A STEM Instructor Like Me: Female Teacher-Student Interactions in Engineering Colleges

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Abstract

This study provides causal evidence on the impact of exposure to female faculty on female STEM students. We leverage the random assignment of undergraduate STEM students to instructors, which is rarely feasible in higher education settings, to circumvent identification issues arising from non-random sorting of students to classrooms based on instructor or peer characteristics. We find that female students taught by female faculty achieve higher course grades, improving by 2.7 percentile points. Moreover, increasing female faculty exposure by 10 percentage points over two years (from a baseline of 34 percent) yields a 0.03 standard deviation improvement in standardized test scores of female students. Beyond academic performance, we find that exposure to more female faculty leads to a reduction in STEM anxiety among female students and more equitable gender beliefs among male students. These findings suggest that the exposure to female faculty helps improve the performance of female students in STEM through higher academic achievement and reduced anxiety as well help reshape traditionally held gender-based stereotypes in STEM.

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1 Introduction

Gender disparities in STEM fields remain a global concern, with substantial implications for economic productivity and social equity. Although women now enroll in college at higher rates than men (Parker, 2021), they continue to be underrepresented in STEM in college and the workforce—especially in lucrative fields such as computer science and engineering (Beede et al., 2011; Bertrand, Goldin, & Katz, 2009; National Center for Science and Engineering Statistics, 2023). Moreover, while recent data show a narrowing gender gap in STEM performance at younger ages, significant disparities in STEM performance during and post college exist and cannot be fully explained by pre-college human capital or demographic differences (Loyalka et al., 2019, 2021; Michelmore & Sassler, 2016). Taken together, this suggests that the institutional environment of STEM fields may play a key role in perpetuating gender gaps (Blau & Kahn, 2017; Mandel & Semyonov, 2014).

A growing body of research suggests that cultural norms, gender biases, and stereotypes affect female participation and performance in STEM fields. In college, these factors can shape how female students view themselves relative to male peers. Studies show that women often underperform in such environments, even when they possess skills comparable to those of men. Previous studies show that this disparity can largely be attributed to differences in confidence and competitive attitudes in traditionally male-dominated domains (Niederle & Vesterlund, 2007, 2011). Gender-biased beliefs and stereotypes also contribute to higher stress and anxiety levels among women in STEM, potentially becoming self-fulfilling prophecies ('stereotype threat') (Bordalo, Coffman, Gennaioli, & Shleifer, 2016, 2019; Coffman, 2014; Exley & Kessler, 2022; Steele & Aronson, 1995) that further undermine performance and discourage persistence in these fields (Buser, Niederle, & Oosterbeek, 2014; Ceci, Ginther, Kahn, & Williams, 2014; Kahn & Ginther, 2018).

Increasing the presence of female faculty in STEM education is one potential strategy for mitigating negative cultural norms, biased beliefs, stereotypes and their adverse effects. Female instructors can serve as role models, promote a sense of belonging, and create more inclusive learning environments (Bettinger & Long, 2005; Dee, 2005, 2007). A few studies find positive impacts of female faculty on "cognitive" assessments and outcomes of female students in the Air Force Academy (Carrell, Page, & West, 2010) and general college education (Hoffmann & Oreopoulos, 2009), but their impacts on "non-cognitive" outcomes (such as confidence and anxiety) and beliefs about gender stereotypes) are largely unexplored.

In this paper, we estimate the impact of greater exposure to female faculty on cognitive and non-cognitive outcomes of female engineering students. We explore these questions by creating a large, nationally representative dataset of faculty and students at engineering colleges in India. Engineering colleges in India employ roughly a quarter of a million faculty and enroll 4.5 million students (AICTE, 2023). We analyze a comprehensive set of student outcomes including course grades and standardized test scores as well as measures of students' confidence and anxiety about STEM subjects and beliefs about gender differences in STEM fields.

This study leverages random assignment of students to classrooms to estimate the causal impact of female faculty on student outcomes. Estimating the impact of female faculty on student outcomes presents challenges due to potential selection biases. For example, the female students who benefit the most from female professors may be the ones who are also more likely to enroll in courses taught by female professors. This type of sorting biases comparisons between male and female faculty in terms of their influence on female student performance. To address these challenges, we leverage data from engineering colleges where students are randomly assigned to faculty-taught sections within courses (referred to hereafter as "classrooms"). Such random assignment is extremely rare in higher education because the norm is for college students to have choice.[1] This setting enables us to estimate the causal impact of female faculty on student outcomes.

Another important feature of engineering colleges in India is that student grading occurs at the course level through standardized end-of-semester exams, which are administered and graded by a central university system encompassing multiple colleges, rather than by individual faculty members. This centralized grading process mitigates the possibility that female faculty might exhibit favorable bias towards female students (or any group) through higher grading. Additionally, the course content is standardized, with faculty adhering to a syllabus set by a national governing body (AICTE, 2018).

We find that female students perform better (in terms of grades) in courses in which they are taught by female faculty, compared to courses in which they are taught by male faculty, by about 2.7 percentile points. The difference is statistically significant at the 1 percent level.. We also find that, conditional on baseline test scores, female students with a 10 percentage point higher share of female faculty in the first two years of the program (of a base of 0.34) have 0.03 standard deviations higher test scores on academic skills tests administered and proctored by the research team. This difference is statistically significant at the 5 percent level.

For non-cognitive measures, we find that, conditional on baseline differences and other characteristics, female students with a 10 percentage point higher share of female faculty in the first two years of the program express around 0.1 standard deviations lower anxiety about STEM subjects (math and physics). We also find that students exposed to a greater share of female faculty in the first two years of the program express more equitable beliefs about gender differences and representation in STEM. Importantly, these effects are largely driven by the impact of female faculty on the beliefs of male students, with a 10 percentage point higher share of female faculty associated with 2.5 percentage point higher likelihood of male students responding equitably (as compared to 1.3 percentage points for female students).

[1] A notable exception that has been previously studied is the U.S. Air Force Academy (Carrell, Page, & West, 2010).

2 Materials and Methods

2.1 Data

We collected student, faculty and administrative data from a nationally representative sample of engineering and technology colleges in India. We drew nationally representative samples of faculty and students from broadly defined computer science (CS) and electrical engineering (EE) majors, the two largest majors in engineering and technology colleges. Further details about the population of colleges and sampling procedure are described in Appendix A.

Using surveys conducted with department heads, we found that students in a subset of departments in 12 colleges were randomly assigned to "classrooms" or sections for all courses taken during the first two years of college. These departments indicated they used a formal, computerized procedure for the random assignment of students to classrooms. However, one of the 12 colleges was an all-women's college and therefore excluded from the sample. We obtained granular course-level grade information from these departments for all courses taken by students during the first two years.

Students enroll in courses each term in which there are typically multiple "classrooms." Classrooms are defined as separate course sections taught by faculty during the same term to maintain small classroom sizes. For example, Electrical Engineering 101, Spring 2019 at a given college is a course that might have three separate classrooms: Section A is taught by Faculty X, Section B is taught by Faculty Y, and Section C is taught by Faculty Z. Each classroom would have roughly one third the total course enrollment for that semester. The number of classrooms for a course ranges from 1 to 15, with a median of 3 classrooms per course. Courses are distinctly defined for each college and department.

Students within a given department generally enroll in the same set of courses prescribed during the first two years of college (AICTE, 2018). Within each of these prescribed courses, the random allocation of students to course sections or classrooms ensures that students do not self-select into classrooms based on faculty and classmate characteristics. Consequently, for this sample of colleges, we can estimate the causal effects of being assigned female faculty on student course grades. Furthermore, since students are randomly assigned to classrooms within each course, and courses are not selected within majors in the first two years, variation in the share of female faculty that students are exposed to is also as good as random. For this reason, we can also estimate the long-term impacts of exposure to a greater share of female faculty on standardized test scores and non-cognitive outcomes.

2.2 Variables

For our sample, we combined administrative data on students and faculty, survey data from students and faculty, and assessment data on students from standardized tests that we conducted. Administrative data on students includes course enrollments, classroom/instructor assignments and course grades.[2] We combine this information with standardized test scores on academic skills tests (a combined math and

[2]More details on grading policies are described in Appendix A

physics test) that students took at the beginning of the program and after two years into the program, as well as their demographic information, survey questions regarding their confidence and anxiety about math and physics, and survey questions regarding gendered attitudes regarding STEM subjects.[3]

We matched data on students to data on faculty who taught them in the first two years. Data on faculty were sourced from survey and include their ladder rank, qualification, and demographic information. The survey data also include information on their time spent on teaching-related activities, and teaching practices.

2.3 Estimation Strategy

2.3.1 Assessment Outcomes

We investigate the impacts of female faculty on female students' academic outcomes using three specifications. First, we estimate the impact of being randomly assigned to a female instructor's classroom on female students' course grades using Equation (2.1):

$$Y_{ikcf} = \alpha + \beta_1 Fem_f \times Fem_i + \lambda_i + \lambda_c + \epsilon_{ikcf} \tag{2.1}$$

Here, Y_{ikcf} is the percentile grade for student i for course k, assigned to classroom c taught by faculty f, Fem_f indicates whether faculty f is female, Fem_i indicates whether student i is female, λ_i are student fixed effects, and λ_c are classroom fixed effects (which subsume course fixed effects). β_1 is the coefficient of interest and indicates the relative improvement for female students from being taught by a female faculty instead of a male faculty. The unit of observation is a student-course, and standard errors are clustered at the faculty level.

We also estimate the impacts of female instructors on students' performance on standardized tests on academic skills (math and physics), that we conducted and proctored at both the beginning of the program (baseline) and after the first two years of the program (endline). Estimating the effects on test scores complements grade estimates because grades may capture non-cognitive elements of learning (Borghans, Golsteyn, Heckman, & Humphries, 2016; Cornwell, Mustard, & Van Parys, 2013; Jackson, 2018) or are responsive to factors such as student demand for courses in addition to measuring the impacts of female faculty on students' achievement. Equation (2.2) estimates the effects of female students being assigned to a greater share of female faculty in their first two years, on their test score in said standardized tests, conditional on observable student and faculty characteristics, including students' score in the baseline test.

$$Y_{is} = \alpha + \beta_1 FemShare_{is} + \beta_2 Fem_i + \beta_3 FemShare_{is} \times Fem_i + \gamma^{\intercal} \bar{\Omega}_{is} + \delta^{\intercal} \eta_i + \lambda_l + \lambda_s + \epsilon_{is} \tag{2.2}$$

[3] Students' demographic information includes gender, parents' education, whether they belonged to a disadvantaged caste or socioeconomic group, and whether they came from a rural or urban area. Multiple survey questions about subject specific (math and physics anxiety and confidence were combined to create confidence and anxiety indices using a standardized inverse-covariance weighted average (Anderson, 2008). Survey questions about gender attitudes were used to construct binary variables about student beliefs (0=traditional; 1=non-traditional)

Here, Y_{is} is the standardized test score for student i in school/department s, $FemShare_{is}$ is the share of classrooms that student i was assigned to in their first two years, taught by female faculty, $\bar{\Omega}_{is}$ is a vector of average faculty characteristics for student i in school s, η_i is a vector of student characteristics, λ_l are subject fixed effects (with $l \in$ {Math, Physics}), and λ_s are school/department fixed effects.

2.3.2 Non-Cognitive Outcomes and Gender Stereotypes

We investigate the impacts of exposure to a greater share of female faculty on (a) female students' confidence and anxiety in STEM subjects, and (b) students' attitudes and beliefs about gender differences in STEM subjects, using the Equation (2.3):

$$Y_{is} = \alpha + \beta_1 FemShare_{is} + \beta_2 Fem_i + \beta_3 FemShare_{is} \times Fem_i + \gamma^{\intercal}\bar{\Omega}_{is} + \delta^{\intercal}\eta_i + \lambda_s + \epsilon_{is} \tag{2.3}$$

Here, Y_{is} reflects (a) the confidence/anxiety index measure for student i in school/department s (z-scores, constructed using the method proposed by Anderson (2008)), and (b) a binary measure for whether student i in school/department s holds traditional or non-traditional beliefs (0=traditional; 1=non-traditional).[4] The remaining variables are as defined for Equation (2.2).

3 Results

3.1 Descriptive Statistics and Balance Tests

Female and male students in our sample exhibit substantial baseline differences in academic performance, though differences in non-cognitive measures are less pronounced. Thirty-two percent of our sample of students are women. We find considerable baseline differences between female students in our sample scored approximately 0.20 points lower on both the national JEE entrance examination and the standardized academic skills tests conducted by the research team. Figure 3.1 plots baseline differences between female and male students for academic skills test scores (Panel A) and JEE scores (Panel B). Turning to non-cognitive skills, female students report lower confidence and higher anxiety at baseline, but these differences are not statistically significant. Figure 3.1 displays confidence index z-scores (Panel C) and anxiety index z-scores (Panel D).

We conducted a balance check on student characteristics to test for any differences in student characteristics between classrooms taught by female and male faculty (see Table B1). Results are consistent with students being randomly assigned to faculty, with no differences in characteristics between classrooms led by female and male faculty. The only exception across is a small difference of 2 percentage points in whether father attended college, which is statistically significant at the 10 percent level.

[4] Responses from both faculty and students on the relative academic abilities of male and female students are recorded on a five-point Likert scale, where 1 indicates a strong belief that male students are much better, 2 indicates a belief that male students are slightly better, 3 indicates a belief that male and female students are equal, 4 indicates a belief that female students are slightly better, and 5 indicates a strong belief that female students are much better. To construct our outcome, these responses are coded as a binary variable, where 1 and 2 are classified as traditional beliefs (coded as 0), and 3, 4, and 5 are classified as non-traditional beliefs (coded as 1).

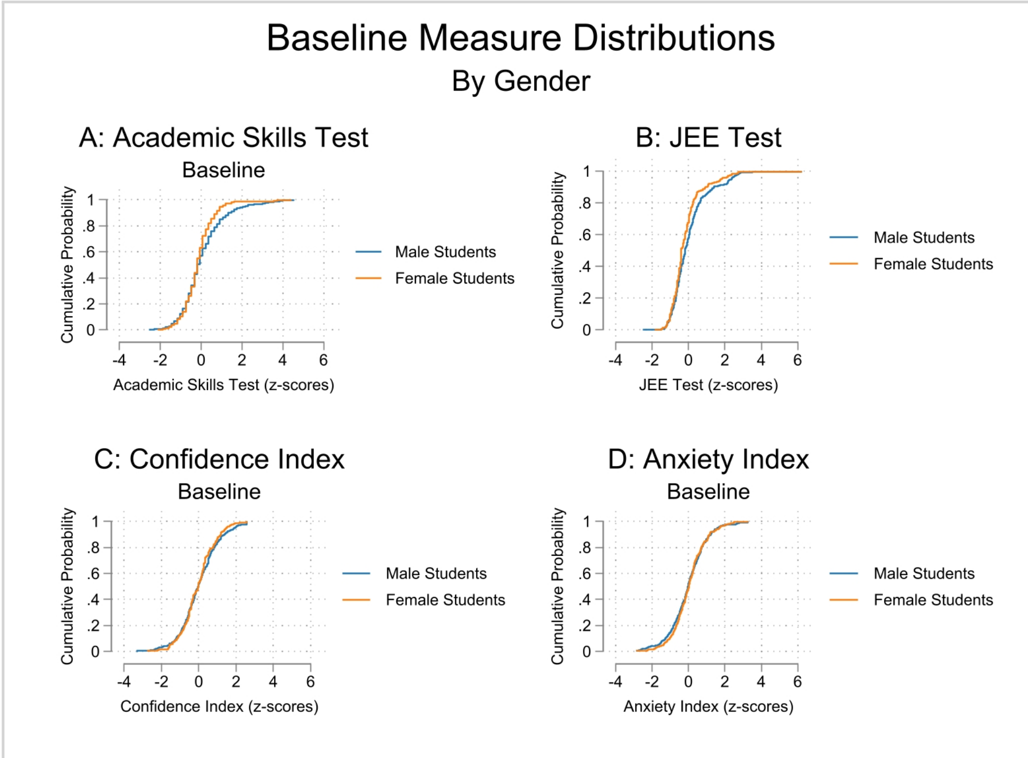

Figure 3.1: Baseline Measure Distributions By Gender

3.2 Gender Differences in Academic Performance

We estimate models of a student's course grades and test scores regressed on indicators for female student, female faculty, and the interaction between the two controlling for individual characteristics and fixed effects. The key parameter of interest is the female student-female faculty interaction which captures the added effect of having a female faculty on a female student relative to a male student. For test scores, we use the female faculty share of courses taken by the student instead of an indicator for female faculty. Table 3.1 shows the results from estimating Equations 2.1 and 2.2 for two measures of academic performance: course grades and standardized test scores. Column I estimates the effects of being randomly assigned to a female-taught classroom for a given course, on a student's percentile rank in the course, controlling for student, course, and classroom fixed effects. We find that female students assigned to female faculty have a 2.7 percentile point higher rank within a given classroom for a course, compared to their counterparts assigned to male faculty.

Table 3.1: Performance on Assessments

	I Course Grade	II Standardized Test Score
Female Faculty × Female Student	2.70***	
	(0.97)	
Female Faculty Share × Female Student		0.033**
		(0.016)
Female Faculty Share		-0.008
		(0.014)
Female Student		0.022
		(0.066)
Faculty Characteristics	Classroom Fixed Effects	Qualifications+ Demographics
Dependent Variable Mean	50.9	0
N	28469	1600

Notes: The dependent variable in Column I is a student's grade for a given course, scaled to their percentile rank in the course (1-100 scale). The model in Column I includes student and classroom fixed effects. The dependent variable in column II is a student's standardized test score in math and physics, conducted two years into the program, and scaled to a z-score. The model includes student and faculty controls, and subject and department fixed effects. Standard errors are clustered at the faculty level for Column I and at the department level for Column II. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

We estimate Equation (2.2) for students' performance on a standardized test on academic skills (math and physics), that we conducted and proctored at both the beginning of the program (baseline) and after the first two years of the program (endline). Column III estimates the relative effects on the test scores of female students from being assigned to a greater share of female faculty in their first two years, conditional on observable student and faculty characteristics, including students' score in the baseline test. We find that female students assigned to 10 percentage points more female faculty in the first two years (base of 0.34) improve their standardized test score by 0.033 standard deviations relative to their counterparts taught by fewer female faculty.[5] These findings indicate that the presence of female faculty positively influences the academic performance of female students, as evidenced by improvements in both course grades and standardized test scores.[6]

Given the random assignment of students to classrooms, and the grading procedure followed by the engineering colleges in our sample, these estimates can be interpreted as capturing causal effects.

[5] The estimates for all outcomes are robust to different specifications and to excluding the one elite college from the sample.

[6] We test for whether female faculty put more time into teaching, measured along a range of dimensions, and whether they implement different teaching practices based on Teaching Practices Inventory (TPI) measures (Wieman & Gilbert, 2014). We find no differences between male and female faculty in their reported time spent on teaching-related activities and their teaching practices (see Appendix Tables C1 and C2).

3.3 Gender Differences in Anxiety and Confidence

Table 3.2: Anxiety and Confidence Indices

	I Confidence Index	II Anxiety Index
Female Faculty Share x Female Student	-0.033	-0.107***
	(0.037)	(0.040)
Female Faculty Share	-0.020	-0.105
	(0.052)	(0.057)
Female Student	0.131	0.246
	(0.145)	(0.158)
Faculty Characteristics	Qualifications + Demographic Characteristics	Qualifications + Demographic Characteristics
Dependent Variable Mean	0	0
N	797	797

Notes: The dependent variables in Columns I and II are indices constructed from students' responses to survey questions about their anxiety and confidence regarding STEM subjects, using the methodology of Anderson (2008). Both models include student and faculty demographics, and students' baseline characteristics (specifically baseline and anxiety measured at the beginning of the program). Standard errors are clustered at the department level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

We test whether the impact of female instructors in STEM education goes beyond academic performance, influencing non-cognitive outcomes such as confidence, anxiety, and gender perceptions. Stereotype threat regarding gender differences in STEM ability often manifests itself as female students tending to express lower levels of confidence in STEM subjects and higher degrees of anxiety about their STEM skills (Bian, Leslie, & Cimpian, 2017; Exley & Kessler, 2022; Exley & Nielsen, 2022). Female faculty may counter these tendencies by serving as role models. We test for their impact on the anxiety expressed by their students regarding several dimensions of their coursework in STEM subjects. We construct the index for both baseline (beginning of the program) and endline (after two years) surveys, using a standardized inverse-covariance weighted average (Anderson, 2008).

Controlling for baseline differences, we estimate the impact of being taught by female faculty on students' anxiety regarding STEM subjects, using Equation (2.3). In Table 3.2, we report the impacts of a greater share of female faculty on students' endline indices for confidence (Column I) and anxiety (Column II). Controlling for baseline differences, we do not find any significant differences between female instructors' impact on their female students' confidence relative to their impact on male students' confidence. The results differ for anxiety. An increase in the share of female faculty by 10 percentage points reduces female students' anxiety by 0.11 standard deviations relative to male students. A higher share of female faculty has no effects on male students' anxiety. These findings underscore the role that female faculty can play in shaping the outcomes of female students, beyond simply their impact on academic assessments.

3.4 Gender Stereotypes in STEM

We explore the effects of exposure to more female engineering instructors on gender stereotypes held by students. Stereotyped beliefs about gender differences in STEM are among the most pervasive forms of stereotype threat in this field, affecting both students and teachers (Bian et al., 2017; Carlana, 2019;

Dhar, Jain, & Jayachandran, 2022; Leslie, Cimpian, Meyer, & Freeland, 2015). Such beliefs are closely linked to gender disparities in academic achievement and participation (Aksoy, Exley, & Kessler, 2024). We surveyed both students and faculty regarding their beliefs about gender differences. Specifically, we asked students who they believe performs better in STEM subjects—male or female students.[7]

Figure 3.2 presents a set of descriptive and causal results regarding students' beliefs about gender differences in STEM subjects and the impact of a greater share of female faculty on students' beliefs. In Panel A, we find that male students typically hold more traditional beliefs than their female counterparts, with 34-41% of males in our sample stating that male students are much better or slightly better than female students at math or physics. In contrast, only 15% of female students hold the same belief that male students are better.

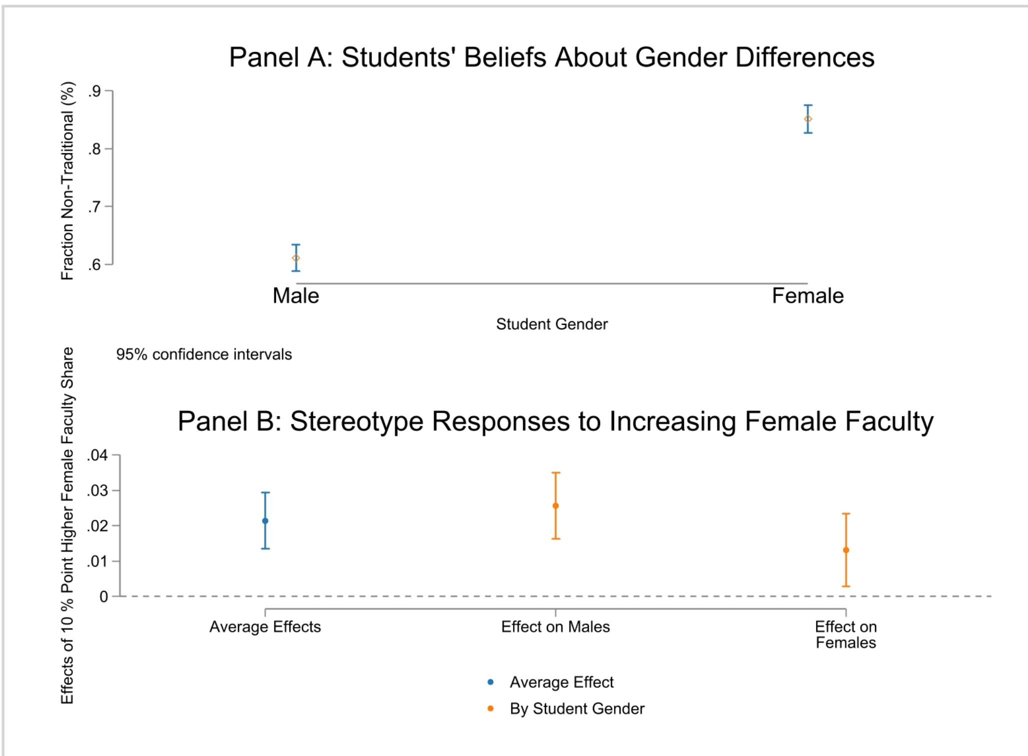

Figure 3.2: Stereotype Levels and Responses by Gender

To investigate the impact of being assigned to a greater share of female faculty on students' beliefs, we estimate Equation (2.3). Panel B plots the results from these regressions. We first find that an increase in the share of female faculty by 10 percentage points increases the likelihood of a student giving non-traditional responses by about 2.1 percentage points. The increase is statistically significant and robust to different specifications. Crucially, however, we find that this increase is primarily driven by the response

[7]Students' responses were recorded on a likert scale from 1 to 5, with 1 indicating that male students are much better, 2 indicating that male students are slightly better, 3 indicating that male and female students are equal, 4 indicating that female students are slightly better, and 5 indicating that female students are much better. We recode these to binary variables, where 1 and 2 are classified as traditional (0), and 3, 4, and 5 are classified as non-traditional (1)).

of male students; with the effect size being 2.5 percentage points for male students (as compared to 1.3 percentage points for female students).

Our results are robust to several different specifications. Specifically, we find that female faculty have qualitatively similar impacts on students' reported beliefs, when we use (a) standardized versions of students' Likert scale responses (see Figure D1), (b) when we recode the variable to reflect the share of students who believe that their own gender is better in STEM subjects (see Figure D2), and (c) when we recode the variable to reflect the share of students who believe that both genders are equally good in STEM subjects (see Figure D1).[8]

4 Discussion

Gender inequality in STEM fields is a major source of concern in higher education and labor markets around the world. We find that female students perform relatively better (2.7 percentile points) in courses in which they are taught by female faculty, compared to courses in which they are taught by male faculty. We also find that female students taught by a 10 percentage point higher share of female faculty in the first two years of the program have 0.03 standard deviations higher test scores for academic skills tests. Moving to unexplored non-cognitive measures, we find that female students taught by 10 percent more female faculty express significantly lower anxiety about STEM subjects (in both math and physics) than their counterparts. Finally, we find that students exposed to a greater share of female faculty express more equitable beliefs about gender differences and representation in STEM. These differences are largely driven by female faculty's impacts on the beliefs of male students. Female faculty appear to affect female students through multiple channels reaching beyond improving academic outcomes to changing STEM anxiety and beliefs. The positive influence of female engineering faculty on both the cognitive and non-cognitive outcomes of students may bode well for longer-term impacts on reducing gender inequality in higher education and careers in STEM.

Our findings have two main broad implications. First, although previous research finds some evidence of positive impacts of female faculty on the outcomes of female students in terms of assessments and course selection (Bettinger & Long, 2005; Birdsall, Gershenson, & Zuniga, 2020; Carrell et al., 2010), much less is known about their impacts on non-cognitive measures such as confidence, anxiety, and beliefs about gender- especially in college and beyond. While a small but growing (primarily laboratory experimental) literature investigates gender differences in confidence and beliefs in STEM settings (Buser et al., 2014; Coffman, 2014; Coffman, Exley, & Niederle, 2021; Exley & Kessler, 2022)- our study is the first to holistically explore both cognitive and non-cognitive measures for female students in STEM settings and explore them through the lens of faculty-student gender matching. Furthermore, from a methodological and identification perspective, the availability and use of random assignment of students to faculty in classrooms is exceedingly rare and thus far only in specialized settings such as the US Air Force Academy (Carrell et al., 2010). We conduct our study in the most populous country in the world, and in a setting

[8] We find similar results when we use measure female faculty share in standard deviation units relative to the mean, instead of 10 percentage point units.

that has large and important domestic and international implications. There are 4.5 million enrolled students in engineering colleges in India (AICTE, 2023), and these colleges account for nearly 25 percent of all engineering degrees awarded each year globally National Science Foundation (2016). Many engineering graduates find work in the United States.

Secondly, our findings speak to the role that engineering colleges play in reducing gender inequities in a highly gender-unequal society such as India, and the singularly important role that female faculty can play in that regard. India has one of the lowest female labor force participation rates in the world (Afridi, Dinkelman, & Mahajan, 2018), early marriage is far more common among women (Kishor & Gupta, 2004), and women as a group have lower inter-generational mobility than men (Asher, Novosad, & Rafkin, 2023). Engineering education is competitive and lucrative and is seen as a major source of upward mobility (Mitra, 2019). It thus represents an important driver of societal change and changing traditional beliefs by women in society. Having female role models is of crucial importance in this endeavour, and our findings highlight the seminal role that they can play in promoting an equitable environment in what is traditionally considered to be a male-dominated space.

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Supporting Information

A Data, Sampling, and Variables

A.1 Nationally Representative Sample

We drew nationally representative samples of faculty and students from broadly defined computer science (CS) and electrical engineering (EE) majors, the two largest majors in engineering and technology colleges. The sample captures the typical or representative experience of college students and faculty at engineering and technology colleges in India.

The sampling procedure consisted of three main steps.[9] In the first step, we identified a broad set of CS and EE majors or departments. CS and EE related departments were selected as these departments draw the highest enrollment, accounting for approximately half of the engineering and technology college enrollment in India.[10] Furthermore, these departments comprise roughly one out of every four undergraduate (bachelor's degree) majors in STEM in India. The CS departments included Computer Engineering, Computer Science Engineering, Information Science and Engineering, and Information Technology departments. The EE departments included Electrical Engineering, Electronics and Communication Engineering, Electronics and Electrical Engineering, Electronics and Instrumentation Engineering, and Electronics and Telecommunications Engineering departments. In the second step, we randomly selected colleges that had these CS and EE programs. To do so, we used administrative data on (the population frame of) all colleges with CS and EE programs in the country. We also randomly selected colleges from elite and non-elite college strata. Specifically, we used simple random sampling to select 8 elite colleges and probability proportional to size sampling to select 42 non-elite colleges.[11] The national sample of colleges thus represent the range of elite and non-elite institutions in India. In the third step, we sampled students within CS and EE programs in the selected universities. We first randomly sampled 1 CS department and 1 EE department from each college. In each randomly sampled department, we sampled all first-year students. For all students, we create sample weights that reflect the inverse probability of being sampled at the college, department, and student levels.

Our student survey collected information on the coursework completed by students and individual char-

[9] The first phase of data collection took place from October-December 2017. The second phase of data collection took place from January-March 2019.

[10] See Loyalka et al. (2022) for more details on how these estimates are calculated using administrative data with complete national coverage in India.

[11] Elite institutions were defined as the India Institutes of Technology (IITs), the Indian Institutes of Information Technology (IIITs), the National Institutes of Technology (NITs), and other institutions that ranked in the top 100 of the National Institutional Ranking Framework (NIRF) rankings developed by the Ministry of Human Resource Development, Government of India.

acteristics. We identified all faculty that taught courses taken by these students. We then surveyed these faculty gathering information on faculty characteristics and credentials. In addition to the student and faculty surveys at each college, we also surveyed department heads. Altogether, data were collected for 20,239 students and the 2,710 faculty that taught their courses.

We had the full support of government agencies (in particular, the Ministry of Human Resource Development and the AICTE) as well as college and department administrators—to conduct the study. Considerable time was spent training a large team of enumerators that proctored the survey and assessments in person at each college. They proctors remained for 2-3 days at each college to make sure that students were able to participate even if they were unavailable on a particular day. As such, response rates were extremely high. Among enrolled students at the time of the baseline, approximately 95 percent participated in the baseline survey and assessments. Similarly, among enrolled students at the time of the endline or follow-up survey, approximately 95 percent participated in the endline survey and assessments.

A.2 Course Grades

Course grades in our sampled colleges are determined by assessing student performance on traditionally administered exams. Important to this study, course grades are assigned based on end of semester exams that are conducted and graded by a higher-level entity, which in the context of colleges in India is called the "university" and is the equivalent of a university system. Thus, faculty assigned to classrooms within the same course do not have direct control over assessing student performance. Instead, a higher-level "university" agency provides and grades the final exams for the course for which a majority of the final grade is based.[12]

Grades are not standardized across the colleges. Some colleges provide letter grades whereas some colleges provide grades on a scale of 1-100. We standardize across courses and colleges by creating a ranking of all students within a course. This creates variation in course rankings across classrooms taught by different faculty. Note that course rankings by definition have mean 50 and standard deviation 28.9, because rankings follow a uniform distribution, which has a mean of $\frac{(a+b)}{2}$ and a variance of $\frac{(b-a)^2}{12}$, with $a = 0$ and $b = 100$. Most of our analyses use college-department-course ("course") fixed effects, alleviating concerns about comparability.

[12] Our sample includes a few departments, where a small fraction of the grading structure can be under the instructors' control. But, this proportion is small and never exceeds 30 percent in our sampled colleges.

B Descriptive Statistics and Balance Checks

B.1 Student Summary Statistics

Table B1: Student Baseline and Demographic Characteristics by Gender

	Student Summary Statistics				
Student characteristics	**Mean**	**SD**	**Female-Male**	**SE**	**N**
Female	0.32	0.47	1.000		1793
Reservation status	0.53	0.50	-0.016	0.025	1791
Baseline Academic Skills	0.00	1.00	-0.198***	0.066	826
JEE score	0.00	1.00	-0.200***	0.068	900
Baseline Anxiety	0.00	1.00	0.058	0.071	822
Baseline Confidence	0.00	1.00	-0.049	0.071	822
Father attended college	0.51	0.50	0.085***	0.025	1784
Mother attended college	0.37	0.48	0.057**	0.025	1785

Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

B.2 Balance Checks

Table B2: Balance Checks for Random Assignment

Student characteristics	**Mean**	**SD**	**Female Instructor-Male Instructor**	**SE**
Female	0.32	0.47	0.011	0.010
Reservation Status	0.53	0.50	0.012	0.010
Baseline Academic Skills	0.00	1.00	0.009	0.030
JEE score	0.00	1.00	-0.010	0.021
Baseline Anxiety	0.00	1.00	-0.035	0.033
Baseline Confidence	0.00	1.00	0.010	0.033
Father Attended College	0.51	0.50	-0.019*	0.011
Mother Attended College	0.37	0.48	-0.011	0.009

Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

C Teaching Time and Teaching Practices

Table C1: Weekly Hours Spent on Teaching-Related Activities

	Advising Students	Course-Related Work	Lesson Planning	Teaching Classes	Tutoring
Female	-0.546*	-0.028	-1.061*	-1.067	-0.033
	(0.309)	(0.296)	(0.552)	(0.718)	(0.216)
Mean	3.3	2.8	7.4	11.0	2.7
N	424	425	425	425	425

All models include department fixed effects and control for faculty characteristics. Standard errors are clustered at the department level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table C2: Use of Teaching Practices Inventory Measures

	In-class features and activities	Assignments	Feedback and testing	Collaboration
Female	-0.420	0.388*	0.127	-0.167
	(0.328)	(0.201)	(0.270)	(0.152)
Mean	9.6	3.5	8.1	4.2
N	428	428	428	428

All models include department fixed effects, control for faculty characteristics, and standard errors are clustered at the department level. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

D Further Results on Gender Stereotypes

D.1 Raw Stereotypes Variable (Z-Scores)

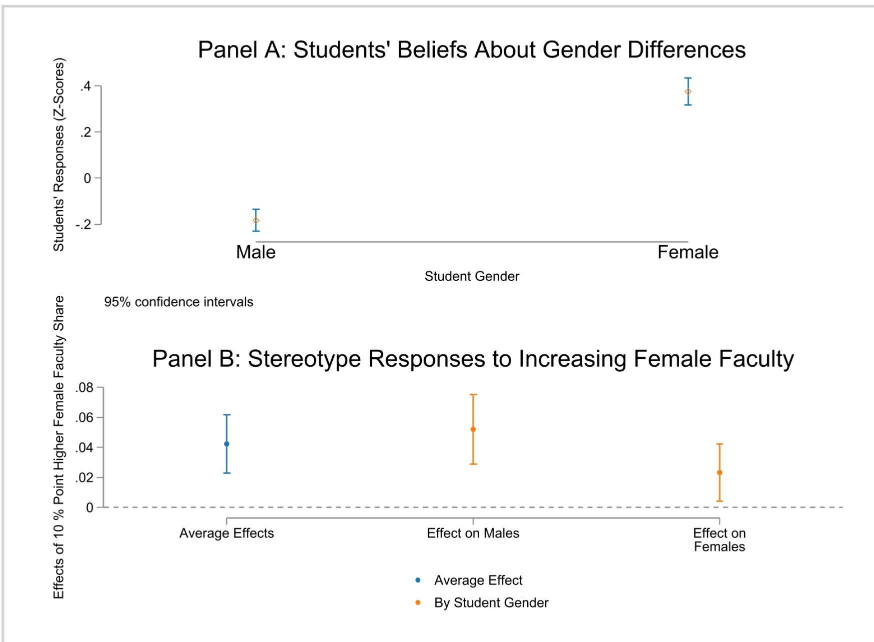

Figure D1: Stereotype Levels and Responses by Gender

D.2 Believe Own Gender is Better

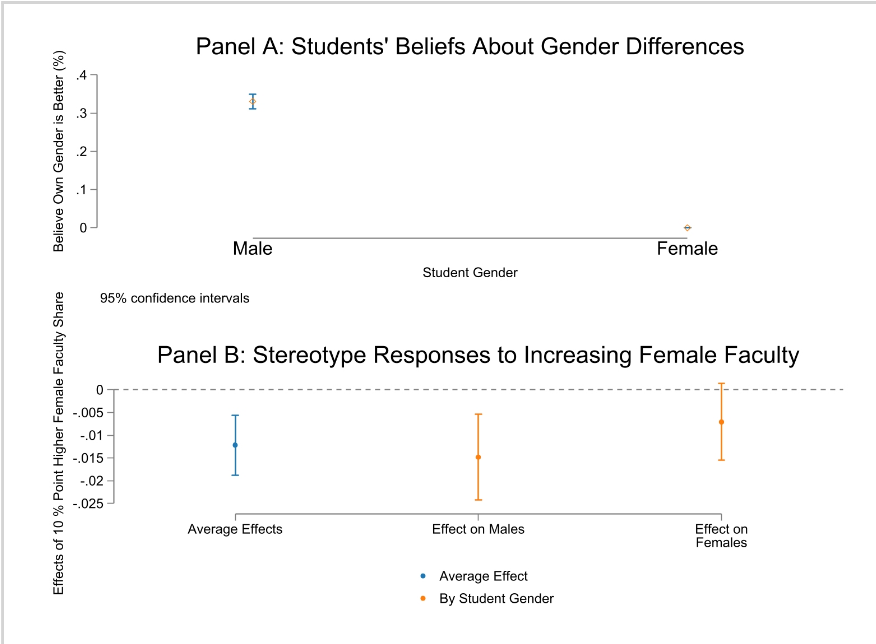

Figure D2: Fraction Who Believe Own Gender is Better, and Female Faculty Impacts

D.3 Believe Both Genders are Equal

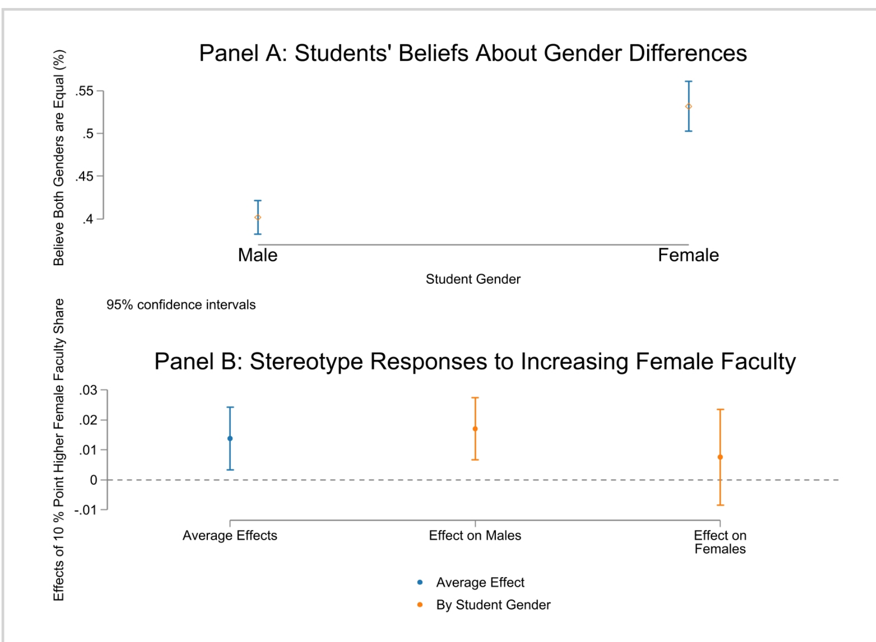

Figure D3: Fraction Who Believe Both Genders Are Equal, and Female Faculty Impacts