.
Text-Preprocessing	Tokenization, Stemming	We clean the data beforechanging it to the base data. We eliminate the stop-words, special characters, punctuation etc.
Feature Extraction	Term Frequency-Inverse Document Frequency (TF-IDF)	We convert the text that was preprocessed into numerical features such that it can be understood by the Artificial Intelligence models.
Topic Modeling	Non-negative Matrix Factorization (NMF)	NMF decomposes the createdterm-document matrix to the term-topics
Deep Learning Model	Transformer / Long Short-term Memory Networks	We train a neural networkcentered model that takes a string of words as input and groups the topics into the predetermined clusters.
Clustering	k-Means Clustering	Clusters on feature vectors help in grouping the related topics together derived from their themes.
Visualization	Bar-plots	We visualize the results to gain comprehensions.

5. Results

The thorough analysis of the content enables us to gain insights into the numerous challenges and difficulties that women come across while following their careers in STEM fields. These barriers and challenges can vary from gender discrimination to inequitable access in the workplace. It becomes easy to grasp the visually presented results, so we have represented the data using bar-plots so as to comprehend the magnitude of these hindrances.

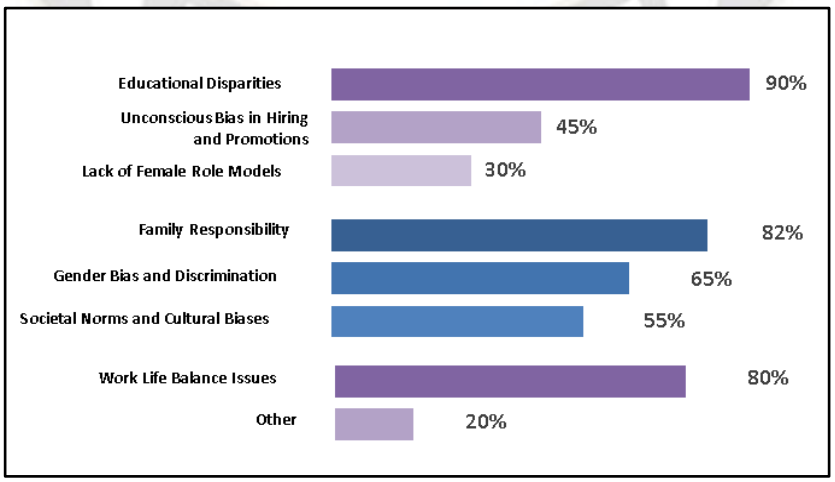

Figure 1: Challenges faced by Women in Science and Technology in India

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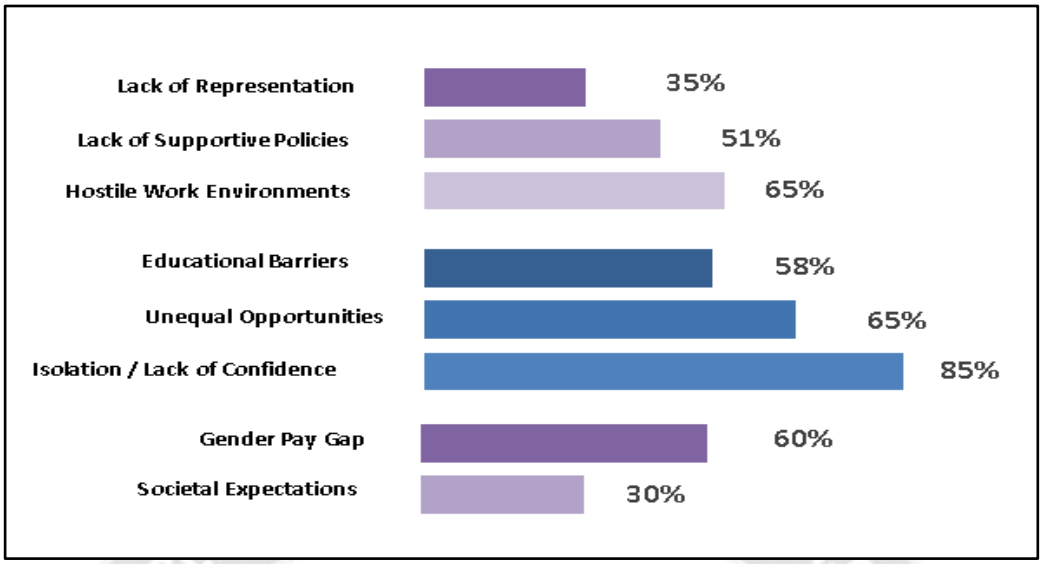

Figure 2: Barriers faced by Women in Science and Technology in India

Figure 1 represents the challenges faced by women in science and technological fields in India while Figure 2 depicts their barriers within the same area. These figures help in highlighting the inconsistencies and problems that women encounter in STEM fields, thereby contributing to an improved understanding of the essential requisite for gender equivalence in STEM disciplines.

5.1 Insights from the Study

A momentous development in the field of women empowerment in the science and technology sectors has been made in India in the direction of nurturing gender inclusiveness. This is evident by the prominent accomplishments of women like Tessy Thomas and Kalpana Chawla. Various government policies as well as the educational initiatives have played a great role in supporting the women who pursue careers in STEM fields. Fellowships as well as scholarships for women have played a motivatingpotency in drawing women pursuing STEM education. In order to fight against the gender bias and inspiring girls to come in STEM fields, continued efforts in education and cognizance are most important. Campaigns have increased the awareness and brought to attention the significance of gender parity in STEM fields. Both innovations as well as economic development have been contributed by commercialactivities led by women. From the content analysis, the challenges and barriers faced by women can be stopped or lessened when organizations both government as well as private prioritize assortment and inclusion of policies and initiatives so as to guarantee unbiased opportunities to both the genders. Mentorship programs in addition to the networking can help to provide the vital support for women in STEM education. There must be appealing scholarships and benefits to encourage involvement of women in research and innovation. This can not only bring variedviewpoints but also fetch progress in science and technology. Last, but not the least, the change in stereotypes, societal insights and sensitivities is way too important in order to create a niche where women can contribute to STEM disciplines significantly.

6. Conclusion

Regardless of progress, women face gender disparity in science and technology fields in India. The reason for it is the stereotypes, organizational obstacles and most importantly the rooted biases. Our proposed method helps to bring forth the challenges, barriers as well a notable progress of women in science and technology by using the existing literature. Even though there is a considerable increase in the percentage of women in STEM fields and many women are succeeding in this field but still it is a challenge to plug in the gaps created due to gender inequality which is still not allowing them to reach to their full potential. These barriers and challenges need to be tackled and that requires a strong multi-layered approaches. Our findings emphasize that the barriers faced by women in STEM can be narrowed down by abrupt consideration in addition to cooperative action from the educational institutions, policymakers as well as STEM community equally.

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