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Impact of Teacher Gender and Role Models on Student Outcomes in India

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Keywords: Gender, Role Models, Test Scores, Attendance, Attitudes, Co-Educational Schools, Single-Sex Schools

JEL Code: J16, I21, I24

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1 Introduction

Gender inequality has existed in education historically due to traditional social norms and beliefs. They are still prevalent in our society and they prove to be fatal in terms of learning outcomes of students. Often, in the scenario of gender inequality and women underrepresentation in educational setups, females attach themselves to their female faculty and role model effects come to play, which enhances their learning outcomes. This is mainly due to females starting

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to believe that they could also achieve their ambitions.

In this paper, we try to examine the impact of teacher gender on student outcomes through their academic achievements, transferrable skills, attendance and attitudes. We check for the presence of role model effects in subjects with gender-specific dominance. Hence, we examine our results for a male-dominated subject, such as Mathematics, and a female-dominated subject, such as English, in accordance with the deep-rooted traditional beliefs that males are better teachers for STEM subjects, while females are better teachers for languages.

Apart from academic achievements, we also consider transferrable skills, such as critical thinking or problem solving, attendance and attitudes as other student outcomes. We find that role model effects are prominent when we consider academic achievements as an outcome. We also witness evidences of female role model effects in English, for most of the student outcomes. However, we find that student outcomes get negatively affected in presence of a female Maths teacher. These results are also driven by student perception regarding females being worse teachers at Maths. We also perform a sub-sample analysis for co-educational sections.

The paper is organised as follows. Section 2 presents the existing studies in the related literature and identifies the gaps in the existing literature. Section 3 and 4 presents the data and the summary statistics, while section 5 discusses the estimation strategy. We present the results for all the student outcomes in section 6, and present the results for sub-sample analysis of co-ed sections in section 7. We also talk about alternative mechanisms in section 8, followed by robustness checks in section 9. We conclude this paper by drawing policy implications in section 10 and conclusion in section 11.

2 Literature Review

There is a growing strand of studies in the literature of role models. Certain studies (Jensen and Oster (2009); Chong and La Ferrara (2009); La Ferrara, Chong, and Duryea (2012)) have examined role model effects by examining the impact of TV exposure on relevant behaviour of individuals. Beaman, Duflo, Pande and Topalova (2012) show that female leadership influences adolescent girls' career aspirations and educational attainment. In the context of education, Dee(2005) finds that the racial, ethnic, and gender identity have large effects on teacher perceptions of student performance. Bettinger and Long(2005) find that female faculty increase student interest in a subject as measured by course selection and major choice. They find role model effects in courses where women are generally underrepresented, such as, mathematics and geology. There are also studies on effects of role model exposure on STEM engagement (Camp, Gilbert and O' Brien (2019); Shin, Levy and London (2016)). Dennehy and Dasgupta (2017) find that female peer mentors early in college increase women's positive

academic experiences and retention in engineering. Porter and Serra(2020) find that female role models affect choice of majors for females in the field of economics, where women are less represented.

In the literature of gender gaps in education; Carrington, Merrell and Tymms (2008) measure the impact of teacher gender on attitudes of students to school, reading, mathematics and science; Ng'ang'a, Mureithi and Wambugu (2018) measure the gender gap in mathematics in Kenya and attribute it to utilization of educational resource differentials between boys and girls. Although there are a number of studies in the context of developed countries, there are very few studies in the contexts of developing countries like India. Muralidharan and Sheth (2016) study gender gaps in learning in the Indian state of Andhra Pradesh and find that female teachers are more effective at teaching girls than male teachers, but no worse at teaching boys. Behrman, Hervé, Lamkang, Laxminarayan, Mani and Nandi (2021) also study gender gaps in cognitive and noncognitive skills among adolescents in India. Das and Singhal (2023) study gender gaps in basic mathematics in rural India.

Our study contributes to the literature of role models as well as to the literature of women underrepresentation or gender gaps in education. Our study is the first study which estimates the role model effects and compares it for subjects with gender specific dominance, i.e, we try to compare the effects of teacher gender in a male-dominated subject such as Maths, as well as in a female-dominated subject such as English in the context of a developing country like India, while considering academic achievement, transferrable skills, attendance and attitudes as student outcomes, unlike other studies in the context of role model effects which look at the student outcomes only through test scores. We also try to examine the dilution of role model effects on co-educational sections. We also find students' perception regarding traditional beliefs of subject-specific gender dominance to be prominent when measuring the impact of teacher gender on students.

3 Data

We use Young Lives India dataset, Round 5 for the time period 2016-17 for our analysis. Young Lives dataset is a survey dataset of grade 9 students, teachers, and headmasters across 9820 students in 205 schools of Andhra Pradesh and Telangana. The survey captures students', teachers' and headmasters' characteristics and attitudes, as well as the section and the school characteristics. The survey was carried out in two waves, once at the beginning of the academic year 2016-17, and then at the end of the same academic year.

In both the surveys, students' test scores are captured by an English and a Maths test conducted by the team of Young Lives across all the schools in the sample. We also have information on scores of transferrable skills tests which

were conducted only in wave 2. Transferrable skills refer to critical thinking and problem solving skills of the students. The survey captures student attitudes through a set of statements to which the students are supposed to respond in the form of categorical responses of "Strongly Disagree" , "Disagree", "Agree", "Strongly Agree". These are only captured in the wave 2 survey. We also have information on students' attendance in school since the first day of the academic year 2016-17.

We focus on Round 5 dataset because of the presence of teacher-student mapping, which is absent in previous rounds. Teachers vary at the section level, and every student is mapped to a section teacher. Hence, we are able to study our research question through this dataset. We merge wave 1 and wave 2 datasets and use it for our study purpose.

However, one limitation here is that the data is self-reported by students, teachers and headmasters. However, they are provided with options for most of the questions asked, and we only consider categorical variables as controls in our dataset, which reduces the extent of measurement error. Also, the questions asked are regarding the attributes and attitudes of students, teachers and headteachers; and, hence, do not suffer from recall biasness. However, there are chances of social desirability biases in our data. However, since the responses are anonymous and the names of students, teachers and headteachers are not revealed, there are quite lesser chances of social desirability biases in our dataset.

4 Summary Statistics

Out of the total sample of 205 schools, 29 are private aided, 55 are private unaided, 85 are state government, while 36 are TSW schools. The summary statistics of Maths and English teacher by gender in these type of schools are presented in section 12.1 of appendix.

We now present the descriptive statistics in the table below. We consider variables for student, teacher, section and school level characteristics. We conduct a t-test for all of these variables and report the standardized differences between control and treatment group by Maths and English teacher gender in columns 2 and 3 respectively. For instance, we can see from the table below that students score more in the first wave survey Maths test when they are taught by male teachers; while students score more in English when they are taught by females. Also, female teachers are more likely to teach girls. Section 12.2 of appendix shows the descriptive statistics for rest of the variables.

Section 12.3 of appendix shows the summary statistics of different characteristics by student gender. Clearly, female students are more likely to attend school, participate in classes, repeat a grade, and hope to complete a higher educational degree. Male students are more likely to have better health, and higher dropout

rate.

Table 1a : Summary Statistics

Variables	Standardized difference (Maths)	Standardized difference (Eng)
	Panel A: Student Characteristics	
Wave 1 score	1.837***	-2.285 ***
	(0.1425)	(0.227)
Gender	-0.314***	-0.2805***
	(0.0102)	(0.0098)
Caste	0.255***	0.001
	(0.0202)	(0.0193)
Mothers' Education	-0.1004**	-0.538***
	(0.0407)	(0.0384)
Fathers' Education	-0.068	-0.468***
	(0.043)	(0.0407)
School Droupout	0.017***	0.014**
	(0.0059)	(0.006)
Owns a computer	-0.002	-0.085***
	(0.007)	(0.007)
Attendance	-5.502***	-2.876***
	(0.715)	(0.694)
Aspiration	-0.281***	-0.493***
	(0.0377)	(0.0356)
	Panel B: Teacher Characteristics	
Experience	2.181***	3.1996***
	(0.193)	(0.177)
Caste	0.022	-0.135***
	(0.021)	(0.019)
Age	3.858***	3.978***
	(0.228)	(0.334)
Salary	0.385***	0.784***
	(0.032)	(0.0296)
Time spent on class preparation	10.586***	16.887***
	(0.976)	(0.9559)
Teacher Qualification	-0.027**	-0.0402***
	(0.013)	(0.009)

Table 1b : Continued

Variables	Standardized difference (Maths)	Standardized difference (Eng)
	Panel C: Section Level Characteristics	
Teacher's desk	0.054***	0.007
	(0.009)	(0.008)
Electric light	-0.154***	-0.124***
	(0.008)	(0.008)
Electric fan	-0.132***	-0.144***
	(0.009)	(0.0086)
Duration of periods	1.225***	1.862***
	(0.368)	(0.353)
Co-ed	0.940***	0.607***
	(0.0162)	(0.0169)
Ability	-0.086***	-0.029
	(0.0241)	(0.023)
	Panel D: School Level Characteristics	
Head teacher experience	0.787***	-0.143
	(0.111)	(0.105)
Head teacher qualification	-0.073***	-0.095***
	(0.0108)	(0.0103)
Head teacher salary	-4994.741***	-982.5049
	(698.4507)	(679.2157)
Library	-0.0337***	0.005
	(0.008)	(0.007)
School Type	-0.162***	0.232***
	(0.0202)	(0.0193)
Functional computers	-3.556***	-3.006***
	(0.3601)	(0.345)
Individual toilets	-8.019***	-4.583***
	(0.296)	(0.2901)
Mid-day meal	-0.116***	0.0599***
	(0.009)	(0.009)
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

5 Methodology

5.1 Empirical Specification

We estimate the following regression equation:

$$Y_{is} = \beta_0 + \beta_1 S_{is} + \beta_2 T_s + \beta_3 S_{is} \times T_s + \beta_4 Y_{is}^0 + \beta_5 X_{is} + \delta_{school} + \epsilon_{is} \quad (1)$$

Y is the dependent variable, which is the subject test score, transferrable skill test scores, attendance and attitudes of a student i studying in section s. T denotes the gender of the teacher teaching in section s. Similarly, S denotes the gender of the student studying in section s. Y^0 denotes the baseline outcome, i.e, the subject test score, transferrable skill test scores, attendance and attitudes of a student i studying in section s during wave 1 survey. X denotes various controls at student and teacher level, such as students' participation in class, access to facilities, parental education, background etc; and teachers' capabilities, caste, age, efforts etc.; as well as section level controls, such as infrastructure of a section, capability of a section, etc. δ denotes the school fixed effects. Errors are clustered at the section level.

We define treatment group here as the students in sections which are assigned to female teachers, and control group as the students in sections which are assigned to male teachers. To study the role model effect, we measure the differential impact of teacher gender on girls and boys by interacting teacher gender dummy variable with student gender dummy variable. We try to estimate the model using school fixed effects in our specification as it helps in dealing with various observable and unobservable school specific characteristics and help us to capture the variation within a school. Adding student level, teacher level or section level fixed effects leads to dropping of the teacher gender dummy variable as teachers vary across sections. As a student is mapped to both Maths and English teacher, we run the specification for both subject teachers separately and measure their impact.

β_1 gives the impact of a male teacher on a female student than male students, β_2 gives the impact of a female teacher on a male student than when a male teacher teaches a male student, while β_3 gives the differential impact of a female teacher teaching a female student. The omitted category here is male teachers teaching male students.

Alternatively, we can also write a specification using school level controls, such as, infrastructure, head teachers' gender and age, provision of mid-day meal etc, along with student, teacher and section level controls etc., while excluding school fixed effects. This could be tested as there are schools with one sections only and including school fixed effects might boil down to capture variation within a section. Since there is no compliance issues in our study, we measure the average treatment effect on the Treated (ATT) parameter here.

5.2 Threats to Identification Strategy

One important concern here is the effect of spillovers, which might not give us the actual causal impact, as students may interact with students of other sections within the same school, and across schools. It is also possible that students also go to private tuitions and the impact on student test scores could also be due to the gender of the private tuition teacher, or peer interactions in the private tuitions. We deal with private tuition spillovers by using the number of hours spent in private tuitions as a proxy for private tuition spillovers and control for this proxy in our main specification. Later, we also show robustness of our results by excluding this proxy. Hence, spillovers through the channel of private tuition do not affect our main results. Similarly, spillovers through school sections are also not much of a concern as we expect the magnitude of spillovers through school sections to be lower than the magnitude of spillovers through private tuitions, as spillovers through private tuitions occur through both peer interactions as well as through the influence of private tutor; while school section spillovers occur through peer interactions only. We discuss this later in detail in robustness section.

Other concerns could be the assignmment of teachers to the students. As per our summary statistics, female students are slightly more likely to be taught by female teachers. It is highly possible that female teachers are assigned to schools with higher girl enrollment. This might affect our estimate as the assignment of teachers is not random. To address this concern, we use school fixed effects in our main specification.

There are no compliance issues in our study, as students who are assigned to the teachers at the beginning of the year stick with them throughout the year. Also, there are no different forms or dosages of treatment, as we control for teacher attributes such as teachers' capabilities, efforts, and other relevant variables such as duration of school hours etc. in our specification.

6 Results

We present the results for subject test scores in the tables below.

6.1 Subject Test Scores

Table 2 : Impact of Maths Teacher Gender on Maths Test Scores

Maths Test Score Wave 2	(1)	(2)	(3)
Maths Test Score Wave 1	0.562***	0.451***	0.523***
	(0.0075)	(0.00995)	(0.0261)
Student Gender	-0.057	-0.793**	-0.609*
	(0.096)	(0.217)	(0.225)
Maths Teacher Gender	-1.4497	-1.642**	0.233
	(1.011)	(0.496)	(0.573)
Student Gender × Maths Teacher Gender	0.5081	0.295**	-0.924
	(0.386)	(0.085)	(0.869)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	7,751	6,640	6,330
R-squared	0.581	0.627	0.544

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 : Impact of English Teacher Gender on English Test Scores

Eng Test Score Wave 2	(1)	(2)	(3)
Eng Test Score Wave 1	0.481***	0.392***	0.470***
	(0.0191)	(0.00987)	(0.00874)
Student Gender	0.204	-0.282	-0.529
	(0.266)	(0.405)	(0.316)
Eng Teacher Gender	1.816*	1.711**	0.0801
	(0.839)	(0.391)	(0.318)
Student Gender × Eng Teacher Gender	0.238**	0.107	0.529**
	(0.0608)	(0.104)	(0.173)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	7,662	6,873	6,312
R-squared	0.731	0.766	0.716

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Clearly, the Math test scores fall when a male teacher teaches a female student, than when he teaches a male. Scores even fall when a male student is taught by a female teacher in comparison to the case when he is taught by a male teacher. On the other hand, there is an increase in test scores when females are taught by females. However, there is an overall decrease in test scores if females teach Maths, as the decrease in Maths marks is more for boys than the increase in marks for girls when taught by a female teacher. Hence, it depends on the overall proportion of a class by gender whether a female teacher will be effective in teaching Maths overall or not. Also, as per our results, losses in test scores for males is high when they are taught by a female teacher than the losses when a female student is taught by a male teacher.

Clearly, the English test score increases when a male student is taught by a female teacher. The test score increases when a female student is taught by a female teacher. Overall, female teachers are effective at teaching English to both boys and girls than their male counterparts. However, female teachers prove to be better at teaching English to male students. Male teachers do not influence test scores for English.

Assigning female English teachers to any sections, irrespective of the relative number of girls and boys, would help in increasing marks of students, however, assigning female Maths teachers to girls' schools or single-sex sections with only girls would prove to be beneficial. In co-ed schools with classes having sufficiently relatively large number of girls than boys, assigning female Maths teachers would be overall effective.

6.2 Transferrable Skills

Transferrable skills refer to critical thinking or problem solving skills of students. These skills also get transferred from one person to another. Hence, we estimate the impact of teacher gender on transferrable skill test. We present the results for transferrable skill test in the table below.

Table 4 : Impact of Maths teacher gender on Transferrable skills

Transferrable skills	(1)	(2)	(3)
Maths Test Score Wave 1	0.093***	0.065***	0.073***
	(0.004)	(0.002)	(0.005)
Student Gender	0.253**	0.105	0.116
	(0.059)	(0.087)	(0.125)
Maths Teacher Gender	-0.217**	-0.326	-0.122
	(0.074)	(0.165)	(0.211)
Student Gender × Maths Teacher Gender	0.083	0.060	0.019
	(0.160)	(0.232)	(0.303)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	7,695	6,588	6,280
R-squared	0.191	0.223	0.152

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 : Impact of English teacher gender on Transferrable skills

Transferrable skills	(1)	(2)	(3)
Eng Test Score Wave 1	0.072***	0.055***	0.052***
	(0.003)	(0.002)	(0.003)
Student Gender	0.164	0.065	0.001
	(0.086)	(0.119)	(0.206)
Eng Teacher Gender	-0.060	0.049	-0.005
	(0.202)	(0.247)	(0.192)
Student Gender × Eng Teacher Gender	0.131	0.087	0.078
	(0.167)	(0.207)	(0.223)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	7,628	6,537	6,208
R-squared	0.202	0.229	0.149

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Clearly, transferrable skills are also getting affected due to role model effects. Transferrable skills increase when a female student is taught by a male Maths

teacher, opposite to our main results of subject scores. They decrease when a male student is taught by a female Maths teacher. This could be due to negative role model effects, as seen in the subject test scores too. There is a negative role model effect in case of subject scores, indicating that female students do poorer in terms of subject scores but perform better than boys in terms of transferrable skills. This provides an evidence of role model in aspects other than pure subject matter. Students learn skills other than pure subject matter from teachers. However, our results do not remain robust with other specifications. We do not see any kind of differential impact of English teacher's gender on transferrable skills.

Also, in most cases, same gender role model effects play in subject matter ability. Our results show that opposite role model effects also prove to be important when we consider other aspects apart from pure subject skills, such as, problem solving skills or critical thinking skills. However, there are losses in both subject matter and transferrable skills when female Maths teachers teach male students, as evident from our results. It would be overall effective only if female Maths teachers are assigned to sections with sufficiently higher proportion of girls relative to boys.

6.3 Attendance

We now look into the impact of teachers' gender on students' attendance. We take attendance to be our dependent variable and use specification 1 to estimate the impact.

Table 6 : Impact of Maths teacher gender on Attendance

Student Attendance	(1)	(2)	(3)
Maths Test Score Wave 1	0.419**	0.0836*	0.155
	(0.116)	(0.038)	(0.086)
Student Gender	7.354***	3.015***	4.893***
	(0.321)	(0.542)	(0.644)
Maths Teacher Gender	-1.284	1.211	-3.101**
	(3.749)	(1.339)	(0.716)
Student Gender × Maths Teacher Gender	1.001	1.255	-4.878***
	(0.749)	(0.822)	(0.866)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,247	6,607	6,292
R-squared	0.329	0.595	0.318

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

When female students are taught by male Maths teachers, their attendance in Maths classes rises. However, when females are taught by female Maths teachers, their attendance falls. Additionally, the attendance of male students taught by female Maths teachers also fall. This is due to students' perception of males being better Maths teachers than females, as Maths is considered to be a male-dominated subject by students.

Table 7 : Impact of English teacher gender on Attendance

Student Attendance	(1)	(2)	(3)
Eng Test Score Wave 1	0.295**	0.097**	0.108*
	(0.115)	(0.028)	(0.039)
Student Gender	6.127***	2.532***	3.686**
	(0.626)	(0.221)	(1.105)
Eng Teacher Gender	3.787	5.344**	-2.028
	(4.800)	(1.145)	(1.887)
Student Gender × Eng Teacher Gender	3.203**	1.412**	-0.857
	(0.920)	(0.344)	(0.661)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,181	6,529	6,203
R-squared	0.336	0.599	0.318

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Attendance of female students is high when they are taught by male or female English teachers. Male students also attend school more when they are taught by female teachers than when they are taught by male teachers. This is also in line with our main result of test scores. When girls and boys are taught by female English teachers, their scores rise.

6.4 Attitudes

Role model effects can also influence aspirations and attitudes of students. Positive attitudes tend to increase the learning motivation among students. We try to measure positive attitudes through certain statements mentioned in the student survey to which they answered within any of these categories - strongly disagree, disagree, agree and strongly agree, which are coded as variables taking the values 1,2,3 and 4 respectively. We only consider the statements relevant for measuring the impact on students' attitudes. We try to measure positive attitudes through statements whose higher values correspond to positive attitudes. The exact statements considered for these attitudes are listed in section 12.4 in the appendix. We take the sum of these variables for each statement and create a variable of positive student attitude. We now regress it on the relevant variables as mentioned in specification 1.

Table 8 : Impact of Maths teacher gender on Attitudes

Student Attitude	(1)	(2)	(3)
Maths Test Score Wave 1	0.288***	0.069***	0.056***
	(0.029)	(0.011)	(0.012)
Student Gender	3.996***	0.206	0.311
	(0.480)	(0.155)	(0.234)
Maths Teacher Gender	0.0111	1.224	-0.435*
	(0.904)	(0.772)	(0.185)
Student Gender × Maths Teacher Gender	-1.937***	-0.212	0.0149
	(0.170)	(0.703)	(0.213)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,248	6,577	6,577
R-squared	0.100	0.203	0.106

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Clearly, female students have a more positive attitude when taught by male teachers than male students. However, they have lower motivation when taught by female Maths teachers. Also, male students too have lower motivation when taught by female Maths teachers. This again shows that students have perceptions about female Maths teacher being worse than male Maths teachers. However, our results do not remain robust for alternate specifications.

Table 9 : Impact of English teacher gender on Attitudes

Student Attitude	(1)	(2)	(3)
Eng Test Score Wave 1	0.177***	0.057***	0.0377***
	(0.031)	(0.009)	(0.0073)
Student Gender	3.174***	0.389	0.412
	(0.565)	(0.296)	(0.436)
Eng Teacher Gender	0.430	0.300	0.324
	(2.362)	(1.260)	(0.456)
Student Gender × Eng Teacher Gender	0.255	-0.171	-0.054
	(0.699)	(0.771)	(0.763)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,182	6,509	6,509
R-squared	0.099	0.213	0.115

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

When male English teachers teach female students, the positive attitudes of these students rise as per the first model specification. However, we do not see any significant results of changes in student attitudes due to a female English teacher.

7 Do role model effects get diluted in co-ed sections?

We now examine whether there is any dilution of role model effects in co-ed sections. It is highly possible that the effect of teacher gender is quite different for co-ed than single-sex sections. We expect that co-ed sections would show a lesser amount of role model effects in comparison to single-sex sections, due to gender diversity within students in co-ed sections, diluting the effect of role model effects. For this purpose, we perform a sub-sample analysis for co-ed sections, checking our hypothesis.

Table 10 : Impact of Maths teacher gender in Co-ed sections

Maths Test Score Wave 2	(1)	(2)	(3)
Maths Test Score Wave 1	0.578***	0.465***	0.521***
	(0.0273)	(0.0236)	(0.0339)
Student Gender	-0.126	-0.784**	-0.790***
	(0.127)	(0.191)	(0.0999)
Maths Teacher Gender	-1.588	-2.391***	-0.650
	(1.063)	(0.187)	(0.464)
Student Gender × Maths Teacher Gender	0.617	0.197	0.366
	(0.345)	(0.199)	(0.370)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	4,410	3,953	3,714
R-squared	0.586	0.639	0.570

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results are similar to the one obtained when we considered the entire sample of co-educational and single-sex schools. Male teachers teaching Maths to female students leads to a decrease in marks of the female students. Also, scores of male students fall when they are taught by female teachers. However, there is no differential impact of female teachers on female students for co-ed sections, unlike our results for the entire sample.

Table 11 : Impact of English teacher gender in Co-ed sections

Eng Test Score Wave 2	(1)	(2)	(3)
Eng Test Score Wave 1	0.494***	0.396***	0.448***
	(0.0235)	(0.0132)	(0.0144)
Student Gender	0.0611	-0.304	-0.539
	(0.318)	(0.462)	(0.499)
Eng Teacher Gender	2.393**	1.768*	0.526
	(0.789)	(0.638)	(0.388)
Student Gender × Eng Teacher Gender	0.245	0.012	0.159
	(0.138)	(0.106)	(0.145)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	4,349	3,949	3,697
R-squared	0.736	0.779	0.734

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

English test scores of male students in co-educational sections increase when they are taught by female teachers. This in line with our earlier results when we considered the entire sample of sections. However, here also we do not find any differential impact of female teachers on female students, unlike our results for the entire sample.

In co-ed sections, student interactions between boys and girls play a very important role. The effect of a female teacher on a female student might get diluted. Female role models play into effect when female students attach themselves to female teachers. However, this might not entirely be the case in a co-ed environment. Students' perceptions also change under influence of their peers. Female students might get more influenced by their male peers than their female teachers, leading to the dilution of the female role model effects.

8 Alternative Mechanisms

8.1 Can school attendance also be driven by other factors?

When we consider attendance as the dependent variable, we find that female Maths teachers reduce student attendance overall, while male Maths teachers increase female attendance. On the other hand, we observe increase in attendance in English. This is due to the perception of students regarding female

Maths teachers being worse than male Maths teachers. Alternative arguments could be female teachers being more lenient towards attendance, unlike male teachers. Male teachers are generally known to be stricter than female teachers. However, in our case, as shown in descriptive statistics in Table 1a, school attendance is more when students are taught by female Maths teacher than male Maths teacher. Hence, it is not the case that female Maths teachers are in general more lenient towards attendance than male Maths teacher, and the result from attendance is driven by students' perception of female Maths teachers.

It is also possible that school attendance is driven by school characteristics, i.e, whether a school is government, private or whether the school has midday meal or proper infrastructure. In Table 6 and 7, we use school fixed effects in specifications (1) and (2) and school level controls in specification (3). In presence of controls or fixed effects at school level, our results suggest that female Maths teachers lower school attendance for both boys and girls, and hence, is not driven by any school level characteristics. We also control for student level characteristics in specifications (2) and (3), showing that after controlling for students' participation in subjects, we derive similar results.

Hence, school attendance is driven by role model effects, or perception of students regarding teachers' gender across subjects.

8.2 Can attendance and attitudes also serve as possible mechanisms for marks attainment due to role model effects?

Role model effects lead to increase in attendance and attainment of positive attitudes. It is also possible that attendance and positive attitudes serve as mechanisms for marks attainment by students. Even in this case, marks attainment is due to role model effects, as role model effects cause increase in attendance and positive attitudes, also leading to increase in test scores.

As per our results, when male students are taught Maths by female teachers, their positive attitudes as well as attendance fall. These two together also explain the fall in test scores and can act as possible mechanisms for a fall in test scores. Similarly, when male students are taught English by female teachers, their scores rise, as well as their attendance. When female teachers teach English to female students, their attendance and test scores increase. However, there is no impact of female English teachers on students' attitude. Hence, attendance can be a possible mechanism through which English test scores rise for these female students. For establishing these as definite mechanisms, we require more information on these which we lack at this point of time. We are only able to hint at these possible mechanisms due to the lack of data.

9 Robustness Checks

We now show robustness of the effect of teachers' gender on students' positive attitude by considering student negative attitudes. The variable for negative attitude is created in a similar way as that of the positive attitude variable. Section 12.4 from appendix provides information on statements considered for negative attitudes. However, a key difference here is that higher values of negative attitude corresponds to lower student motivation. We only consider the statements relevant to our purpose. The following tables show the results of regression of student negative attitude as a depending variable on relevant independent variables as per the specification in equation 1.

Table 14 : Impact of Maths teacher gender on Negative Attitude

Student negative attitude	(1)	(2)	(3)
Maths Test Score Wave 1	-0.111***	-0.130***	-0.134***
	(0.0125)	(0.0136)	(0.0105)
Student Gender	0.637	-0.380**	-0.498***
	(0.302)	(0.0871)	(0.0817)
Maths Teacher Gender	1.063*	-0.343	0.0157
	(0.442)	(0.179)	(0.144)
Student Gender × Maths Teacher Gender	-0.893	0.00948	-0.236
	(0.526)	(0.576)	(0.373)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,248	6,577	6,577
R-squared	0.076	0.234	0.168

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

When a female student is taught by a male, the negative attitude of the student reduces. This is in line with our earlier result of positive student attitude. When female teachers teach males, the negative attitude of a student rise, which also is in line with our earlier result. When females are taught by females, we do not see any significant results. Our results for negative attitude are robust to the results for positive attitude.

Table 15 : Impact of English teacher gender on Negative Attitude

Student negative attitude	(1)	(2)	(3)
Eng Test Score Wave 1	-0.112***	-0.119***	-0.109***
	(0.00689)	(0.00943)	(0.00457)
Student Gender	0.422	-0.352*	-0.113
	(0.212)	(0.136)	(0.0732)
Eng Teacher Gender	-0.0226	1.004*	0.223**
	(0.292)	(0.366)	(0.0597)
Student Gender × Eng Teacher Gender	-0.0590	-0.181	-0.710
	(0.245)	(0.368)	(0.395)
Student Level Controls	No	Yes	Yes
Teacher Level Controls	No	Yes	Yes
Section Level Controls	No	Yes	Yes
School Level Controls	No	No	Yes
School Fixed Effects	Yes	Yes	No
Observations	9,182	6,509	6,509
R-squared	0.080	0.239	0.176

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Negative attitudes of female students reduce when they are taught by male teachers, which is in line with our results for positive attitudes. It increases when female teachers teach males. Our results for negative attitude are robust to results for positive attitude.

There is also a possibility of spillovers among students across the treatment and the control group (i.e, across students getting taught by female teachers and students getting taught by male teachers). Spillovers could be due to students' interactions across sections, or spillovers due to students' interactions in private tuitions, or influence of private teacher gender on students. Since we do not have information on private tutors' gender and student interactions in private tuitions, we take the number of hours spent in private tuition by students as a proxy for spillovers through the channel of private tuitions. Though we already have controlled for this proxy in our main regression specification, we also present evidence of private tuition spillovers not affecting our results. Section 12.5 of appendix shows that even after not including the control for hours spent in private tuition as a proxy, we get similar results for our main specification. Controlling for this proxy only improves our results, as done in our analysis.

We expect that spillovers from students' interactions across sections in schools would be similar to spillovers through private tuitions. In point of fact, private tuition spillovers should be stronger than school section spillovers, as private tuition spillovers consist of getting affected directly by getting influenced from private tutors' gender as well as through private tuition peer interaction; while,

school section spillovers only affects students through peer interaction. Since we find our main results to be robust to exclusion of private tuition spillovers, we expect that our results are also robust to exclusion of school section spillovers.

10 Policy Implications

Though female Maths teachers have a negative impact on boys, they have a positive impact on girls when we consider subject test scores. Though the negative impact on boys is higher than the positive impact on girls. Hiring female math teachers would be effective if they are assigned to sections with a significantly higher proportion of girls than boys when considering co-ed sections. Our results also show that they have a negative impact on students' attendance and attitudes.

On the other hand, students do have perceptions on teacher gender, as evident from our results. They perceive that female teachers are good at English, but not good at teaching Maths. This is also highly perceived by female students, as our results show. It is highly important for students to change their attitudes towards gender biases and differences across subjects. From a policy perspective, it is extremely important to look at reshaping gender attitudes and change the traditional belief among these adolescents.

11 Conclusion

We started with measuring the impact of teacher gender on student outcomes by gender. We established the presence of female role model effects when considering test scores. We also showed the presence of female role model effects while considering female English teachers for various other student outcomes, such as, attendance and attitudes. However, female Maths teachers negatively impact female student outcomes while considering transferrable skills, attendance and attitudes. This is due to traditional student perception about female Maths teachers performing worse. These perceptions are even held by female students, and get aggravated by the influence of male students' beliefs in co-ed sections. We later also establish that lower attendance when females teach Maths is driven by students' perceptions about female Maths teachers. We also try to check whether attendance and attitudes also serve as possible mechanisms for marks attainment. We find in cases when females teach English, attendance could be a possible mechanism driving this. Also, when boys are taught Maths by female teachers, both attendance and attitudes might be possible channels causing this.

We also prove our results to be robust when considering negative attitudes. We also argue our results to be robust to spillover effects. From a policy perspective, our findings suggest hiring female Maths teachers in single-sex sections

and co-ed sections with significantly higher proportion of girl students relatively. Since, females Maths teachers negatively impact other student outcomes such as attendance and attitudes, due to students' perceptions about female Maths teachers, hence, we also suggest reshaping gender attitudes among these adolescents so that they overcome their traditional beliefs. We contribute to a growing field of literature, which is quite generalizable in the context of subject-specific gender dominance, as well as in the context of settings such as the Indian education system where hiring teachers is based on certain factors, which proves to be important for student outcomes.

12 Appendix

12.1 Summary statistics: Maths teacher gender across school types

School Type	Maths		English	
	Mean	Std. Dev.	Mean	Std. Dev.
Private Aided	1.4142857	0.4927743	1.661406	0.47340137
Private Unaided	1.2488038	0.43242335	1.5014648	0.50011997
State Government	1.2760951	0.44711649	1.3839962	0.48641457
TSW	1.5431755	0.4982712	1.495322	0.50011576
Total	1.3403989	0.47386805	1.4714753	0.499212

Teacher gender is coded as 1 for males and 2 for females

12.2 Summary Statistics

Variables	Standardized difference (Maths)	Standardized difference (Eng)
	Panel A: Student Characteristics	
Language spoken at home	-0.091**	0.239***
	(0.038)	(0.036)
Class Participation	-0.132***	-0.167***
	(0.024)	(0.023)
Place of living	-0.359***	-0.0185
	(0.0205)	(0.0199)
Number of meals	-0.017***	0.0219***
	(0.0059)	(0.0057)
Health Problems	0.057***	-0.021**
	(0.0106)	(0.0101)
Elder sibling	0.061**	-0.041*
	(0.024)	(0.0227)
Place to study	0.018*	-0.035***
	(0.009)	(0.009)
Has internet	0.008	-0.064***
	(0.0078)	(0.007)
Repeated a grade	-0.005	-0.042***
	(0.008)	(0.008)
Late for school	0.065***	0.092***
	(0.019)	(0.0179)

Variables	Standardized difference (Maths)	Standardized difference (Eng)
Teacher is absent	0.0178	0.159***
	(0.0197)	(0.0186)
Homework checked by teachers	0.074***	0.099***
	(0.014)	(0.014)
Time spent on homework	-0.013	0.008***
	(0.0169)	(0.0157)
Attend extra classes	0.363***	-0.026
	(0.048)	(0.0364)
Private tuition	0.062	-0.067
	(0.057)	(0.041)
Owns textbook	0.013***	0.006
	(0.004)	(0.004)
Panel B: Teacher Characteristics		
Time spent on teaching	17.218***	12.597***
	(1.8598)	(1.984)
Hours communicating with parents	1.293***	-1.711
	(0.2096)	(0.2793)
Owns a computer	-0.061***	-0.0596***
	(0.0098)	(0.0099)
Has internet	-0.095***	-0.118***
	(0.009)	(0.0099)
Specialisation in subject taught	-.0251***	0.0655***
	(0.004)	(0.019)
Trained in English medium	0.001	0.070***
	(0.0106)	(0.006)
Periods taught	0.613***	-1.399***
	(0.192)	(0.179)
Takes extra classes	0.057***	0.046***
	(0.008)	(0.009)
Time spent on disciplining students	-4.273***	-1.688***
	(0.259)	(0.247)
Helping students outside classes	2.971***	0.255**
	(0.571)	(0.125)
Panel D: Section Level Characteristics		
Teacher's chair	-0.005	0.011**
	(0.004)	(0.004)
Books	-0.022**	-0.003
	(0.0105)	(0.0100)

Variables	Standardized difference (Maths)	Standardized difference (Eng)
Windows without glass	0.107***	0.133***
	(0.0103)	(0.0098)
Maximum periods taught	0.1698***	0.186***
	(0.0144)	(0.0164)
	Panel D: School Level Characteristics	
Outside space	0.171***	0.253***
	(0.0154)	(0.0144)
Separate classrooms	-0.024***	-0.039***
	(0.004)	(0.0042)
Electricity	-0.007***	-0.009***
	(0.0014)	(0.0014)
Internet	-0.115***	-0.092***
	(0.0103)	(0.0097)
Needs repair	-0.0656***	0.088***
	(0.009)	(0.009)
Verandas for teaching	0.056***	0.074***
	(0.008)	(0.007)
Teaching in open space	-0.0096	0.047***
	(0.0082)	(0.008)
Robust standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

12.3 Statistical test for baseline characteristics across male and female students:

Variables	Standardized differences
Attendance	-11.572***
	(0.6758)
Participation in Maths	-0.292***
	(0.0229)
Participation in English	-0.293***
	(0.0226)
Health problems	0.083***
	(0.00997)
Dropout	0.021***
	(0.0056)
Repeated a grade	-0.0908***
	(0.008)
Aspirations	-0.372***
	(0.035)
School Type	0.098***
	(0.0192)
Individual Toilet	0.622***
	(0.0167)
Robust standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

12.4 Statements for positive and negative student attitudes for Maths and English

The statements were coded in the following way:

1 = Strongly disagree
2 = Disagree
3 = Agree
4 = Strongly agree

The sum of all the statements under consideration were taken to create the variable of positive and negative attitudes. When we measure positive attitudes, higher values of the variable corresponds to rise in positive attitudes; while, higher values of the variable corresponds to rise in negative attitudes.

These statements were considered for measuring the impact of Maths teacher gender on positive student attitude:

- I study to increase my job opportunities for a good type of work in the future.

- I am working hard in school to ensure that my future will be financially secure.
- Making an effort in my studies is worth it because it will help me in the work I want to do later on.
- I want to learn as much as I can in school to help me get good work in the future.
- I want to learn as much as I can in school to help me go on to college/university.
- I am working hard in school to help me gain admission to higher studies.
- Making an effort in my studies now is worthwhile because it will help me in my studies later on.
- Learning well in school will improve my work prospects and chances in the future.
- Keeping up with my studies helps to develop my character.
- I am willing to do my best in class.
- I study hard for my tests in school.
- When studying, I keep working even if the material is difficult.
- When studying, I try to do my best to acquire the knowledge and skills taught.
- I look forward to my maths lessons.

The same set of statements were used to measure the impact of English teacher gender on positive student attitude, by only changing the last statement to "I look forward to my English lessons".

For measuring the impact of Maths teacher gender on negative student attitude, we consider the following set of statements:

- If I perform poorly nobody will be concerned.
- I often feel like quitting school.
- I am always waiting for the lessons to end.
- I always do poorly in tests.
- I am not willing to put in more effort in my school work.
- I choose easy options in school so that I don't have to work too hard.
- I find maths really boring.

- Learning maths is a waste of time.

For measuring the impact of English teacher gender on negative student attitude, we make use of the following statements:

- I day dream a lot in class.
- I often feel like quitting school.
- I am always waiting for the lessons to end.
- I always do poorly in tests.
- I am not willing to put in more effort in my school work.
- I choose easy options in school so that I don't have to work too hard.
- I find English really boring.
- Learning English is a waste of time.

12.5 Robustness to private tuition spillovers

Test Score Wave 2	Maths		English	
	(1)	(2)	(3)	(4)
Test Score Wave 1	0.451***	0.524***	0.392***	0.472***
	(0.0105)	(0.0257)	(0.0101)	(0.00860)
Student Gender	-0.790**	-0.625*	-0.289	-0.552
	(0.224)	(0.238)	(0.398)	(0.302)
Teacher Gender	-1.646**	0.265	1.718**	0.0621
	(0.491)	(0.609)	(0.387)	(0.303)
Student Gender × Teacher Gender	0.291**	-0.927	0.0760	0.534**
	(0.0860)	(0.913)	(0.101)	(0.183)
Student Level Controls	Yes	Yes	Yes	Yes
Teacher Level Controls	Yes	Yes	Yes	Yes
Section Level Controls	Yes	Yes	Yes	Yes
School Level Controls	No	Yes	No	Yes
School Fixed Effects	Yes	No	Yes	No
Observations	6,639	6,329	6,635	6,311
R-squared	0.627	0.544	0.769	0.715
Robust standard errors in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

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