

An Analytical Study of Gendered Interaction in Mathematics Classrooms

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Abstract

Mathematical skills are crucial in the present age of artificial intelligence and machine learning, as they form the foundation for logical reasoning and problem-solving. Developing these skills requires teaching practices that ensure equal and meaningful participation of all students in mathematics classrooms. Although efforts have been made to make mathematics enjoyable, fear of mathematics remains a persistent challenge. Mathematics anxiety disproportionately affects girls, particularly when it is combined with gender-biased behaviours of teachers. For instance, classroom practices such as giving more attention, time, or opportunity to boys can unintentionally marginalise girls, leading to unequal learning opportunities. Such gendered interactions not only reinforce stereotypes but also risk creating long-term disparities in mathematical competence. This paper attempts to analyse classroom interactions of teachers and students in mathematics classrooms from a gender lens. A total of eight classes of four mathematics teachers were observed. The classroom observation was done after getting consent from the teachers. Two teachers agreed to videotape, and the remaining two teachers' classes were observed with the help of an observation schedule. Two classes of each participating teacher were observed.

Keywords: Mathematics, classroom interaction, gender

Introduction

Mathematics is not just about doing arithmetic effectively. It involves problem-solving, use of heuristics, estimation and approximation, visualisation, making connections, systematic reasoning, and mathematical communication. All these processes, which are central to mathematics, lead to the mathematization of thinking. (NCERT, 2006a; NCERT, 2023). It not only makes individuals efficient in dealing with numbers, but it also develops critical thinking and creative problem-solving skills in individuals. Mathematics also plays a crucial role in understanding concepts of different subjects. The National Curriculum Framework for School Education 2023 has highlighted the strong association of

mathematics with science, technology, and artificial intelligence, which further acts as a deciding factor for achieving future success. But the way teachers, parents, and society perceive mathematics has created a sense of fear among students. Fear and anxiety about mathematics at the school level restrict any further advancement of individuals. Labelling mathematics as a tough subject or a subject more suitable for boys creates unnecessary fear among students, especially among girls (NCERT, 2023). It was found that all over the world, the participation of women in STEM fields is very low in comparison to men. Only 29.3 per cent of females are involved in scientific research in the world. For the

Asia-Pacific region, there is a further decline in this percentage. Only 18.5 per cent of women are in research positions in South and West Asia (UNESCO, 2020).

According to the All India Survey on Higher Education (AISHE), 2020-21, female enrolment in Engineering and Technology (in UG, PG, MPhil and PhD) is just 29.3 per cent (Ministry of Education, n.d.). Fewer women in STEM fields result in a waste of talent and ideas, and can also lead to severe economic drawbacks. The gender gap in STEM education has its roots in teaching and learning practices used in schools. Among other factors that impede girls from pursuing STEM education, the two most prominent are gender-discriminatory practices in classrooms and the way subjects such as mathematics are taught in schools (UNESCO, 2020).

Studies have shown that classroom interactions are not equally distributed among boys and girls (Hassaskhah & Roshan Zamir, 2013; Mundelsee & Reschke, 2025; Sadker, 2000; Sadker & Sadker, 1985, 1986, 1995). Grace and Gravestock (2009) mentioned that teachers unconsciously give more time and attention to male students than female students. Some of the teachers do not even realise when they endorse gender stereotypes (UNESCO, 2019). Other studies also found that teachers were unaware of their own gender bias in classrooms (Mougharbel & Bahous, 2010; Shmurak & Ratliff, 1994).

Teachers are often seen as role models by boys and girls. Girls and boys are perceived and treated differently from the moment they enter school. Teachers interact differently with boys and girls (Bhattacharjee, 2021; UNESCO, 2019). Several studies confirm that boys and girls are treated differently in classrooms; some get more time and attention from teachers

while others are deprived of it (Bassi et al., 2016; Bhattacharjee, 2021; Hassaskhah & Roshan Zamir, 2013; Kumar, 2017; Mundelsee & Reschke, 2025; Sadker, 2000; Sadker & Sadker, 1985, 1986, 1995).

Girls and boys learn what is expected of them and behave accordingly. How teachers treat girls and boys may be the most important factor in the creation of gender stereotypes. In a study, it was found that teachers place different expectations on boys and girls (Kushwaha & Gautam, 2014). Teachers often consider that girls cannot excel in mathematics even after scoring good marks in mathematics (NCERT, 2006b). Gendered expectations from students affect the motivation of students. Mathematics is an important subject that plays a key role in the future success of individuals; gender biased behaviour of teachers will hamper the progress of individuals. It was found in a research that an 'active learning methodology for teaching mathematics', which involved balanced student participation in classroom discussion (like sharing ideas, students' engagement, problem posing, and problem-solving), reduces the gender gap in mathematics (Tommaso et al., 2021) therefore researcher felt that it is pertinent to analyse the interaction between teachers and students in mathematics classrooms from a gender lens.

Objective

Analyses of teacher-student interaction from a gender lens in mathematics classrooms.

Method and Procedure

Sample description:

In the present study, teachers were selected through purposive sampling to achieve maximum variation with respect

to the type of schools, grade levels taught, years of teaching experience, gender and age. The mathematics teaching methods and practices of four teachers were observed, of which three teachers were male and one was female. People of different age groups were included; the youngest was 32 years old, having 8 years of experience, and the oldest was 48 years old, with 20 years of experience. The data were collected from four teachers teaching in Grades 4 to 8 in four schools, including central government, state government, and private schools, affiliated to the Central Board of Secondary Education (CBSE) and Uttar Pradesh Madhyamik Shiksha Parishad (UP Board). Classroom observations were conducted in three English and one Hindi-medium school. This study has a slightly greater number of girls than boys. In this study, there were 134 boys and 140 girls (48.91 per cent boys and 51.09 per cent girls).

Research procedure:

The present paper is based on classroom observation of four teachers teaching in Grades 4 to 8. Schools and teachers were contacted to participate in the study to capture the maximum variation based on the types of schools and to capture variation in terms of Grades 4 to 8. Among the schools and teachers who gave consent for the videotaping/classroom observation, they were selected for the present study. A total of eight classes, with two classes per teacher, were observed. Two teachers gave consent for videotaping, so out of the eight classes, four were videotaped, and the remaining four were observed using an observation schedule. The researcher sat at the back of the classroom and observed/recorded classroom proceedings.

To ensure that classroom interactions

were observed as naturally as possible, teachers were informed about the study in general terms rather than being told its specific focus. The researcher also spent time building rapport with both teachers and students before the observations began. These steps helped participants feel more comfortable and reduced the likelihood that they would alter their usual classroom behaviour during the observation period. To ensure the confidentiality and anonymity of the participating schools, teachers, and students, their real names have not been used in this paper. Also, codes were assigned and used for schools and teachers during data analysis.

The analysis of classroom observation was done both quantitatively and qualitatively; the teacher's classroom time was measured in terms of how much the teacher's time was spent, on whom, and for what purpose(s). For the qualitative analysis of classroom interaction, thematic analysis was done with reference to two dimensions of classroom teaching:

- a. Who gets teachers' time in the mathematics classroom?
- b. Who was allowed to participate in the mathematics classroom ?

The coding process used to identify themes in this study was guided by the coding scheme originally developed by Sadker and Sadker (1995) and subsequently adapted by Bassi et al. (2016). This coding framework provided the basis for systematically identifying, categorising, and analysing patterns of teacher-student interaction observed in the classroom data. Through the systematic analysis of these codes, broader themes were generated to capture recurring gendered patterns in classroom practices.

Results

Thematic Analysis: The following themes emerged when videotapes and observation schedules were analysed with reference to the above-mentioned dimensions of classroom teaching:

A. Boys received a larger share of teachers' time

The time duration of every class is limited. Therefore, the teacher's available time is also limited in the classroom. Thus, it is important to analyse who gets the teacher's time in the classroom and for what purpose. For this, "called out" and "called on" behaviours were considered.

Bassi et al. (2016) used variables developed by Sadker and Sadker (1995) along with three more variables: first is 'calling on by name', second is 'Time spent', and third is 'students call out'. Bassi et al. (2016) also divided their entire coding scheme into 'teacher-initiated behaviour' and 'student-initiated behaviour'. However, initially Sadker and Sadker (1985) mentioned the calling-out behaviour of students, which was student-initiated. Bassi et al. (2016) used the 'time spent' category to analyse the time spent by teachers with boys and girls in total. In

this theme, the coding scheme of Bassi et al. (2016) and Sadker and Sadker (1985), for 'call on' and 'call out', was used in the modified form; details of the modified codes are given below:

'Called on' is a teacher-initiated behaviour to engage students in classroom activities. It includes the time when a teacher asked questions, invited students to solve questions on a blackboard, did behaviour correction, and called the students for any activity.

'Called out' is a student-initiated behaviour that results in classroom engagement. It is the situation when students get involved in a classroom activity that is not initiated by the teacher but is initiated by the students themselves. It includes responding to the teacher's question without waiting for the teacher's permission and going on the blackboard/whiteboard to solve questions without the teacher's permission. However, only those behaviours are kept in the 'called out' category when they are followed by a teacher's response or approval. Less than one second was not recorded. The collective responses of students were also not recorded.

Table 1
Time spent by teachers with students in classrooms

	Classes observed	Time spent with boys (in seconds)	Time spent with girls (in seconds)
Called on	8	2248 (281.00)	1532 (191.50)
Called out	8	563 (70.38)	166 (20.75)
Total time		2811	1698

Note: Numbers given in parentheses are the mean time spent by teachers with students per class in seconds.

Figure 1
Time spent by teachers with students in classrooms

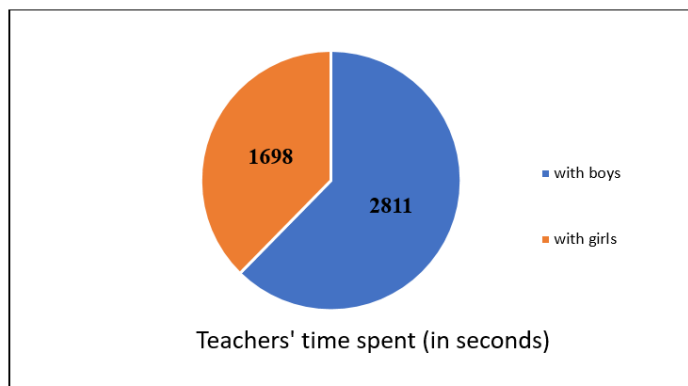


Table 1 shows that when students were called on, teachers spent 2248 seconds with boys and 1532 seconds with girls. This means teachers spent 716 seconds (11 minutes 56 seconds) more time interacting with boys than with girls when students were called on. Similarly, in the 'called out' category, teachers spent 563 seconds with boys and 166 seconds with girls. This indicates that teachers spent 397 seconds (6 minutes 37 seconds) more time with boys than with girls when students called out.

Table 1 further indicates that the mean time spent with boys per class in the 'called on' category was 281.00 seconds, compared to 191.50 seconds for girls. This suggests that teachers engaged with boys for an extended period when boys were provided with opportunities to respond or solve problems on the blackboard in classrooms. A similar pattern is evident in the 'called out' category, where the mean time spent with boys (70.38 seconds per class) was more than three times the mean time spent with girls (20.75 seconds per class). This indicates that boys were considerably more likely than girls to attract teachers' attention by calling out.

Overall, teachers spent a total of 2,811 seconds interacting with boys, compared to 1,698 seconds with girls. Thus, boys received 1,113 seconds (18 minutes 33 seconds) more of teachers' interaction time than girls. These findings suggest a gendered pattern of classroom interaction in which boys received substantially greater teacher attention and engagement. Similar findings have been reported by Bassi et al. (2016), who analysed 237 videotaped classroom observations in low-performing Grade 4 classrooms in Chile and found that boys received more teacher time and attention than girls.

The process through which students learn and understand concepts is influenced by several factors, many of which depend on the support and conducive learning environment provided by teachers (Vygotsky, 1978, as cited in Monteiro et al., 2019). Consequently, teachers' interactions with students play a crucial role in shaping students' learning experiences and understanding. In the present study, the difference in the total amount of teachers' time received by boys and girls was approximately 18 minutes.

It is important to note that girls not only received less teacher time overall, but they also had fewer opportunities to engage in high-quality instructional interactions with teachers. In the observed classrooms, girls rarely initiated interactions or behaviours that would enable their active participation in classroom activities.

The qualitative findings revealed that although teachers called on both boys and girls, boys received more probing questions. Boys were often asked to provide reasons or justifications for their answers. Additionally, when boys called out during the lesson, teachers were more likely to respond to them, giving them greater opportunities to ask questions and clarify their doubts. As a result, a larger share of the teachers' time and attention was directed toward boys.

In an English-medium government school, one of the male teachers was discussing the tools/instruments of the geometry box in Grade 6. The teacher asked a boy and a girl to estimate the length of a line segment simply by observation. The girl was not asked any further questions, while the boy was asked to mention the disadvantages of measuring a line segment simply by observation. In another incident, the teacher asked students to recall the names of instruments kept in the geometry box. In doing so the teacher asked both a boy and a girl to identify the ruler and a divider but more probing was done with the boy like the teacher asked the boy that which instrument will be helpful in measuring the length of line segment more accurately, when the boy replied that divider will be helpful to measure accurate length of a line segment the teacher further

asked the boy the reason for his answer but in this class no probing was done with girls and girls were neither asked reasons and justifications for their answers. These incidents show that boys were encouraged to think, explain and engage more deeply, whereas girls' participation was limited to surface-level responses rather than deeper conceptual understanding.

In another government school, while teaching rational numbers in Grade 7, a male teacher called on both boys and girls to answer questions and solve problems. However, when the classroom interactions were analysed, it was found that when boys were given the opportunity to solve questions on the blackboard, the teacher gave tough questions to the boys. The teacher also closely supervised the boys' steps, offered feedback, and encouraged them to continue even when they made mistakes. These kinds of challenges and support allowed boys extended interaction with the teacher and more of the teacher's time. But girls were often given simpler questions, and the teacher showed little concern about how they solved them; as a result, girls received less time, minimal guidance, and fewer opportunities for meaningful interaction.

Furthermore, allowing boys to make mistakes as part of the learning process may have contributed to the development of their cognitive abilities. Opportunities to explore ideas, make errors, and receive feedback are considered important for promoting deeper understanding and intellectual growth (Alexander, 2004, 2006, as cited in Monteiro et al., 2019).

Among the eight classes observed, only in one class, taught by a male teacher

in a private English-medium school, did girls receive more of the teacher's time than boys. However, in that class, the teacher asked girls mostly recall-type questions or definitions.

When teachers ask routine or simple recall-based questions, students tend to engage in lower-order thinking. In contrast, intellectually challenging questions provide opportunities for students to reason, analyse, and justify their responses. When students are required to explain the rationale behind their answers, it promotes deeper cognitive engagement and strengthens their problem-solving skills (Smart & Marshall, 2013). Overall, it was found that boys received more meaningful engagement and instructional attention from the teacher, which effectively gave them a larger share of the teacher's time.

In the observed classrooms, boys were more frequently engaged in cognitively demanding interactions. Consequently, they were provided with greater opportunities to clarify and consolidate their understanding, develop reasoning skills, and strengthen

their cognitive abilities. Girls, on the other hand, were more often asked fewer challenging questions and received fewer opportunities to participate in intellectually demanding exchanges. These findings are consistent with the observations of Sadker and Sadker (1995), who argued that when girls receive less teacher time and are presented with fewer academic challenges, they are encouraged to remain passive and such instances may further negatively affect their self-esteem and academic confidence.

B. Boys' participation was the norm in mathematics classrooms

This theme is about when the teacher gave the opportunity to students to participate in classroom activities by calling on students or when the students themselves called out, which followed the teacher's response or attention. In our study, eight classes were analysed. Table 2 gives us the actual number of times teachers called on students as well as the number of times students called out.

Table 2
Called on and called out frequency for boys and girls

	Classes observed	Boys	Girls	Total
Called on	8	92 (50.55)	90 (49.45)	182
Called out	8	86 (78.18)	24 (21.82)	110
Gender-wise total frequency		178 (60.96)	114 (39.04)	292

Note: Numbers given in parentheses are in percentages.

Figure 2
Called on and called out frequency for boys and girls

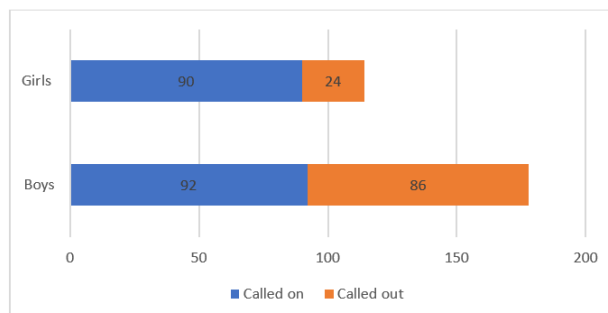


Table 2 shows that the difference in the 'called on' category between boys and girls was only 1.1 percentage points. However, a substantial difference was observed in the 'called out' frequency. Boys called out more frequently ($n = 86$) than girls ($n = 24$) in the classrooms, resulting in a difference of 56.36 percentage points. Similar patterns have been reported in previous research, which found that boys tend to call out more frequently than girls during classroom interactions (Bassi et al., 2016; Sadker & Sadker, 1995).

Figure 2 further shows that when the frequencies of 'called on' and 'called out' interactions were combined, the overall frequency of teacher–student interactions was lower for girls ($n = 114$) than for boys ($n = 178$). That is, teachers interacted with girls 114 times compared to 178 interactions with boys. Consequently, girls received only approximately 39 per cent of the total teacher–student interactions in the observed classrooms. This finding suggests that boys were engaged in classroom interactions more frequently than girls. Similar patterns of gender disparity in classroom interactions have been reported by Hassaskhah and

Roshan Zamir (2013), Bassi et al. (2016), and Sadker and Sadker (1995).

Qualitative findings indicated that, in the observed classes, boys' participation had become the norm regardless of the situation. Whether teachers called on girls or boys, boys were more likely to participate actively. Teachers were also found to give preference to boys when they called out, whether to seize an opportunity to solve a question or to provide an answer.

For example, in a Hindi-medium government school, a Grade 6 Mathematics teacher used an activity involving sex-segregated groups to teach preceding and succeeding numbers. Five girls were arranged by height and numbered from 5 to 1 to demonstrate that subtracting one gives the preceding number, while five boys were similarly arranged and numbered from 15 to 11 to illustrate succeeding numbers. Although the activities were structurally identical, boys called out seven times during the girls' activity, whereas no girls called out during the boys' activity. Moreover, the teacher neither intervened to curb the interruptions nor encouraged girls to participate. Instead, he praised a boy for

calling out the correct answer.

This interactional pattern suggests that girls' participation, although formally permitted, occurred within a classroom environment where boys exercised greater vocal dominance. By failing to address boys' interruptions, the teacher implicitly legitimised their assertive participation and reinforced unequal access to classroom discourse. The fact that boys repeatedly called out during girls' activity, while girls remained silent during boys' activity, indicates a gendered pattern of interaction in which boys occupied a more visible and authoritative position within the learning space. Similar patterns were observed across other classrooms, where boys' calling-out behaviour frequently remained unchecked.

These findings are consistent with Sadker and Sadker's (1995) observation that boys' calling-out behaviour is often tolerated by teachers and that boys consequently receive greater visibility and participation opportunities in classroom interactions. Such patterns can marginalise girls' participation and contribute to the development of gendered dispositions towards learning. Sadker and Sadker (1995) further argued that such patterns of classroom interaction can have long-term consequences for girls. Over time, girls may learn to participate less assertively, remain silent in public learning spaces, and perceive subjects such as mathematics as masculine domains, thereby reinforcing traditional gender stereotypes and limiting their confidence, engagement, and academic aspirations.

A similar pattern was observed in an English-medium school, where a female teacher who taught in Grade 4 gave questions based on the BODMAS rule. During the lesson, one of the boys was so determined to solve a question on the whiteboard that he went up to the board and began solving it without the teacher's permission. When the teacher noticed him, she said, "Okay, solve it," allowing him to continue. In another instance in the same class, when the teacher asked who would like to solve the question, she noticed one of the boys already standing near the board, ready to attempt it. The teacher then said, "Yes, come", inviting him to solve the question. In both instances, participation opportunities were effectively claimed by boys through assertive behaviour rather than being equitably distributed by the teacher.

Notably, the teacher made no deliberate effort to involve the girls in classroom activities or encourage them to solve the questions or give answers. Instead, she simply allowed whichever student called out or approached the board to attempt the solution. Her choice and discretion regarding who should solve the question or answer in class appeared to be based on convenience rather than a deliberate or rational decision. Boys who volunteered assertively or physically positioned themselves near the board were readily permitted to solve problems, whereas comparable efforts were not made to invite, encourage, or support girls' participation. Although the teacher did not explicitly favour boys, the teacher's passive

approach to classroom management disadvantaged girls. This finding is consistent with the work of Sadker and Sadker (1995), who reported that boys received a greater share of teachers' time and attention and were frequently rewarded with attention for assertive behaviours such as calling out and volunteering responses. Such interactional patterns can contribute to the normalisation of boys' visibility and participation in classrooms while rendering girls less visible in the learning process.

Conclusion

The results and discussion demonstrate that the interactions observed across all eight classrooms were gendered, and subtle gender bias was found in teachers' behaviour. Although there was no major difference in the number of times boys and girls were called on by teachers, boys consistently received greater amounts of teachers' time, attention, and instructional support. The findings suggest that teachers, either consciously or unconsciously, allowed boys greater opportunities for participation by acknowledging and engaging with their calling-out behaviour. As a result, boys occupied a more visible position in classroom interactions, while girls' participation remained comparatively restricted. Ultimately, teachers play a crucial role in determining whose voices are heard, whose responses are recognised, and who gains access to meaningful participation opportunities within the classroom. The use of sex-segregated activities, coupled with gendered patterns of teacher–student interaction, points to pedagogical practices

that inadvertently privileged boys over girls and contributed to unequal participation in mathematics classrooms.

Bassi et al. (2016) found that gender bias in classroom interactions negatively affects girls' achievement in mathematics. Similarly, Sadker and Sadker (1995) argued that gendered patterns of classroom interaction gradually undermine girls' self-confidence in mathematics, making them less likely to attempt challenging problems or engage with new mathematical tasks. As a result, girls may have fewer opportunities to develop and strengthen their mathematical competencies. Consistent with these observations, Singhal and Das (2023) reported that girls lag behind boys in basic mathematics. Furthermore, data from the All India Survey on Higher Education (AISHE) 2020–21 indicate that women remain underrepresented in Engineering and Technology programmes (Ministry of Education, n.d.). Taken together, these findings suggest that gender disparities in mathematics and mathematics-intensive fields cannot be explained solely by differences in ability or individual choice. Rather, they should be understood as the cumulative outcome of everyday educational experiences and classroom interactions that differentially encourage, recognise, and support the participation of boys and girls.

Thus, there is a need for greater awareness of gendered classroom interactions in teacher education and professional development programmes. Teachers need to reflect on how they distribute their attention, feedback, and

participation opportunities so that both boys and girls are equally encouraged to engage in mathematics learning. Although the findings are based on a small purposive sample and cannot be generalised to all schools, they shed light on the subtle ways in which gender inequalities can be reproduced in mathematics classrooms through everyday classroom practices. Addressing these classroom interaction patterns is essential for helping girls develop confidence in mathematics and participate more actively in learning. When girls are given equal learning opportunities in mathematics, they may be more likely to see themselves as capable of pursuing mathematically intensive fields

Recommendations for Further Research

In the present study, a small purposive sample was used so future research could involve a larger and more diverse group of schools and participants. Exploring students' experiences of classroom participation and teacher behaviour would also provide valuable insights into how gendered interactions are perceived by boys and girls. Finally, more intervention-based studies are needed to examine whether gender-sensitive teaching practices and teacher training programmes can help create more equitable classroom environments.

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