

Finding My Place in This Man's World – Investigating the Perspectives of Equity In Engineering Education

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Abstract: The gender equity in engineering fields' education or workplace is an area of great concern as brought up by researchers across globe. India is no exception. Women in engineering face various issues like retention, discrimination and career issues **importantly**. This necessitates the need to identify the root causes and suggest strategies to resolve them. The present study addresses this need and identifies barriers that women in their undergraduate study face. At the same time, the number of women working in engineering educational institutes also shows a steady leak at each step. In this study, 249 women undergraduate students enrolled in engineering programs and seven women in top leadership positions responded a survey that collected data related to challenges experienced by them during their education/career. The study identified various barriers faced by them and suggested strategies to overcome them. For making these women move forward and achieving an equal and inclusive space there is a need to support them in engineering as well as to create an awareness on gender equity.

Keywords: Women Undergraduates, Women in Leadership, Gender Equity, barriers

1. Introduction

The gender inequity in engineering fields across globe and in India is well-known fact established by researchers alike.[1],[2]. As the proverb goes, women hold up half the sky is true in the literal population sense, but the same loses the weight when it comes to the gender distribution in engineering education. As per the AISHE 2019-20 the undergraduate programs in engineering are still dominated by males, BTech (71.5% males) and BE (71% males) [3]. As the demographics are not improving much despite

national level policies, the onus has shifted to educational institutions to develop educational environments and create an inclusive culture facilitating women enrolment and progression. Increasing diversity can not only improve the class dynamics but also the problem solving[4] and innovation skills[5]. Percentage of women in engineering institutes makes it more difficult to achieve strong diversity at industries as well. The management consulting firm Zinnov jointly with Intel India in their study titled, Zinnov-Intel India Gender Diversity Benchmark revealed that there is a mere 26% women in technical roles at corporates across India. The diversity declines as we move to higher level leadership roles (Fig. 1) with only 11% women at the top.[6].



Fig. 1 : Gender Diversity Across Levels

Working now to achieve diversity will help improve this percentage in the long run by removing barriers to success [7] and increasing female role models. Lack of female role models is a major reason women avoid the STEM fields[8]. As a discipline, engineering has been involved in various 'girls empowerment' and outreach programmes, yet these have failed to bring significant changes to the gender make-up of engineering courses [9]. To achieve equity we must understand the lived experiences of women in engineering education and develop solutions which are grounded in research. Thus, the basic thrust of the present study is to discover the factors that have hindered the success of such women up the ladder, with focus on women in engineering educational institutions. Extensive studies have been conducted on identifying the barriers hindering women from achieving career advancement and reaching top positions. However,

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studies focusing on the factors impacting of women in engineering education have not received much attention. Thus, our study is unique in its focus specifically on women in engineering education. It helps identify the barriers, and recommend solutions for achieving more gender equitable classrooms.

2. Literature Review

Engineering and Technology is regarded as a critical contributor to the nation's economic and technological development. As a result, achieving diversity and inclusion necessarily call for action in this field. Expanding the engineering workforce is hence a point of concern for the Indian government, industries, and educators. Attracting and retaining women in engineering will help maximize innovation and creativity. Engineers are involved in diverse fields from civil, mechanical and automobiles to developing software for our all basic and advanced needs. If women are not involved in it, the female perspectives in these designs will be missing and hence they will not be a proper beneficiary of the same as well. For example, the Apple's Comprehensive health App. It can be used for tracking the copper intake but not the periods[10]. Car seatbelts, which date back to the nineteenth century, are still often configured for men, forgetting women who tend to sit closer compared to men when driving[11]. However, despite tremendous efforts we have been unsuccessful in creating equity at all places. The journey to the top is biased from the very beginning when female students enroll for the undergraduate program in Engineering. Fig. 2. represents the number of females per 100 males[3]. It is visible that still we are far away from equal representation during enrolment

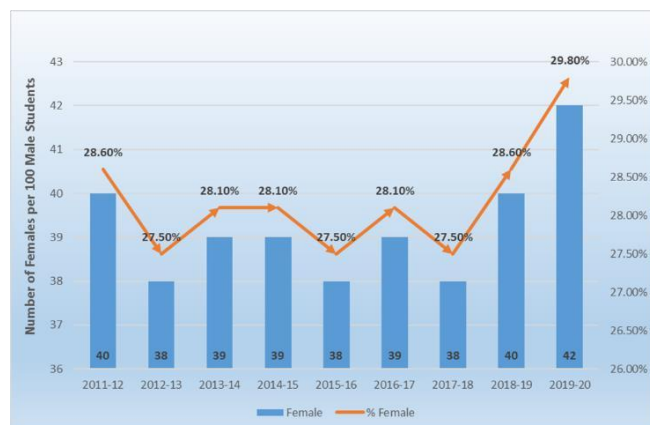


Fig. 2 : Number of females per 100 males

A. Key Factors contributing for women underrepresentation in engineering education

Several studies have been carried out all over the world to identify the factors contributing for women underrepresentation in engineering fields. The following are the major contributors:

- 1) *Gender Stereotypes*: Engineering education is considered to be a masculine field. Parents and girls often themselves underestimate their technical abilities[12]. Katelyn Cooper in her study identified that women are 3.2 times less likely to admit that they are smarter than the people whom they collaborate with. They often underestimate their intelligence[13].
- 2) *Male Dominated Cultures*: The behaviour of teachers within the classroom has been perpetuating gender stereotypes by favouring boys in many classroom activities[14]. India is a patriarchal society and the male dominated cultures are carried to engineering classrooms as well by students and teachers alike[15].
- 3) *Lack of Female Role Models*: Girls come across and have only few role models to inspire their curiosity and interest in engineering fields, as there are limited examples of female engineers and scientists.
- 4) *Women's Self-aspiration*: Women lack confidence and do not aspire for higher positions. And hence most of them drop out at each stage of their education and career. Fig. 3 shows the leak during various stages.

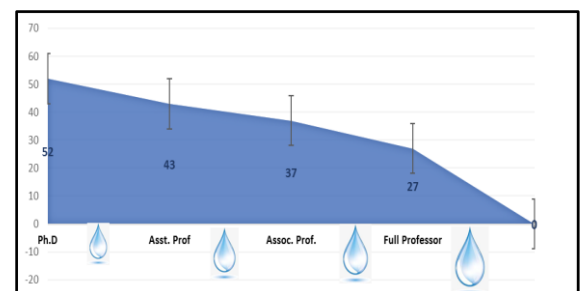


Fig. 3 : Leak of women from entry level position to the top positions in the field of engineering

3. Research Methodology

The used data from two category of respondents. One group was of undergraduate women in Engineering, and the other was the women in leadership positions at engineering education institutes. As we needed to understand the classroom experiences of undergraduate women in engineering we designed a survey and shared with female undergraduate students in various engineering colleges in Sangli District, Maharashtra. The girl student participants were from Maharashtra and other states including Jammu and Kashmir admitted under out of Maharashtra and J&K categories. A total of 249 girls responded to the survey. For identifying the key barriers that hindered women in leadership positions in engineering and the strategies employed by them to overcome these barriers, retain and advance in their fields we needed to understand the lived experiences of the women leaders[16]. A descriptive

intersectional approach with structured open ended interview questionnaire was used as this method is most suited for revealing the perceptions of phenomena by the individuals own perspectives [17].The intersectional approach was needed to understand the impact of interconnectedness of geographies, religion, culture, and lifestyle etc. on the advancement of women. The interviews also explored the strategies that the participants applied whenever they faced challenges. The researchers decided to select women at top positions as the sampling units as they will be in better position to share their experiences at all levels from student to a working women

There are very few women in engineering academics occupying positions as Directors, Vice-Chancellor and Pro Chancellors. Consequently, purposive sampling (Patton, 2002) was used in selecting the participants of the study. Six women in senior leadership position in engineering education in India were chosen as the participants. The number of participants selected in the study was within the range recommended by [18] (between 5-25 participants) and [19] (minimum of six participants). All the participants voluntarily consented to be interviewees in the study.

The participants were from various universities and autonomous institutions of India, holding top leadership positions like Vice-Chancellor, Director, or Member of Governing Body. All of participants are women between 52-58 years old, are married, and have either children or parents' dependent on them (Table I). All of them have occupied the position for at least 5 years.

Table 1 : Participant's Profile (Women in Leadership Positions)

Participant	Name*	Age (in years)	Marital status	No. of years in leadership position
ID1	Deepthi	54	Married	14
ID2	Seema	58	Married	15
ID3	Priya	58	Married	30
ID4	Shruti	56	Married	10
ID5	Arya	55	Married	15
ID6	Aabha	52	Married	10
ID7	Shipra	54	Married	5

Table 2 : Profile of Participants(Undergraduate Women in Engineering)

Sr. No	Branch	No. of Participants
1.	Mechanical Engineering	97
2.	Computer Science	84
3.	Civil Engineering	49

4.	Electronics And Telecommunication Engineering	52
5.	Electrical Engineering	33
Total		249

Data collection

Two Semi-structured mail interview questionnaire was adopted for collecting data. The questionnaire for undergraduate women in engineering consisted of Mostly closed ended questions with a few open ended ones The questionnaire for women leaders interview questions were kept open-ended to capture maximum possible themes to emerge. Each participant was assured of participant anonymity, data usage for the special purpose of research, and having the right to withdraw at any time without penalty. No financial or material incentive was offered to any participant.

4. Findings and Discussion

The Cronbach alpha score of 0.89 indicates that the instrument was reliable and the findings are valid.

A. Experiences of Undergraduate women in engineering

Q1. Why did you join engineering?
26% of the women undergraduate said they have joined engineering because of their passion for engineering, 25% joined because of parental pressure, 18% joined because of their good mathematical skills. Only 4% said that they joined because of role model and 9% said that engineering is their dream career. It is quiet pertinent that lack of role models is an important concern.

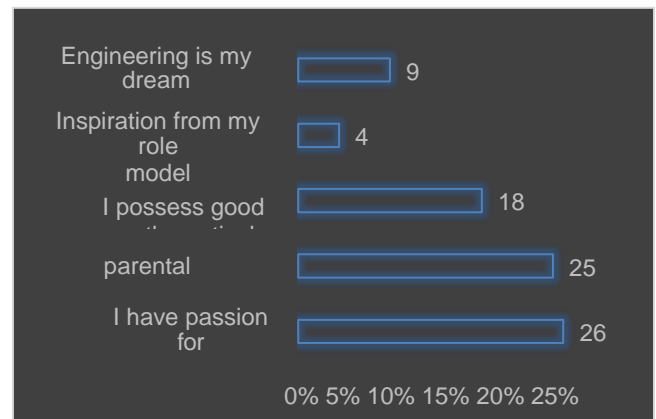


Fig. 3 : Reason for Joining Engineering Education

Q2.Perception of Inclusive Classroom

The following fig.4 represents the perception of women about inclusive classroom.



Fig. 4 : .Perception of Inclusive Classroom

It is observed that almost around 20% of the women feel that the professors think that they can be good engineers and have the desired skills, but only 9% feel that their professors have high expectations from them. This indicates that despite equity efforts our engineering classrooms are not that inclusive.

Q3. Do you think females face barriers in pursuing engineering? IF yes, please specify some barriers.

53% of the women responded that they do not face barriers in pursuing engineering, while 47% agreed to face barriers. Some important barriers listed by the are-

Gender Stereotyping, Societal pressures, lack of self-confidence, and unequal treatment by teaching and non-teaching staff.

This is a point of concern that despite the education being considered as a fundamental right, women in engineering are facing various barriers while exercising this right.

Q4. Would you like to continue your engineering education further for completing masters and higher ? Why ?

Only 42% of the women respondents said that they are going to pursue higher education in engineering as it will help them to get a desired placement ,12% of the respondents said that they are not going to do any higher studies after that and would like to work,39% of the respondents said that their parents are thinking about their marriage and they will think about future after that and others wanted to pursue MBA.

This indicates that still women are not the decision makers regarding their own career, they either depend on their parents or spouse or in-laws.

B. Experiences of Women in leadership positions in engineering.

The experiences of women in leadership positions revealed several barriers faced by them rising up the career ladder from the entry level irrespective of their intersectional identities.

- **Gender Stereotyping:** All the participant agreed that engineering fields stereotype women as weak. Words like home, children, maternity leaves, childcare were consistently used whenever discussions regarding career advancement of women or responsible duties allocation were involved.
- **Social Barriers:** India is a patriarchal society. Women are considered to be home makers. Even when women have started working, they have to take care of dual responsibilities- both at workplace and home. They have to play the role of a mother, sister, wife, daughter - in-law and a good employee or leader as well.
- **Lack of Aspiration:** The participants unanimously endorsed that woman lack aspiration. Even though they are working equally well or at times better than men they will never ask for promotions or a salary hike, while men openly ask for the same. They always say yes for any opportunity immediately, while women first start planning in their mind as what they will do with family, and how they will make necessary arrangements and give delayed response.
- **Lack of Networking Skills:** Today women are successful in building a strong presence in this traditionally male dominated engineering field. However, despite these big strides' women percentage has not improved in leadership positions. Women should build strong networks, both vertically and horizontally. Peer relationships should also be strengthened. Men are able to move ahead because the do all the walk and build good networks.

The women shared the strategies they used to reach leadership positions by breaking all these barriers.

- **Developing Self-awareness:** Women must analyse their strengths and weaknesses so as to develop their abilities as a leader .They should focus on developing their skills and accept if they do not possess some. This will help them to take steps to develop those. One of the participants said

"To climb up the ladder of success, I did my SWOT first and it really helped me to analyse my own self. I suggest all women should do their self-analysis".

One other participant quoted

"Many a times women don't even know themselves well, and as a result they are unable to utilize their strengths to the fullest". Analysing self and creating self-awareness will realize the aspirants to focus on their capabilities. It is one of the important factor in psychology that influence the behaviour of people.

- **Learn to assimilate :** Women should spend some time in developing their networks, get assimilated in the male - dominated groups but maintaining their own-self at the same time .Male domination in society in India is the biggest problem and hence they should learn to take a leap besides such constraints.

"I am working in a male-dominated engineering field. In the beginning it was difficult for me to make the men realize that I am equally capable. Also, I used to feel out of place

in groups as most of the time I used to be the only female. But I learnt one thing that unless you open up and involve yourself in those groups it will be difficult for to get their support."

One of the leaders remarked "Men are men. They will not let you be one of them easily and accept you or your leadership. You should take their views, involve them in decision making, but remember to take the final call yourself. You must get on without getting discouraged to mark a hole in the wall of male -domination."

- **Maintain Balance:** Women must manage their work and personal lives. They should not feel guilty as sometimes it may happen that they develop a feeling that they are neither giving proper time to family nor their work. They should be more confident and be responsible for their own career.

As per one of the participant

"To balance the work life and home, you must make your family more independent. My son is in tenth with board exams coming up, but he knows my mother needs to fulfil job responsibilities also .My in-laws and husband are also supportive. And I think such a support is needed to achieve balance."

Another participant added

"It wouldn't have been possible if my mother and mother-in-law have not been there on every step. Their presence and support made my mind relaxed to concentrate on work responsibilities. But, one must know where to draw the line as family is equally important, and mother is an important person in shaping life of their kids".

- **Develop risk taking ability:** Women must learn to take risk as many a times men do in order to get the desired outcomes at work. Remaining in the comfort zone may harm them as it may be considered as a sign of lack of leadership skills.

- **Life-long learning:** In order to sustain in the leadership positions women must be life- long learners. As industries are very dynamic in nature the desired skill set of the leaders keep on changing. This will help in planning their tasks meticulously and avoid stress as they are generally scared about what if a project undertaken by them fails

- **Foster Collaboration:** They should preferably use the collaborative leadership style. They should involve the stakeholders in decision making this will help resolve many of the problems as it increases the ownership in the organization

- **Voice out opinions:** Women should learn to voice out their feelings and opinions .they should learn to say no. They should openly ask for promotions like men, be more responsible towards their career rather than expecting their mentors or bosses to build their career. One respondent remarked

"When I joined this organization I was in middle management level, I used to be on field for around 4- 5 hours, and there was no ladies washroom at that site. There were two other women, I don't know how they managed for six months since they started working here. I talked to the

management and made them understand this basic requisite and got their consent. The washroom was constructed in next three months!!"

"Management is not superhuman. You must speak out your expectations. May be the things must not have struck their mind." added another participant.

5. Conclusion

The primary objective of this study was to identify the barriers faced by women in engineering which indirectly hinders the economies across globe in achieving gender equity.

The findings of the study have identified important barriers at both stages of their career – education phase and work life phase. In examining the survey results, women undergraduates reported discouragement and stereotyping by peers and professors more often as compared to their male counterparts. The results also showed that lack of role models hinder them from identifying exemplar engineers to connect with and take inspiration. This indicates the need for better education of women undergraduates on the accomplishments of successful leaders and engineers in their area of interest. In order to encourage the perception of equal opportunity to be successful in the profession, and to ensure that the contributions of all genders of engineers are recognized, we need to arrange workshops and expert sessions helping these women to understand their capabilities and develop self-confidence.

Additionally, there were many strategies discussed by successful engineering women in leadership positions that reinforced the notion that you can, if you think you can. But, it doesn't negate the fact that the educational environment in engineering educational institutes is unfavourable leaving aspiring women less motivated to further pursue higher education or career in the field. This shows that although there initiatives taken towards solving the retention of women undergraduates and leaders are undertaken, further research is needed to better understand the reasons behind female engineering students leaving the profession. There is a dire need to change the atmosphere in engineering institutes to better support females students and faculties and encourage respect. Further research on this topic could include including women undergraduates across country and including more women leaders as well. Also, the study could be expanded to include women pursuing post-graduate and doctorate studies as well.

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