

Exploring Indian Views on the underrepresentation of female teenagers in STEM

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ABSTRACT

Only 15% to 20% of tenured faculty at Indian universities are women, while 14% of employed researchers in STEM fields are women. To investigate reasons for this problem, the present research study was conducted to gather data for Indian respondents' perceptions of the reasons for understanding of the women underrepresentation in STEM (Science, Technology, Engineering, Mathematics) fields, focusing on female teenagers. The study asked respondents to rate the overall underrepresentation and the importance of different factors on a scale of 1 to 7, along with their own explanations and suggestions. The study found that the most important factor to explain the underrepresentation was Poverty, followed by Parent's Traditional values. In contrast, the least important factors were Feminine Attributes and the idea that female teenagers wanted to avoid the male field, while Absorb Stereotypes (the idea that female teenagers subconsciously take in stereotypes of STEM being a male field), Teacher's Discouragement and Less Confidence were given ratings closer to the middle. Additional factors suggested by respondents included females having to take care of family responsibilities and lack of role models in STEM fields. This suggests Indians have increased awareness of the underrepresentation of women in STEM fields.

Introduction

The underrepresentation of females in STEM (Science, Technology, Engineering, Mathematics) fields in India is a serious issue. Women are only 15%-20% of tenured faculty at Indian universities (Bhattacharya, 2020). In 2009, only 3.2% of 744 Indian National Science Academy Fellowships were women. The United Nations stated that only 14% of employed researchers in STEM fields in India were women (Sindhvani, 2020). While roughly 43% of the graduates in science are women (Jain, 2020), this percentage tends to be lower at elite Indian Institutions such as the Indian Institute of Technology (Sharma, 2016). As women constitute half of India's population, it is integral that they help contribute to science such that India can develop itself further, both in terms of academic research and in terms of science and engineering.

A variety of reasons have been investigated for the underrepresentation of women in STEM fields worldwide, some of which have also been backed up by studies. A UN report classified these factors under four different levels: individual, parents, school and society (Choi & Sass, 2017).

At the individual level, natural differences in ability between both genders are not shown to be very significant. In primary education, girls have been found to do slightly better in biology and chemistry, as well as computing. Boys score higher at most levels of education in mathematics due to their slightly better spatial reasoning (the capacity to think about objects in 3 dimensions) that has been linked with scoring higher in mathematics. This shows that there is little overall difference in ability at a young age (Choi & Sass, 2017).

However, both genders absorb stereotypes from a young age, which includes the idea that STEM is a male-dominated field. This hurts girls' confidence and interest, which discourages them from taking up the sub-

ject. In India, one study taken at unaided private institutions of English instruction found that there was a significant gap in science and mathematics levels, which actually increased as students progressed through school, so a gap can be seen quite early, which shows how they absorb more stereotypes and become less interested in STEM (Bhagat & Vijayaraghavan, 2019).

Parents also play a factor, with many of them discouraging girls to go into STEM fields. They have a higher impact on girls' decisions than boys' decisions. Well educated mothers give the girls a role model to show that family life and work can be balanced. Better educated parents also encourage their children to go into STEM fields, set higher academic expectations and purchase more tutoring, which helps improve the representation of girls. Families of a lower socioeconomic status also have more traditional values on these issues including a belief that females are supposed to take care of the house and children. This leads to a lower representation of girls (Choi & Sass, 2017)

Teachers also affect the representation of women in STEM. If they have many years of expertise and a higher level of interest in mathematics and science, it helps the students learn STEM subjects better. There is a correlation between the share of female teachers in a country and girls' performance in mathematics. Female teachers inspire their female students in STEM by acting as role models to help their students counter gender-related myths. Conversely, sub-par teachers can make students less interested in STEM, and drop out of STEM subjects early. Teachers can also pass down gender-related stereotypes subconsciously. However, much of the research relating to teachers and STEM do not focus on gender (Choi & Sass, 2017).

Research focusing on India has found that mobility and retention are the two main reasons women are underrepresented in science, where mobility is moving to a higher position in the field and retention is staying in the field. While the percentage of women in universities studying science is high, the number keeps reducing, termed by some as a "leaky pipeline". 43% of those in STEM fields at universities in 2018 are women. However, they begin dropping out after that, with 3% doing a PhD in science and 6% doing a PhD in engineering and technology (Jain, 2019). They tend to drop out of the workforce as they have to help take care of the family along with doing their research. Since it is difficult to get flexible work-hours, it is challenging to maintain balance between the two (Zill-e-Anam, 2020). A government survey titled "Final Report Status of Women in Science among Select Institutions in India: Policy Implications" found that 32% of sampled Indian women working in science at premier institutions said that family responsibilities negatively affected their career attainment, while only 17% said that it had a positive effect (Mallick, 2017).

A report found that 81% of Indian women working in STEM fields felt that they face gender-biases in evaluations. Many may also not feel comfortable at the workplace because too few of their colleagues are female (Jain, 2020). A trade association found that while women were 34% of workers in the key Information Technology sector, higher than that of similar fields in Western countries, they found that women were less represented at higher levels (Ring, 2018).

While there are some reports that have focused on Indian women, they haven't focused specifically on Indian female teenagers. Many have also cited different reasons for the underrepresentation but haven't explored if some reasons are more significant than others within the context of India. Through this study that examines Indian respondents' opinion of the underrepresentation of female teenagers in STEM overall based on their ratings of contributing factors, a more specific and in-depth understanding of the phenomenon could be achieved and solutions could be proposed to address the more impactful factors.

Methodology

Research Design

The aim of this research study is to examine the phenomenon of the underrepresentation of Indian Teenagers in STEM fields (Science, Technology, Engineering, Math) through an online survey of Indian respondents to elicit their perceptions of the lack of participation in STEM.

More specifically, the respondents would be asked to rate the importance of biological, motivational, family-level, school-level, and societal-level factors, which have been identified from a report (Choi et al., 2017), on a scale of 1 to 7. Furthermore, respondents' perceptions of young Indian women's participation in STEM were also rated. Two open-ended questions will allow the respondents to provide additional detail for their response, along with other factors they feel for the underrepresentation. Hence, a mixed-method approach featuring both qualitative and quantitative data was adopted for the research study to provide a rich analysis. The respondents' age group, location and gender would be recorded to explore differences between ratings of factors that could potentially affect their perceptions.

In total, 60 valid responses were received. There were 34 respondents under 22, compared to 26 above 22. The respondents skewed towards bigger cities, with 43 of them living in Tier-1 Cities (Mumbai, Delhi, Kolkata, Hyderabad, Bangalore, Pune, Ahmedabad, Chennai) and 17 living in other parts of the country. 21 respondents were male and 39 were female. Potential respondents were informed that their responses were anonymous as their name was not asked in the survey.

Hypothesis

The following hypotheses were tested:

Null Hypothesis: There would be no significant differences between the mean ratings of the factors that determine the lack of representation of Indian female teenagers in STEM fields.

Alternative Hypothesis: There would be significant differences between the mean ratings of the factors that determine the lack of representation of Indian female teenagers in STEM fields.

A further analysis would be done breaking it up by:

- Age (under 22, over 22)
- Gender (Male, Female)
- Location (Tier-1 City, other area). Tier-1 Cities refer to the 8 largest metropolitan areas of India: Mumbai, Delhi, Bangalore, Kolkata, Chennai, Pune, Hyderabad, Ahmedabad

Difference between demographics

Null Hypothesis: There would be no significant difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by respondents under 22 years of age and those at or above 22.

Alternative Hypothesis: There is a difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by respondents under 22 years of age and those at or above 22.

Null Hypothesis: There is no difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by male and female respondents.

Alternative Hypothesis: There is a difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by male and female respondents.

Null Hypothesis: There is no difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by respondents living in Tier-1 Cities and those not living in Tier-1 Cities.

Alternative Hypothesis: There is a difference between the mean ratings of factors that determine the lack of representation of Indian female teenagers in STEM fields given by respondents living in Tier-1 Cities and those not living in Tier-1 Cities.

The Regression

Null Hypothesis: The respondents' ratings of the importance of the factors had no effect on their perceptions of Indian female teenagers' participation in STEM as a whole.

Alternative Hypothesis: The respondents' ratings of the importance of the factors did have an effect on their perceptions of Indian female teenagers' participation in STEM as a whole.

Data Collection Procedure

A questionnaire was prepared on Google Forms to be sent out. These questions were a mix of closed-ended questions and open-ended questions. The data was anonymised as no identifying information would be gathered. The survey was distributed through WhatsApp and Instagram. The link of the survey was accompanied by a message that stated the survey was anonymous and explained the benefits of participation.

Data Analysis

First, descriptive statistics was used to calculate means. Second, a one-way ANOVA would be run to compare the mean ratings of different factors that affect Indian female teenagers in STEM, and see if there is a statistically significant difference between them.

Third, a 2-sample t-test would be run to test for the difference of means between the ratings of two different demographic groups. From here, it can be seen if there is a statistically significant difference in the mean rating of a factor between two demographic groups.

Fourth, a multivariable regression analysis would be used to compare each participant's rating of different factors that affect women in STEM to their rating of the underrepresentation of women in STEM overall. In this case, their rating of the factors is the independent variable and their overall rating is the dependent variable. From here, it can be checked if a few specific factors have a large influence on the overall rating.

Results and Findings

In total, 60 responses were received. There were 34 respondents under 22, compared to 26 above 22. The respondents skewed towards bigger cities, with 43 of them living in Tier-1 Cities (Mumbai, Delhi, Kolkata, Hyderabad, Bangalore, Pune, Ahmedabad, Chennai) and 17 living in other parts of the country. 21 respondents were male and 39 were female.

Indian Respondents' Perceptions of the Factors that Affect the Underrepresentation of Female Teenagers in STEM Fields

This section explores the means ratings assigned to each of the factors, and the relative importance given to each of them. The most important factor was rated to be poverty ($M=5.70$, $SD=0.19$), followed by parent's traditional values ($M=4.28$, $SD=0.23$). On the other end, avoiding a male-dominated field ($M=2.48$, $SD=0.19$) and feminine attributes ($M=2.12$, $SD=0.19$) were strongly rejected as a factor, while absorbing stereotypes, teachers discouraging and Indian female teenagers having less confidence were given ratings that suggested neither rejection nor approval.

Table 1: Descriptive Statistics of Overall Underrepresentation and factors

Factor	Mean	Standard Error	Median	Standard Deviation
Overall Underrepresentation	4.48	0.17	5	1.32
Avoid Male Field	2.48	0.19	2	1.50
Feminine Attributes	2.12	0.19	2	1.45
Absorb Stereotypes	3.62	0.25	3	1.92
Parent's Traditional Values	4.28	0.23	5	1.81
Teachers Discourage	3.08	0.21	3	1.65
Poverty	5.70	0.19	6	1.50
Less Confidence	3.37	0.23	3.5	1.78

To test if the difference of means was statistically significant, a one-way ANOVA was carried out for the difference of means. **Table 2 shows that the p-value is 0.000, $p < 0.05$, hence, the null hypothesis is rejected and the alternative hypothesis is retained i.e., the difference in means is statistically significant.** The F of 30.93 is much higher than the F crit of 2.12.

Table 2: (One-way ANOVA): Source of Variation

SS	df	MS	F	P-value	F crit
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Between Groups	516.16	6	86.03	30.93	1.11E-30	2.12
Within Groups	1148.65	413	2.78			
Total	1664.81	419				

Overall, respondents rated the underrepresentation with a mean of 4.48 on a scale of 1 to 7. 27% of students enrolled in B. Tech (Bachelor of Technology) and B. E (Bachelor of Engineering) programs were female in 2015-16, while 47% of those enrolled in B. Sc (Bachelor of Science) programs were female. This does fall at elite institutions, for instance the percent of female students in the IITs and NITs was 18% and 15% respectively in 2017. 14% of scientists in research institutions are female.

The rating of 4.48 implies that female teenagers are underrepresented in STEM fields by a fair amount. This is well in line with the data; however, it more closely resembles Engineering & Technology than just Science. It is also closer to that of elite institutions than that of general ones. This may be because Indians hear too much about underrepresentation in engineering as a problem in the media and elsewhere and are extending it to science. They may also be extrapolating the greater underrepresentation from the workplace level to the teenage level, instead of knowing about the teenage level itself. (http://conflict.lshtm.ac.uk/page_174.htm, 2009)

Poverty was rated as the most important factor in determining the underrepresentation of women in STEM fields. This was the case by a wide margin (M=5.70, SD=1.50) being far higher than the next most important factor - parent's traditional values (M = 4.28). Other studies focusing on the underrepresentation of female Indians in STEM do not mention poverty often. While 10.5% of India's expenditure is devoted to education, there are vast inequalities between rich states and poor states. Rich Kerala spends \$685 on education per student per year, while poor Bihar only spends about \$100 on the same (Hunter, 2017). Poorer states such as Uttar Pradesh, Madhya Pradesh and Bihar also have wider gender gaps than richer states (Nair, 2010). While India has made improvements, many students still do not go to school, and Oxfam, a charity, estimates that 78% of students not going to school are female (Hunter, 2017). Many poor families have themselves not received a good education, and are therefore less interested in sending their children as they may not quite understand the value of it (Roy, 2018). India being a lower-middle income country means students are less likely to access technical equipment present in scientific and computer laboratories. Only around 21% of Indian secondary schools have physics, chemistry, and biology laboratories, while 26% have computer laboratories (Mehta, 2013). Because of these reasons, poverty reduces access to education, more acutely for girls, leading to less access for them in STEM fields. Here was one respondent explaining why Poverty was an important factor: "Poverty is one of the biggest factors resulting in a great difference between female education and job opportunities compared to men. ... With low-income families, money for education is low so typically the males are the ones having good education and jobs while females are told to stay home and do domestic work such as cooking, cleaning, and taking care of children. "

Traditional values that prioritise male education over female education are more common in lower-income households (Narang and Kotamraju, 2016), linking poverty and traditional values. One respondent observed "*The perception of typical female jobs and engagement is more prevalent among poor and lower middle class society*". Many such families are resistant to sending girls to school. The gap between male and female literacy rates is considerably higher in rural areas, which have more traditional values (Nair, 2010). One respondent chose to elaborate on what was meant by traditional values "Art vs science. Art is for females and science technology for males...". Many female students participate in programs affiliated with their traditional role, such as arts as education, and less so in STEM. Parents also view their daughters as a child bearer or housewife, so education seems like an unnecessary burden. In contrast, the male is seen as a breadwinner who can care for the elderly during his career. 88% of females

in rural areas work in agriculture or related fields, showing they can be used as a helping hand instead of going to school. This makes female education in general less prioritised, and STEM is considered a less viable path because it doesn't align with a traditional female role (Nair, 2010).

Feminine Attributes have been overwhelmingly rejected as a factor that explains the underrepresentation. This is in line with biological studies (Choi & Saas, 2017), which find that brain differences have little to no impact on differences in ability. The fact that this was rated so low shows the evolving views in India on the matter. Furthermore, the gap in Science and Math testing between male and female students has been shown to increase as they study more (Vijayaraghavan & Bhagat, 2019). The explanation for the widening gap has been attributed to women absorbing stereotypes about the people who typically work in STEM being male (Choi & Saas, 2017).

However, female Indian teenagers avoiding a male-dominated field was also rejected by the respondents. Part of the explanation for the low rating stems from the fact that women rated this lower than men (more on this observation later in this section), and respondents to the survey were 65% female, much higher than half. Even so, female Indian teenagers may not be avoiding STEM because it is a male-dominated field, because there isn't a large amount of underrepresentation beyond elite institutions. Women are 34% of IT workers in India, meaning that a woman working has a fair number of female colleagues that would make her feel comfortable in an IT-related environment. Only 25% of those working in computer roles in the United States are women (White, 2021), which is a lower figure than India. Since the field is not overwhelmingly male, female Indian teenagers are not concerned by this when considering their career choices. One respondent noted

“Over the past few decades, standards have improved in which female Indian teenagers are pushed to have better education and go into stronger working fields such as occupations in STEM.”, which illustrates that the field is not overwhelmingly male and that this view has become more common in India, seeping to teenagers. This means female Indian teenagers likely do not choose to avoid STEM because of how male the field is.

Differences in Mean Ratings between Demographic Groups

This section tries to test for differences in mean ratings between particular groups of age, gender and location. First the mean and standard deviations are calculated for each group, and then try calculating a p-value and t-statistic using a 2-Sample t-test. Ideally, the grouping should be done in a way to get 2 groups of similar size, which makes a low p-value for statistical significance easier to find.

Age

The most convenient breakup is comparing those under 22 years of age with those above 22 years of age i.e., 34 respondents under 22, compared to 26 above 22.

Table 3: 2-Sample T Test to test for differences in ratings by Age

Mean for <22	Std Dev for <22	Mean for >22	Std Dev for >22	t	P-Value

Overall Underrepresentation	4.62	1.42	4.31	1.14	0.91	0.37
Avoid Male Field	2.47	1.62	2.50	1.36	-0.07	0.94
Feminine Attributes	1.88	1.30	2.42	1.60	-1.45	0.15
Absorb Stereotypes	3.59	1.84	3.65	2.06	-0.13	0.90
Parent's Traditional Values	4.21	1.77	4.39	1.88	-0.38	0.71
Teachers Discourage	3.38	1.74	2.69	1.46	1.63	0.11
Poverty	5.53	1.60	5.92	1.35	-1.01	0.32
Less Confidence	3.09	1.62	3.73	1.95	-1.39	0.17

However, no positive result is achieved with the threshold at 0.05, as all values fall above it.

- Overall Underrepresentation as rated by those under 22 (M = 4.62, SD = 1.42) showed no significant difference (t = 0.91, p = 0.37) as rated by those over 22 (M = 4.31, SD = 1.14).
- Avoid Male Field as rated by those under 22 (M = 2.47, SD = 1.62) showed no significant difference (t = -0.07, p = 0.94) as rated by those over 22 (M = 2.50, SD = 1.36).
- Feminine Attributes as rated by those under 22 (M = 1.88, SD = 1.30) showed no significant difference (t = -1.45, p = 0.15) as rated by those over 22 (M = 2.42, SD = 1.60).
- Absorb Stereotypes as rated by those under 22 (M = 3.59, SD = 1.84) showed no significant difference (t = -0.13, p = 0.90) as rated by those over 22 (M = 3.65, SD = 2.06).
- Parent's Traditional Values as rated by those under 22 (M = 4.21, SD = 1.77) showed no significant difference (t = -0.38, p = 0.71) as rated by those over 22 (M = 4.39, SD = 1.88).
- Teachers Discourage as rated by those under 22 (M = 3.38, SD = 1.74) showed no significant difference (t = 1.63, p = 0.11) as rated by those over 22 (M = 2.69, SD = 1.46).
- Poverty as rated by those under 22 (M = 5.53, SD = 1.60) showed no significant difference (t = -1.01, p = 0.32) as rated by those over 22 (M = 5.92, SD = 1.35).
- Less Confidence as rated by those under 22 (M = 3.09, SD = 1.62) showed no significant difference (t = -1.39, p = 0.17) as rated by those over 22 (M = 3.73, SD = 1.95).

This means the null hypothesis, that there are no differences in the mean rating between those under 22 years of age and those over it, failed to be rejected. This means respondents under 22 and respondents over 22 agree on the reasons why women are underrepresented in STEM fields, with the same rating being given to each factor. Older people are expected to have more traditional views on issues such as gender, however, this data doesn't really measure

gender attitudes. The adult respondents were also a more urban and educated cohort than India as a whole, which may also create some difference to the result.

Gender

There were 21 male respondents and 39 female respondents. A 2-sample t-test for the difference of means was run in a similar fashion to the way the test was run for age.

Table 4: 2-Sample T Test to test for differences in ratings by Gender

	Mean for Male	Std Dev for Male	Mean for Female	Std Dev for Female	t	P-Value
Overall Underrepresentation	4.48	1.18	4.49	1.38	-0.03	0.98
Avoid Male Field	3.10	1.84	2.15	1.18	2.41	0.02
Feminine Attributes	2.48	1.47	1.92	1.42	1.42	0.16
Absorb Stereotypes	4.48	1.83	3.15	1.83	2.67	<0.01
Parent's Traditional Values	4.57	1.40	4.13	1.99	0.91	0.37
Teachers Discourage	3.14	1.32	3.05	1.82	0.20	0.84
Poverty	5.48	1.37	5.82	1.57	-0.85	0.40
Less Confidence	3.48	1.57	3.31	1.91	0.35	0.73

While 6 tests have p-values larger than 0.05, 2 tests have p-values less than 0.05. **For the factors “avoid male field” and “absorb stereotypes”, the null hypothesis is rejected and accept that there is a difference between mean ratings by male and female respondents.** Avoid Male Field was rated higher ($t = 2.41$, $p = 0.02$) by male respondents ($M = 3.10$, $SD = 1.84$) than female respondents ($M = 2.15$, $SD = 1.18$). Absorb Stereotypes was rated higher ($t = 2.67$, $p = <0.01$) by male respondents ($M = 4.48$, $SD = 1.83$) than female respondents ($M = 3.15$, $SD = 1.83$).

For the other 5 factors and the overall rating, the null hypothesis failed to be rejected and hence, there are no differences between the mean ratings of male and female respondents.

- Overall Underrepresentation as rated by male respondents ($M = 4.48$, $SD = 1.18$) showed no significant difference ($t = -0.03$, $p = 0.98$) as rated by female respondents ($M = 4.49$, $SD = 1.38$).

- Feminine Attributes as rated by male respondents (M = 2.48, SD = 1.47) showed no significant difference (t = 1.42, p = 0.16) as rated by female respondents (M = 1.92, SD = 1.42).
- Parent's Traditional Values as rated by male respondents (M = 4.57, SD = 1.40) showed no significant difference (t = 0.91, p = 0.37) as rated by female respondents (M = 4.13, SD = 1.99).
- Teachers Discourage as rated by male respondents (M = 3.14, SD = 1.32) showed no significant difference (t = 0.20, p = 0.84) as rated by female respondents (M = 3.05, SD = 1.82).
- Poverty as rated by male respondents (M = 5.48, SD = 1.37) showed no significant difference (t = -0.85, p = 0.40) as rated by female respondents (M = 5.82, SD = 1.57).
- Less Confidence as rated by male respondents (M = 3.48, SD = 1.57) showed no significant difference (t = 0.35, p = 0.73) as rated by female respondents (M = 3.31, SD = 1.91).

Male respondents were more likely than female respondents to think that female Indian teenagers wanted to avoid a male-dominated field, shown by their higher mean rating (M = 3.10, SD = 1.84). Male respondents were also much more likely than female respondents to think that female Indian teenagers absorbed stereotypes, which explained their underrepresentation in STEM fields. These 2 factors are linked, as avoiding a male-dominated field requires absorbing stereotypes about it being male-dominated and unfriendly to women in the first place. A reason for the difference might be that male respondents are trying to attribute the disparity to female teenagers themselves, while female respondents do not do so and give more weight to other factors as explanations for the disparity.

Location

There were 43 respondents in Tier-1 Cities and 17 respondents outside them, either in Tier-2 Cities, Other Urban areas, Small Towns or rural areas. Tier-1 Cities refer to India's eight largest metropolitan areas: Mumbai, Delhi, Kolkata, Chennai, Bangalore, Hyderabad, Pune, Ahmedabad.

Table 5: 2-Sample T Test to test for differences in rating by Location

	Mean for in-side Tier-1 City	Std Dev	Mean for outside Tier-1 City	Std Dev	t	P-Value
Overall Underrepresentation	4.51	1.13	4.41	1.68	0.25	0.81
Avoid Male Field	2.47	1.45	2.53	1.66	-0.15	0.88
Feminine Attributes	2.00	1.41	2.41	1.54	1.41	0.16
Absorb Stereotypes	3.84	1.95	3.06	1.78	1.42	0.16
Parent's Traditional Values	4.40	1.71	4.00	2.06	0.76	0.45
Teachers Discourage	3.19	1.62	2.82	1.74	0.76	0.45

Poverty	5.79	1.39	5.47	1.77	0.72	0.46
Less Confidence	3.26	1.68	3.65	2.06	-0.76	0.45

All of the tests are negative.

- Overall Underrepresentation as rated by respondents in Tier-1 Cities (M = 4.51, SD = 1.13) showed no significant difference (t = -0.25, p = 0.81) as rated by respondents outside Tier-1 Cities (M = 4.41, SD = 1.68).
- Avoid Male Field as rated by respondents in Tier-1 Cities (M = 2.47, SD = 1.45) showed no significant difference (t = -0.15, p = 0.88) as rated by respondents outside Tier-1 Cities (M = 2.53, SD = 1.66).
- Feminine Attributes as rated by respondents in Tier-1 Cities (M = 2.00, SD = 1.41) showed no significant difference (t = 1.41, p = 0.16) as rated by respondents outside Tier-1 Cities (M = 2.41, SD = 1.54).
- Absorb Stereotypes as rated by respondents in Tier-1 Cities (M = 2.00, SD = 1.41) showed no significant difference (t = 1.41, p = 0.16) as rated by respondents outside Tier-1 Cities (M = 2.41, SD = 1.54).
- Parent’s Traditional Values as rated by respondents in Tier-1 Cities (M = 4.40, SD = 1.71) showed no significant difference (t = 0.76, p = 0.45) as rated by respondents outside Tier-1 Cities (M = 4.00, SD = 2.06).
- Teachers Discourage as rated by respondents in Tier-1 Cities (M = 3.19, SD = 1.62) showed no significant difference (t = 0.76, p = 0.45) as rated by respondents outside Tier-1 Cities (M = 2.82, SD = 1.74).
- Poverty as rated by respondents in Tier-1 Cities (M = 5.79, SD = 1.39) showed no significant difference (t = 0.73, p = 0.46) as rated by respondents outside Tier-1 Cities (M = 5.47, SD = 1.77).
- Less Confidence as rated by respondents in Tier-1 Cities (M = 3.26, SD = 1.68) showed no significant difference (t = -0.76, p = 0.45) as rated by respondents outside Tier-1 Cities (M = 3.65, SD = 2.06).

The null hypothesis is rejected, that being those in Tier-1 Cities have different mean ratings to those outside Tier-1 Cities. This means that respondents in Tier-1 Cities have the same justification for why Indian female teenagers are underrepresented in STEM fields as those living outside of Tier-1 Cities.

A problem could be that the socioeconomic status of those reached outside Tier-1 Cities was significantly higher than all people living outside Tier-1 Cities. Therefore, using Location as an approximation of socioeconomic status and traditional values was inappropriate since those respondents’ socioeconomic status was not markedly different from respondents living inside Tier-1 Cities. Another could be the sample size, which was too small to give a positive result.

Using Ratings of Individual Factors to Predict Respondents’ ratings of Overall Underrepresentation

A multivariable regression was used to predict respondents’ rating of how they felt women were underrepresented in STEM overall using each individual factor. In this case, ratings of each of the 7 factors are independent variables, while the overall rating is the dependent variable.

Table 6: Multivariable Regression

Regression Statistics	
Multiple R	0.356

R Square	0.127
Adjusted R Square	0.010
Standard Error	1.315
Observations	60

Table 7: ANOVA

	df	SS	MS	F	Significance F
Regression	7	13.085	1.869	1.081	0.389
Residual	52	89.898	1.729		
Total	59	102.983			

With an R-Square of 12.7%, 12.7% of the variation in the overall rating can be explained by the variation in the individual ratings of each factor. This isn't very high, and can be explained by sampling variation. With a F-significance at 0.389, there is a 38.9% chance that this variation would have occurred by random. This is much higher than 5%, so the null hypothesis is failed to be rejected, and accept that the ratings of the individual factors have no predictive outcome on the overall ratings for each respondent.

Table 8: Multivariable regression by variable

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	3.251	0.774	4.201	0.000	1.698	4.803
Avoid Male Field	-0.054	0.144	-0.376	0.709	-0.343	0.235

Feminine Attributes	0.020	0.146	0.140	0.889	-0.272	0.313
Absorb Stereotypes	-0.010	0.126	-0.081	0.936	-0.262	0.242
Parent's Traditional Values	0.186	0.123	1.515	0.136	-0.060	0.432
Teachers Discourage	0.101	0.130	0.780	0.439	-0.159	0.361
Poverty	0.010	0.119	0.081	0.935	-0.228	0.248
Less Confidence	0.058	0.109	0.538	0.593	-0.160	0.276

For each factor, the p-value is higher than 0.05, so a regression model cannot be used as it cannot be ensured that even the closest factor (Parent's Traditional Values) has any predictive value. Avoid Male Field (p = 0.709), Feminine Attributes (p = 0.889), Absorb Stereotypes (p = 0.936), Parent's Traditional Values (p = 0.136), Teachers Discourage (p = 0.439), Poverty (p = 0.935) and Less Confidence (p = 0.593) all have p-values higher than 0.05.

This means their rating overall for how much Indians were underrepresented in STEM fields was not affected by their rating of the individual factors, and it can be concluded that the two are independent. If someone rates a particular factor lower or higher, the extent to which they think female teenagers in India are underrepresented in STEM cannot actually be predicted.

Other Factors Suggested

Among those who did mention additional factors, the two factors that were mentioned more than once were the lack of role models and family responsibilities. Factors mentioned exactly once were a lack of confidence and the location of the school.

While designing the survey, family responsibilities were not considered as the focus was on teenagers. However, considerations of family responsibilities may indeed affect how teenagers thinking ahead choose to go into STEM, as work in STEM often needs long hours that are difficult to balance with family responsibilities (NITI Aayog, 2017). One respondent noted that females are more concerned about being "married and taking care of a house and/or children (because many Indian women get married very young)".

In terms of role models, one respondent noted that "One thing that I feel might be affecting the under-representation of female Indian teenagers in STEM subjects might be the lower number of female role models in the field. They tend to identify themselves more and grow and feel motivated when they see someone like themselves."

Lack of confidence was not considered as a factor because factors that tried to explain the lack of confidence were placed in the survey instead.

The Location of the School is an interesting factor that was not considered when designing the survey. If the school is too far, particularly in rural areas where transportation facilities are limited, parents may not send their children to school, leading to less students (particularly female ones) going to school.

Suggestions to Reduce Disparity

The suggestions to reduce the disparity in STEM fell into 5 main categories: Education campaigns/drives for raising awareness/encouraging females, more opportunities, working on changing traditional values, celebrating female achievements in STEM and Free education/providing financial aid.

One respondent noted “Start educational drives or campaigns to educate the masses about the importance of female representation in STEM fields.” Education drives to raise awareness or encourage female teenagers to take up STEM makes a difference. If female teenagers don’t know about the opportunities available in STEM fields, then they will not choose to enter the field, so raising awareness and encouragement makes them consider STEM.

More Opportunities in STEM fields in general will help female Indian teenagers as they can enter the field more easily, instead of competing for a fewer number of jobs. This makes it a more viable field of study in school, because there is a greater chance of working in the field, and this could help female Indian teenagers.

Working on Changing Traditional Values could be a helpful way to reduce disparities, as respondents identified Parent’s Traditional Values as an important factor to explain why female teenagers are underrepresented in STEM fields. This would make parents encourage (or at least not discourage) their daughters to go into STEM fields.

Celebrating Female Achievements helps inspire girls to take up STEM, and provides them with role models so they can see that they are not the only ones trying to take part in STEM, and that there are others before them who have tried the path and succeeded.

Providing Financial Aid helps reduce the disparity because families will then have money to send their girl children to school. Poverty was indeed identified as the key reason for the underrepresentation of girls in STEM. At school, female Indian teenagers get to learn STEM and can complete 10-12 years of education, which helps reduce the disparity in the field at the teenage level. In poorer Indian states and rural areas, setting up schools focused on STEM and providing financial incentives to parents to send their girl children to these schools may also help them significantly.

Conclusion

The most important factor to explain the underrepresentation of women in STEM was poverty, followed by parent’s traditional values. The difference in the means of ratings is statistically significant, so the variation in ratings is very unlikely to have happened by chance. Respondents seemed to overestimate the underrepresentation at the teenage level, because they either hear too much about the issue in the media or are extending the wider disparity at the work level to the teenage level.

Testing for differences in ratings by age and urbanity yielded no positive result. Differences in ratings emerged for 2 factors when tested by gender - Avoid Male Field and Absorbing Stereotypes, with male respondents rating these factors higher than female respondents. This can be attributed to male respondents attributing the disparity to female students themselves, while female respondents do not attribute the disparity this way and instead look for other factors. A multivariable regression to predict overall underrepresentation using ratings for each individual factor yielded no positive result either, which suggests that the overall underrepresentation is independent of the rating of each individual factor.

Overall, this suggests that Indians have an increasing awareness of the importance of women in STEM, especially among those in larger cities. While this increased awareness is a positive, respondents seemed to overestimate the issue at the teenage level.

Future studies can try conducting a survey that is conducted in all languages, not just English. They can also try reaching portions of the population living outside Tier-1 cities and ensuring that they have a mix of respondents representative of the country in terms of socio-economic status, as many respondents to this survey were relatively well-educated and wealthy due to the methods of communication selected. This can allow us to see if the perceptions of Indian female teenagers in STEM have changed throughout Indian society as a whole.

The limitations are that the study's respondents skewed towards better-educated and wealthier residents of larger cities in India, rather than taking a representative cross-section of the country.

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