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Gender Gap in engineering and medical Colleges in India

Anthony Kenneth

Christ University, School of Education, India

Abstract: Engineering field is known for its driving innovation and technological advancements but the existence of Gender gap in the field of Engineering is not new and has been an interest of study for many scholars. The field has witnessed an enrolment ratio dominated primarily by one particular gender (males). In a developing country like India, the population is predominately young and this gap can create a huge difference. However, a noticeable gender gap is also witnessed amidst the students opting for medicine in India with the Enrolment ratio of females being higher. The large population in India creates a surging demand for admissions into reputed institutes, and these institutes are few in number, in order to make it an even ground for students to enter these institutes, National level examinations are conducted every year like the NEET and the JEE. These examinations determine student's admission into IIT's and other reputed institutes. The article analyses the statistical data from past five years of the National-level exams conducted for students interested to pursue medicine (NEET) and engineering (JEE). The mean difference from the following data was tabulated and represented graphical using SPSS. A significant gender gap was observed in enrolement of JEE and NEET, with a statistically difference of 456062.8 for JEE enrolement and 226706.80 NEET. The study also analyses the student enrolment data of Engineering and Medical Science courses in India from 2010-16, which again indicate an existence of gender gap in Engineering and Medical Sciences Colleges in India. Further, the study encourages policies and research towards bridging this gap.

Keywords: *Engineering colleges, Gender Gap, Medical Colleges, STEM Education*

Introduction

India is the second most populated nation in the world. The population is estimated to be about 129.02 Crore in 2016, with the female population estimated to be around 48.59% (*Women and Men in India* 2020). The current population in 2020 is estimated to be about 1.38 billion or approximately 138.3 crores based on worldometer elaborations from United Nations data (*Indian population)*. India has a large number of youth population and highest according to the census conducted in 2001. Together, the general youth and juvenile population make about 40% of the total Indian population (Malik, 2015). The youth population has expanded from 168 million in 1971 to 423 million in 2011 (Youth in India 2017). India, additionally is one of the highest in terms of the number of students studying abroad (Dukkipati, 2010). Being an exceptionally populated nation, it has seen a noticeable gender gap in terms of education and literacy. Since post-independence, the literacy rates have made good progress, where the Indian literacy rates were just 18.3% and the gender gap in literary with males at 27.2% and Females at 8.9%. Now the literacy rates since 2017 stand at 77.7%, with males at 84.7% and females at 70.3%. (*Census of India, Office of Registrar General, India).*

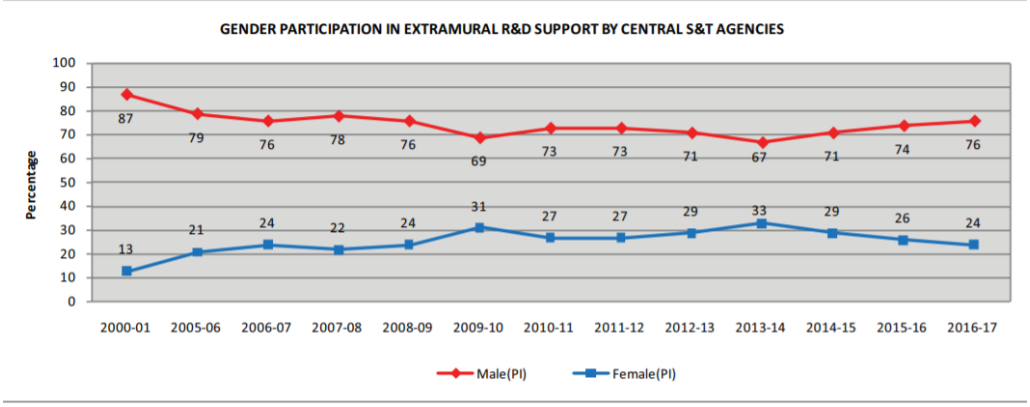
Some of the reasons for this visible gap over the years are that, parents considered that their financial investment returns on their daughters were lesser than sons, and most of those benefits were utilised by their in-laws (Gandhi Kingdon, 2002). Under the Socio-economic status, the girls from wealthier backgrounds were more likely to receive education, and after

marriage staying with their in-laws was seen to have a negative impact on their education (Rammohan and Vu, 2018). Along with being burdened with household work at the age of 12 and biases towards their sons (Singh and Mukherjee, 2018). Even though this gender gap in literacy has been reduced from 28.9 to 16.9 from 1987 to 2017, the literacy gap in adults and elderly requires further improvement (Chandra, 2019).

Gender Gap refers to differences between men and women, which can be seen in their behaviour, attitudes, opinion, etc. (Inglehart and Norris, 2000). The increase in literacy has seen a prominent gender gap showcase in various fields, especially in STEM fields. STEM fields are constantly faced with a gender gap, which can affect factors like economy, productivity (Diaz-Garcia et al., 2013; Settles et al., 2006), and even in business, only a noticeable small number of women entrepreneurs are with STEM backgrounds (Kuschel et al., 2020). This can be seen even in developed countries like, the USA (Beede et.al. 2011; Cimpian et al., 2020), with Engineering fields having one of the most noticeable gender gaps. According to The UNESCO Institute for Statistics (UIS) data, less than 30% of the world's researchers are women (*Women in Science* 2019). India also has some of the largest gender gaps in the field of sciences and researchers have studied the extent of gender gap of sciences in India (Gupta, 2019), educational inequality in India (Singh and Mukherjee, 2017; Rammohan and Vu, 2017), and inequality in the field of Research (Thelwall et al., 2019; Paswan and Singh, 2020). In India, the participation of women in extramural R&D projects is only about to 24% (*RESEARCH & DEVELOPMENT STATISTICS AT A GLANCE* 2020) ref. figure 1. Even though this has witnessed a rise from 13% in 2000-01 there is still an existing gap. India is ranked the 9th among the largest research producers, and currently ranks 9th as of September 2020 in the number of researches published according to Scimago (Lab, *Scimago journal country and rank*) and 3rd in the number of Ph.D.'s awarded in Science and Engineering (*RESEARCH & DEVELOPMENT STATISTICS AT A GLANCE* 2020) but still has one of the lowest international index of gender inequality, ranked at 129th (*Human Development Reports* 2019) and 112th in the global gender gap index (*Global Gender Gap Report 2020*) and displaying gender inequalities in the number of research articles published (Thelwall et al., 2019). There are also fewer number women obtaining doctorates in the field of engineering compared to medicine, and entering as scientists in the workforce (Gupta, 2019). Some of the reasons for fallout of women in sciences are, family decisions, economic issues, gender stereotypes, social differences, social expectations, male domination, lack of role models (Gupta, 2019; Wang and Degol 2017).

Figure 1

Gender Participation in Extramural R&D support by Central S&T agencies. Source: (Research & Development Statistics at a Glance 2020)



Source: NSTMIS, Department of Science & Technology, Government of India

India has around 993 Universities, 1,0725 stand-alone universities and 39,931 colleges with 60.53% colleges located primarily in the rural areas. The maximum student enrolment for Higher education is observed in Undergraduate colleges in India. Highest is seen under ARTS/Humanities with 93.49 Lakh out of which 49% are males and 51% are females, Science is second with 47.13 Lakhs, out of which 49% are males, and 51% are females and Commerce being third with 51.2% males and 48.8% females (*All India survey on Higher Education 2018-19*). However, the country is short in the number of medical colleges. The number of medical colleges in India as of 2018-19 report is 529, with around 58,756 students enrolled for MBBS (*National Health Profile 2019* 2019). This creates a shortage of doctors in the country, with only one allopathic government doctor for every 10,926 people in the country. On the other hand, the number of engineering colleges is over 4,000, and Engineering is the fourth major stream of enrolment in the country with 38.52 Lakh students (*All India survey on Higher Education 2018-19*).

The prevalence of the gender gap, especially in sciences, humanities, and engineering is well known (Dickson 2010). In several developed nations, there are a greater number of women enrolled for medicine (Smith, 2011; Mayorova et al., 2005). Globally, a greater number of women are enrolled in the medical fields than in engineering. 75% of our global healthcare workforce is primarily women and are the ones likely to adhere with the guidelines, i.e., spend more time with patients, and have better communication skills compared to men (Shannon et al., 2019). Women's degrees are the highest in fields like social sciences, and biological sciences, but the same does not apply in Engineering, and the number of degrees has been the lowest in engineering fields. There has also been only a minor progress in math, engineering and computer sciences (Speer, 2017). In India, a profession in medicine and engineering is more sought after, where the parental education plays a key role in whether the child pursues Engineering or Medicine (Gaurav and Sheikh, 2020). The premier institutes offering these courses are the Indian Institutes of Technology (IITs) and the All India Institute for Medical Sciences (AIIMS) for medicine,

with an acceptance rate of 1%. Due to this great demand for admission, entrance exams are held every year. The JEE (Joint Entrance Exam) main and Advanced, for admissions into the IITs, and NEET (National Eligibility cum Entrance Test) for admission into AIIMS (All India Institute of Medical Science). Studying the student enrollment data from these National Level Competitive exams provides an early insight into student interest in Engineering and Medical Sciences. Since students enrolling for these exams are primarily graduates from junior colleges, the demographic data obtained from this can be used to study the difference in the male and female enrolment ratio for that year.

Determining the existence of the gender gap in a particular field provides vital feedback for the respective course. Engineering and medicine contribute immensely to a country's growing economy, from designing the latest tech to providing a roboust medical care. It is vital to ensure that these fields are represented by the best, and a considerable number from both genders. Research in Science can be diversified with the inclusion of women, from designing a vehicle of transport or medication for the heart, women and men process it differently. Women also bring about a unique perspective in Research. New ideas and research questions from different perspectives are possible with a gender-diverse environment (Bert, 2018). Hence, studying the gender gap ratio can present unequal gender representation and promote further studies towards organizing a course that has an equal representation of male and female students. Especially in India, a country with a large young population.

Method

The study employed a quantitative approach and collects demographic data from the two nationally held entrance exams, and the survey data of student enrolment in Engineering and medical colleges in India. The demographic enrolment data of students was collected from the press release of the National Testing Agency (NTA) for JEE, and NEET respectively. Every year the NTA provides the press release of JEE and NEET to the general public; this provides a detailed account of the number of students enrolled, attempted, and cleared. The researcher explored the official websites of NTA, India, and analysed the demographic data of student enrolment uploaded over the period of 5-4 years from various press releases. Based on the data, the gender gap mean from the past five years was tabulated using SPSS, and the gender gap ratio of student enrolment in NEET and JEE from the past five years was also represented graphically. In the second analysis, in order to study the student enrolment ratio in engineering and medical colleges in India, the survey data from all India survey on higher education 2018-19, MHRD was collected, tabulated, and presented using SPSS in the form of bar graphs representing the ratio of the number of females to the number of males enrolment for medicine and engineering colleges in India.

Sample of study

The sample used in the study incorporated survey data and the demographic enrolment data obtained from the different sources and databases. Based on a convenient sampling approach, the sample size was restricted to the data available from past the five years, and was chosen for analysis. Ensuring that the study provided the most recent scenario of the extent of gender gap

difference prominent in the Indian Engineering and Medical Colleges. The data primarily comprised students aged 17-18 years old, having completed their higher secondary school/Pre-university. Students also belong to diverse courses of specializations in sciences, varying from courses of study that comprise mathematics, Physics, and optional subjects like Chemistry, Electronics, Computer Sciences, Biology.

In the data obtained from NEET and JEE enrolment, the students attempting NEET are from a combination of courses that mainly involve Biology, along with subjects like Mathematics, Physics, Chemistry, or home sciences. In comparison, students attempting JEE are mostly from Mathematics, Physics, Chemistry, Electronics, Computer Sciences, or Biology.

Analysis and Results

The data obtained from the demographic data of NEET and JEE was tabulated in the following tables, graphs and the mean difference was estimated to study the extent of the gender gap existing between the who appeared for the JEE and NEET examinations over the course of 5-4 years.

Table 1

Number of students attended JEE exam since 2016-20 (Desk, 2016; JEE main 2017 Result ANALYSIS: Only 6.8% girls in TOP 1000: Shiksha; Chaand, 2018; Press release 2019; JEE Main 2020 Result 2020

Sr.no	Year	Total number of Male students	Total number of Female students
1	2016	8,44,484	2,84,149
2	2017	8,17,000	3,04,385
3	2018	7,76,958	2,97,360
4	2019	8, 16,420	3,30,702
5	2020	6,04,000	2,64,000

Table 2

Number students attended NEET exam since 2016-20 (NEET Press Release, 2016; NEET press release, 2017; NEET press release, 2018; NEET press release, 2019

Sr.no	Year	Total number of Male students	Total number of Female students
1	2016	3,37,572	3,93,642
2	2017	4,73,305	6,16,772
3	2018	5,53,849	7,16,072
4	2019	6,30,283	7,80,467

Figure 2

Graph representing the number of males & females attending JEE from past five years

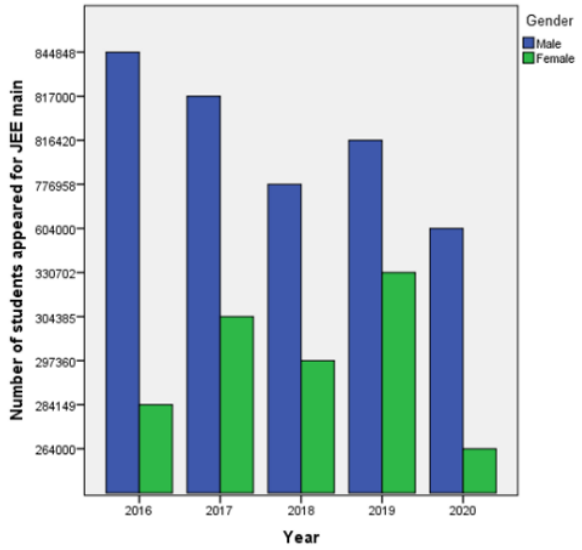
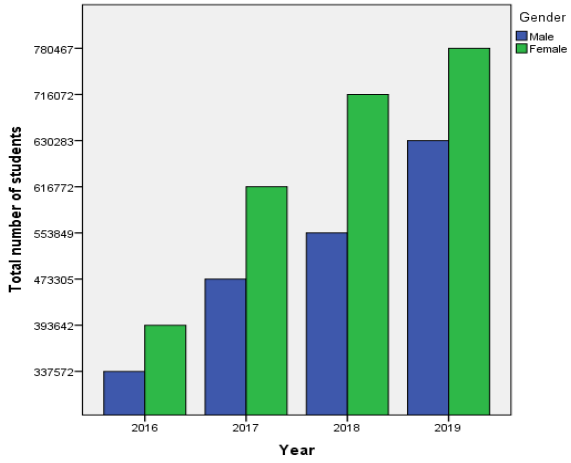


Figure 3

Graph representing the number of males & females attending NEET from past four years



The Figure 2 and 3 provides a graphical representation of the asymmetry observed under the number of students attempting JEE and NEET exams, during the course of 2016-2020. When the data is compared to the demographic data on JEE (Table 1 and Figure 2) and NEET (Table 2 and Figure 3) presented, a gender gap can be observed in both.

A significant gap in Gender was observed in students interested to pursue Engineering and Medicine in India. A significant number of male students were seen appearing for JEE, indicating more male students interested in engineering, and the mean gender statistical difference of 456062.8 (Table 5) was calculated. The same was not the case in NEET examinations, a greater number of females were seen appearing for these examinations, and a statistical difference of 226706.80 (Table 4) was calculated. The mean difference is greater within the students interested in pursuing Engineering compared to medicine, indicating existence of a larger Gap in the Engineering fields.

Table 4

The Mean value of the number of students enrolled for NEET from 2016-19

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Number of Students	Male	5	477730.20	118111.343	52820.998
	Female	3	704437.00	82465.406	47611.424

Table 5

The mean value of the number of students enrolled for JEE from 2016-2020

	Gender	Mean	Std. Deviation	Std. Error Mean
Number of Students	Male	771845.20	96893.536	43332.107
	Female	296119.20	24702.033	11047.085

Table 6

Representing the number of Females per 100 males in Engineering discipline, 2010-16 (Source: Higher education, MHRD

Sr.no	Year	Number of females per 100 males in Engineering & Technology discipline
1.	2010-11	40.9
2.	2011-12	39.9
3.	2012-13	40.4
4.	2013-14	39.6
5.	2014-15	39.0
6.	2015-16	38.7

Represents the number of females per 100 males enrolled in the Engineering and Technology Colleges from 2010-16. It can be seen from the below data that there are, on average only 40 female students per 100 males enrolled for Engineering and Technology disciplines in India. There have not been any significant changes over the course of 6 years, and the number of female enrolments in Engineering and Technology course has been low.

Figure 4

Graph representing the number of Females per 100 males in Engineering discipline, 2010-16

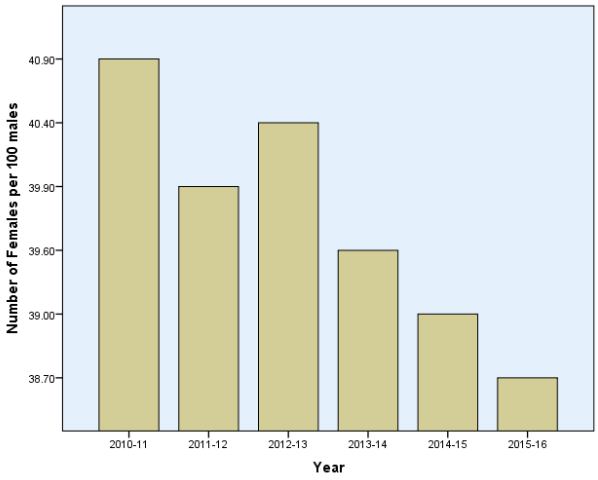


Table 7

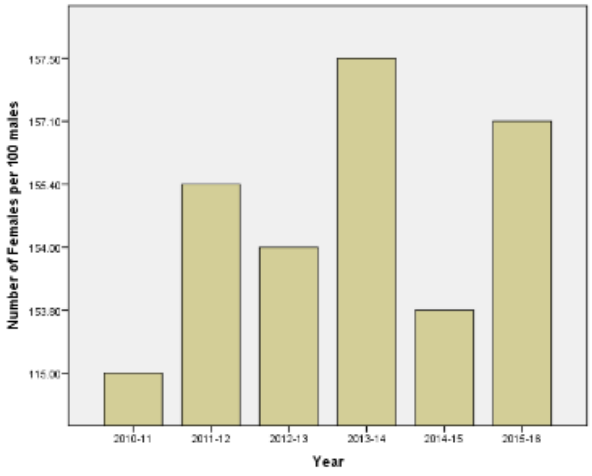
Number of females per 100 males belong to Medical Science discipline in India 2010-16 (Higher education, MHRD

Sr.no	Year	Number of females per 100 males in Medical Science discipline
1.	2010-11	115.0
2.	2011-12	155.4
3.	2012-13	154.0
4.	2013-14	157.5
5.	2014-15	153.8
6.	2015-16	157.1

Represents the number of females per 100 males in Medical Sciences; the data here is contrary to Table 3. The number of females is observed to be more in ratio compared to males. On average, 50 students more, for every 100 male students in the universities.

Figure 5

Graph representing the number of Females per 100 males makes in Medical Sciences discipline, 2010-16



Based on the data from all India survey on Higher education 2018-19, MHRD, the overall presence of females to per 100 males in medical sciences and engineering, the enrolment of students in Engineering and Medicine presents a noticeable Gap, with only an approximate of 40 female students enrolled for every 100 male enrolled for Engineering and every 150 female students enrolled for every male 100 enrolled. Presenting a significant gender gap difference within the engineering and medical sciences fields in India.

Discussion

India is home to one of the largest and one of the youngest populations in the world. There is, however, a problem of inequity in education; there are still biases towards pursuing streams based on Gender. Females seeking engineering in India are among the lowest, and a noticeable gap is present under these streams. This has also created a gender gap in India's number of research publications and PhDs awarded (Bal, 2004). The country produces extensive publications, but more publications are from men compared to women (*RESEARCH & DEVELOPMENT STATISTICS AT A GLANCE* 2020; Thelwall et al., 2019). The men are seen dominating the field of sciences, engineering, and technology, and women are seen in larger numbers in humanities or social sciences. However, in medical sciences, many females are interested in pursuing medicine, and this gender gap has been constant over the years without much change in engineering and medical sciences.

Children can be socialized and stereotyped at a young age into choosing their respective careers (Gaurav and Shiekh, 2020). The child being a doctor and engineer is considered a pride for the family, especially the sons. They are often pressured to opt for Engineering after their higher secondary, and the girls into medicine. Apart from parental factors, numerous factors influence a child's decision to pursue STEM, which includes Engineering (Regan and Dewitt, 2014; Moalker jr and Kim, 2014), and a large gender gap in STEM fields can create a shortage of qualified individuals in the country's workforce.

In the analysis of the gender gap, it was also studied the country also faces a shortage of healthcare staff, and the current number is not sufficient for the entire population, especially during a crisis like COVID-19 (Kumar et al.,2020). With the requirement criteria of at least 20 lakhs doctors in the country, India has only about half of the number. With only about 30,000 students graduating each year in medicine, that gap

cannot be met in another 40 years (Anthony, 2019). In contrast, the number of engineers is at an over-supply to the required demand (Gaurav and Sheikh, 2020), due to the increased number of engineering colleges compared to the number of Medical Colleges in India and offering about 67,000 seats per year (Dubbudu, 2017). With an existing asymmetry with the Engineering and Medical colleges, the addition of the Gender gap in these fields would only reduce the quality of professionals produced from these institutions by losing out on the individuals with a better aptitude for these subjects. The analysis from the past five years of students taking part in nationally held entrance tests for Engineering and Medicine presented an unchanged and significant gender gap. To further strengthen this analysis, the survey data from the enrollment ratio was further studied, which again showed an asymmetry in Gender enrolment. India would benefit from an equal representation of female engineers in the workforce, and the same applies to males in medicine. The reasons for this gender gap in India should be further explored and promote a curriculum that makes such courses attractive for both genders.

Scope and Limitation

The study analyzes the demographic data from NEET and JEE. These exams are one of the toughest exams for higher secondary. Only students passionate about getting into these fields are likely to be seen attempting these exams. Therefore, this study presents an overview of the gender asymmetry of students competing for pursuing medicine and engineering in premier institutes. Since the student enrolment data in these institutes is only updated in the All India survey for higher education after 2-3 years, this provides a quick overview of the expected gender gap in these fields. The study presents the need to consider gender-inclusivity in Engineering and Medicine and parental counseling in schools to remove any gender stereotype notion towards STEM fields and create curriculums that make these fields attractive for both genders. Especially in a country that has an enormous population of youth, forming a vital workforce and further boost the country's economy.

The study is only restricted to engineering and medicine; it does not provide us details about the gender gap in respective fields of engineering. Ex: there might be a more significant gap in mechanical engineering which can increase the overall average in the gender gap. The study also does not provide the reasons for the gender gap only states the existing gap.

Declaration of Interests: None

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Corresponding Author Contact Information:

Author name: Anthony Kenneth

Department: School of Education

Faculty: Scholar

University, Country: Christ University, Bangalore, India

Email: anthony.kenneth@ed.christuniversity.in

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