

Relationship between parents' perception of children's mathematical ability and arithmetic fluency: a gender-based study

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Abstract

Arithmetic fluency is a foundational component of mathematical competence; it is influenced by both cognitive and environmental factors, including parental beliefs about their children's abilities. The present study examined the relationship between parental perceptions of children's mathematical ability and children's arithmetic fluency, with a focus on gender differences within the Bangladeshi context. A cross-sectional design was employed, with a sample of 285 students from grades three to five in three Bangla-medium schools in Dhaka, along with their parents. Children completed the Mathematics Fluency subtest of the Wechsler Individual Achievement Test- Third Edition (WIAT-III). In addition, parents completed the Parental Perceptions of Mathematical Talent (PPMT) questionnaire, which was culturally adapted into Bangla using the TRAPD (Translation, Review, Adjudication, Pretesting, Documentation) framework. A 2×2 between-groups ANOVA indicated that irrespective of the children's gender, fathers' and mothers' perceptions of their child's mathematical ability did not differ. However, an independent-samples *t*-test revealed a small gender difference in arithmetic fluency, with boys showing slightly higher arithmetic fluency than girls. Hierarchical regression analysis showed that children's arithmetic fluency could be significantly predicted by parental perceptions, controlling for gender. The findings highlight the importance of parental beliefs in shaping children's mathematical ability and suggest that parental perceptions play a stronger predictive role in children's arithmetic ability than gender alone.

Introduction

Arithmetic fluency refers to the ability to perform mathematical calculations accurately, efficiently, and flexibly (Kilpatrick, 2001). It involves speed in solving basic math problems, as well as the ability to apply mathematical knowledge across various contexts. Arithmetic fluency is considered a core element of mathematical competence, associated with higher-order skills such as problem-solving, reasoning and understanding of numeric concepts (Kilpatrick, 2001).

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In a world increasingly driven by technology, the significance of arithmetic fluency has gone beyond academic achievement. Different studies have shown that arithmetic skills are essential for education, employment and everyday decision-making (Kappassova *et al.*, 2025). Expertise in arithmetic is associated with success in science, technology, engineering and mathematics (STEM). This expertise is also needed in economic and national development. People with higher arithmetic fluency are also more capable of dealing with complex real-world problems (Serin, 2023).

In South Asian communities, arithmetic holds an extremely important position in formal education. Academic success is prioritized from a very young age and arithmetic is viewed as the core subject that will lead to high-status careers in engineering and medicine. In the Bangladeshi cultural context, arithmetic achievement is considered an indicator of a child's intelligence and it holds a significant familial and social value (Rasool *et al.*, 2021). This results in children experiencing increased academic pressure in mathematics. In this situation, parents play a vital role in determining their child's educational expectations and learning environments.

Parental Perception and Child's Arithmetic Performance

Parents' perceptions of their children's arithmetic interest and ability greatly influence the children's mathematical proficiency (Gladstone *et al.*, 2018). Parents' beliefs influence the opportunities they provide, the encouragement and the expectations they communicate to their children while they are learning (Peixoto *et al.*, 2024). Some theoretical frameworks can provide a foundation for understanding these relationships.

Attribution theory (Weiner, 1986; Yee & Eccles, 1988) describes how explanations for success or failure determine motivation and performance. The attribution of parents regarding their child's arithmetic success or failure (to ability, effort or external factors) influences the child's own beliefs about their competence. Parents who attribute the mathematical achievement of their daughters to their effort instead of their inherent capacity may undermine the girls' confidence in arithmetic. This can disturb their persistence and development of arithmetic fluency. On the other hand, when parents attribute their son's achievement to innate talent, it may improve his self-efficacy in arithmetic tasks.

Social-Cognitive Theory (Bandura, 1986) focuses on the role that observational learning, modeling and social reinforcement play in shaping children's behavior and skill development. Parents are the primary role models for their child and they provide feedback for their child's academic behavior. A positive perception of the parents about the child's arithmetic ability can lead to more frequent engagement in math-related activities, constructive feedback and promoting arithmetic fluency. In contrast, negative or lower expectations may decrease parental involvement, reduce practice and lead to lower motivation and skill development.

These theoretical frameworks suggest that parental perceptions of arithmetic ability and interest can affect arithmetic fluency through multiple pathways.

Empirical evidence suggests that when parents perceive their children as being capable in arithmetic, there is a higher chance that they will support their child's math-related activities, they will adopt a positive attitude towards learning and encourage persistence while facing difficulty (Fernández-García et al., 2019). In contrast, when parents have lower confidence in their child's capability, they may limit exposure to opportunities for improvement and this may negatively affect the child's motivation.

Parental perceptions may be independent of the child's actual arithmetic ability, rather it may be influenced by broader social beliefs, including gender stereotypes (Mejía-Rodríguez et al., 2020). These perceptions can affect the child's arithmetic fluency (Mues et al., 2022). Therefore, it is of utmost importance that we attempt to understand the relationship between parental perception of a child's arithmetic ability and the child's arithmetic fluency, particularly in the Bangladeshi cultural context, where the involvement and expectations of parents strongly influence academic trajectories (Kabir & Akter, 2014).

Sonnenschein et al. (2012) found that parents' beliefs about how their child learns mathematics and their own perceived role in helping their child to learn were significantly associated with their child's engagement in math-related activities at home. These early experiences may contribute to the development of arithmetic fluency by increasing practice opportunities and promoting a positive attitude towards mathematics.

However, the empirical evidence is inconsistent. Tintia et al. (2023) came to the conclusion that there is no significant association between the child's and parent's perception of arithmetic and the child's arithmetic achievement. This suggests that parental perception by itself does not predict arithmetic performance.

Parental Perceptions of Mathematical Ability and Gender Bias

Parents influence their child's academic self-concept, especially in mathematics, where gender stereotypes are traditionally predominant. Research has confirmed that parents' beliefs about their child's capabilities are gender-biased and these beliefs may reveal social stereotypes.

Yee and Eccles (1988) described the difference of the parents' perception of arithmetic ability based on their child's gender. When the performance of the boys and girls on arithmetic were similar, parents attributed the success of the boys to their inherent capacity and the success of the girls to their effort. These differences in attributions influenced the parents' assessments of competence and expectations of achievements, which in turn shapes the child's academic self-efficacy.

Following these studies, Rätty and Kasanen (2007) demonstrated that parental assessment of their child's educational capabilities is influenced by certain gender

stereotypes. In their longitudinal study, these gender stereotypes affected third-grade children's language evaluations and fifth-grade children's mathematics evaluations. These gender biases in academic evaluation were more prevalent among the parents who overtly acknowledged gender stereotypes. This shows how culturally rooted expectations shape parental perception in education.

Recent evidence from the China Education Panel Survey, Xie and Liu (2023) investigated how expectations of the gender-role perceptions affect the child's arithmetic abilities. The findings from their studies reflected that stereotypical beliefs regarding gender roles of both students and their parents have a significant effect on the child's mathematical performance. They positively predicted the arithmetic performance of the boys but negatively predicted the performance of the girls. However, these stereotypes do not harm the girls' performance; they affect the girls' performance through internalized familial and cultural traditions.

Gender Differences in Arithmetic Performance

Gender differences in arithmetic fluency have been widely studied, but the findings were not consistent. Vos et al. (2023) concluded that females scored significantly lower than males on arithmetic and cognitive tests. Furthermore, it was found that gender partially mediated the relationship between math anxiety and gender stereotypes, and gender fully mediated the relationship between math anxiety and cognitive reflection. These findings show that cognitive, psychological and sociocultural factors influence gender differences in arithmetic performance.

Gender differences in mathematical performance have been found in qualitative research as well. Rahman (2025) found that boys had stronger procedural and strategic fluency, whereas girls had better understanding of concepts but weaker procedural fluency.

Several studies have reported no gender differences in mathematical performance. Pina et al. (2021) did not find gender differences in calculation skills and arithmetic fluency. Bautista et al. (2025) did a study with students in a STEAM-based education in an art context. They found no gender differences in arithmetic fluency, but females had higher flexibility scores. These findings indicate that gender differences in arithmetic fluency are context-dependent, such as on the method of instruction, cultural norms and other social factors.

Rationale

The above discussion made it clear that arithmetic fluency is a foundational element of mathematical competence and an important predictor of students' academic performance and future opportunities (Kilpatrick, 2001). Several studies have indicated that children's gender and parental involvement play crucial roles in children's arithmetic ability (Sarker et al., 2017). Although, prior research on gender differences in arithmetic fluency produced mixed results and mostly appears to be context-dependent (Vos et al.,

2023; Pina et al., 2021; Bautista et al., 2025; Rahman, 2025). The inconsistencies in research findings have prompted an examination of gender differences in arithmetic fluency within specific cultural contexts, rather than assuming universal patterns.

Parental perceptions of a child's arithmetic ability represent an important, yet less explored, influence on children's arithmetic fluency. Despite growing evidence of the importance of parental involvement in their child's mathematical ability and its influence on their child's arithmetic achievement (Hanafiah et al., 2024; Boateng et al., 2024), to our knowledge, no prior study in this area has incorporated both the gender of the children and parents to understand the pattern of the relationship between parents' perception of their child's mathematical ability and children's arithmetic fluency. This area is especially important to explore in Bangladesh, where parents are mostly involved in mentoring their children's academic development.

The present study aims to address this gap by examining the association between parents' perceptions of their child's arithmetic ability and the child's arithmetic fluency, while considering the gender of the children and parents in the Bangladeshi context. By investigating whether fathers' and mothers' perceptions differ by children's gender, the study seeks to provide culturally grounded evidence to the literature. This will advance our understanding of how familial beliefs and sociocultural norms interact to shape children's arithmetic development in South Asia.

Objectives

The present study has the following objectives:

1. To investigate whether fathers' and mothers' perceptions of their children's mathematical ability differ based on the child's gender.
2. To determine whether male and female students differ in arithmetic fluency.
3. To evaluate whether parental perceptions of children's mathematical ability predict arithmetic fluency after controlling for the effects of gender.

Materials and Methods

Design and sampling technique

A cross-sectional research design was used to conduct the study. Participants were selected for the study using convenience sampling.

Demographic information

A total of 290 students, studying in classes 3-5 from three Bangla-medium schools in Dhaka city, and their parents participated in this study. Before conducting the study, permission was obtained from the school authorities (names are not mentioned for confidentiality) and each child's parent. Written informed consent was collected from the parents. Ethical approval for conducting this study was obtained from the Institutional

Review Board of the Department of Psychology, University of Dhaka (Ethics Approval Code: PSY 25/05/064). However, after cleaning the data using the full response set, conducting factor analysis, and excluding outliers, 285 data points were retained for final analysis. In these final data, 129 students were female, and 156 were male, with a mean age of 10.24 years ($SD = 1.06$). Among the parents, 143 data were collected from the child's father, and the remaining 142 from the child's mother. The mean age of the parents was 40.89 years ($SD = 6.24$). Fifteen parents held a doctoral degree, 140 completed post-graduation, 45 completed graduation, and the remaining 81 completed only higher secondary education. 266 participants belonged to middle-income families, 11 to higher-income households, and 8 to lower-income households.

Measurement instrument

Mathematics Fluency Test. The Mathematics Fluency Test was administered to assess students' arithmetic fluency. This test is a subtest of the Wechsler Individual Achievement Test—Third UK Edition (WIAT-III) (Wechsler, 2017). In this test, participants completed a series of timed arithmetic tasks that measured students' speed and accuracy in solving fundamental arithmetic problems. The test was divided into three parts (addition, subtraction, and multiplication). Students had to solve 48 subtraction, 48 addition, and 40 multiplication problems, each within 1 minute. A total of three minutes was allocated to complete the test. To measure children's arithmetic fluency, the total number of correct responses was calculated. Higher scores indicated better arithmetic fluency. This test was initially developed in the UK. However, after reviewing the problem types and the Bangladesh educational curriculum, it was found that the Bangladesh educational curriculum covers the test problems for classes three to five. You can find the math textbook for class 3 students at the following link: <https://drive.egovcloud.gov.bd/index.php/s/fZkF0x9uyNGcGmg>.

Parental Perceptions of Mathematical Talent. To measure parents' perceptions of their child's mathematical ability and interests, the Parental Perceptions of Mathematical Talent (Mann, 2008) questionnaire was used. This is a 13-item, 7-point Likert self-report scale (1 = strongly disagree, 7 = strongly agree). The scale contains two subscales: one measuring interest in mathematics and the other measuring mathematical ability. In the original scale, the coefficient alpha for mathematical ability was $\alpha = .88$, and for interest in mathematics was $\alpha = .85$. The scale was cross-culturally validated in the current study. The findings are discussed in detail in the results section. Since this test was originally developed in English, to ensure linguistic and conceptual equivalence between the Bangla version and the original β vs b coefficients English version of the "Parental Perceptions of Mathematical Talent", the TRAPD (Translation, Review, Adjudication, Pretesting, and Documentation) (Harkness, 2003; Walde & Völlm, 2023) was used. Two bilingual translators independently translated the original 13-item questionnaire from English to Bangla. Then, a team of psychologists revised both translated drafts for consistency and readability under the supervision of the lead researcher. After some refinements, a 13-item translated questionnaire was finalized for judges' review.

A multidisciplinary review committee was convened to compare the final translation and the original English version. The committee consisted of one expert in English language and literature, one Bangla-language expert to ensure the articulation and grammatical correctness of the target language, and two psychology professionals and a psychometric expert to verify that the psychological concepts were accurately represented in the translated terms. The committee reviewed the discrepancies item by item; each expert independently assessed the translation's accuracy on a 2-point scale (0 = yes, 1 = no). Experts have suggested some corrections to improve clarity, wording, and the organization of the topics. After their evaluation, the translation's accuracy was verified by calculating the accuracy index ($AI = \text{number of expert ratings} / \text{total number of experts}$) for each item. When the accuracy index was 50% (2 out of 4 experts recommended improvements in the clarity, wording, and readability for items 3 and 9), our research team restructured the wording or sentence structure accordingly. 1 of 4 experts recommended modifications for items 5, 6, 8, 10, and 11. Still, these items remain unchanged, as the remaining three experts approved the previous translation.

The improved version was submitted to a panel of adjudicators: senior psychology professors with expertise in psychometrics, scale construction, and adaptation. The adjudicators assessed the questionnaire for clarity, flow, and cultural relevance using the relevancy index ($RI = \text{number of expert ratings} / \text{total number of experts}$) for each item. They appraised whether this questionnaire is relevant to our cultural norms, using a 2-point scale (0 = Not relevant, 1 = Relevant). One of them noted that some items measured general ability rather than mathematical ability and suggested adding the word "mathematical" to these items. By reviewing those items in light of their observations and recommendations, the translation's accuracy was ensured.

The adjudicated Bangla version was piloted with a small sample of participants ($N = 3$) who matched the target population's demographics. Participants were asked to complete the questionnaire and rate the readability, clarity, comprehensiveness, answerability, logicity, style, and formatting for each item they answered using a 2-point scale (0 = yes, 1 = no). All participants reported that the translated items were clear, logical, comprehensive, readable, answerable, and did not conflict with our cultural norms. This initial test confirmed the face validity of the Bangla version of the scale.

A comprehensive translation log was maintained throughout the process. This document records the development of each item from the original English text through independent translations, experts' review, adjudication, and pretest modifications. This assessment trail ensures the transparency and replicability of the adaptation process.

Data acquisition

To collect participant responses, we selected three coeducational schools in Dhaka city. We approached the selected school authorities and sought permission and cooperation to conduct the research. After obtaining permission, we contacted the class

teachers and provided a brief description of our sampling criteria (age range, class, male-to-female ratio, etc.). The class teachers helped us select participants from classes 3 to 5. After teachers completed their selection, we sent an envelope to the parents of selected students containing a formal letter, a consent form allowing their child to participate in the study, a demographic questionnaire, and a questionnaire on each parent's perceptions of their child's mathematical talent. We subsequently informed them of our study and respectfully asked them to complete the questionnaires. With the help of the school authorities and class teachers, we collected data from the students' parents. Once the collection of parents' consent was completed, we proceeded to the second phase of the study. We assembled the children with parental consent in an empty room. A standardized instruction was given to all participants, and they were informed of their rights and privacy. Afterward, demographic information for children was collected, and their arithmetic achievement was assessed using the Mathematics Fluency Test.

First, the addition part of the test was administered. Students were pointed out where they should start answering. As we signaled "begin," they started solving addition problems under a 60-second time limit. If any child failed to start from the pointed item, we immediately redirected the process without pausing. After 60 seconds, we said "stop" to conclude the answer. We repeated the same process for the subtraction and multiplication sets as well.

Results and Discussion

The present study investigated the role of parental perceptions in shaping their children's arithmetic fluency in the Bangladeshi context, with a particular focus on gender differences. The study attempted to explore how familial beliefs and the child's gender interact to influence arithmetic development in a cultural setting where mathematics holds a significant academic and social value.

In this research, analyses and findings were divided into two sections. In the first part, the data from the scale adaptation were presented. In the second part, the primary analyses were presented, showing the association between parents' perception of their child's mathematical ability and the child's arithmetic fluency.

Parental Perceptions of Mathematical Talent (PPMT) Scale Adaptation

Data Analysis

Initially, data were collected from 290 children and their parents; however, 4 sets were incomplete and were therefore excluded from the analysis. Finally, 286 participants were retained for factor analysis. This sample size is adequate for factor analysis as suggested by MacCallum *et al.* (1999). Based on their study findings, if some items on the scale have low communalities (<0.5), there are six to seven indicators per factor, and the number of factors is small, then a sample of over 100 will be sufficient. In the initial development of the PPMT

scale, there were only two factors (6 and 7 items per factor), and only 6 of 13 items had communalities below 0.5. Based on MacCallum et al.'s (1999) criteria, a sample of 286 is adequate for factor analysis. Another practice for selecting a sample size for factor analysis is the N:p ratio, i.e., the sample size-to-variable/item ratio. Many researchers suggested different ratios ranging from 3 to 6 (Cattell, 1978), 5 (Gorsuch, 1983), and 10 (Everitt, 1975). Even based on this N:p criterion, our 286-sample for the 13-item PPMT scale produces a ratio of 22, which is higher than the recommended ratios reported by different researchers.

Data Screening

Before we fed the data into the factor analysis, we investigated item-level outlier detection by calculating skewness and kurtosis. The analysis found that skewness ranges from -1.20 to -0.42, and kurtosis ranges from -0.80 to 1.30. Both fall within the recommended ± 2 range (George & Mallery, 2010; Tabachnick & Fidell, 2019). These results revealed no problematic outliers and the suitability of the data for factor analysis.

Item Analysis

The correlation matrix for all 13 items, along with their item totals, is presented in Table 1. The correlation matrix shows that 78 of 78 inter-item correlations are significant, with an average of .45. Similarly, all item totals were significantly correlated, ranging from .59 to .77, with an average of 0.70. Thus, all the items were retained for further analysis.

Table 1. Correlation Matrix for PPMT (N = 286)

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	PPMT total
1	1													
2	.463**	1												
3	.394**	.408**	1											
4	.574**	.411**	.384**	1										
5	.466**	.640**	.353**	.430**	1									
6	.482**	.409**	.355**	.464**	.440**	1								
7	.486**	.392**	.385**	.464**	.446**	.569**	1							
8	.516**	.423**	.435**	.545**	.452**	.552**	.703**	1						
9	.449**	.444**	.393**	.405**	.403**	.477**	.475**	.542**	1					
10	.414**	.380**	.307**	.329**	.332**	.469**	.565**	.562**	.519**	1				
11	.402**	.478**	.358**	.412**	.437**	.516**	.402**	.469**	.455**	.460**	1			
12	.435**	.462**	.359**	.486**	.467**	.536**	.518**	.489**	.479**	.393**	.530**	1		
13	.394**	.442**	.339**	.339**	.451**	.489**	.402**	.393**	.452**	.423**	.530**	.627**	1	
PPMT total	.697**	.697**	.589**	.670**	.692**	.735**	.739**	.768**	.711**	.676**	.713**	.751**	.703**	1

Note. ** $p < .001$ (two-tailed). Determinant = .002

Factor Analysis

The correlation matrix (Table 1) shows that 78.21% of the inter-item correlations exceed .30, and the determinant value (.002) also meets the criterion of $> .00001$ (Field, 2005). Thus, no items exhibit multicollinearity or singularity. The Kaiser–Meyer–Olkin (KMO) sample adequacy score was .93, which exceeded the recommended value of .60 (Kaiser, 1970), and Bartlett's test of sphericity was significant, $\chi^2_{(78)} = 1778.56$ ($p < .001$).

All of these test results support the factorability of the correlation matrix. Next, the data were entered into a principal components (PC) analysis with varimax rotation. The initial analysis extracted a single factor using the Kaiser–Guttman criterion (eigenvalues > 1.00), and items with factor loadings $< .40$ were suppressed, accounting for 49.69% of the total variance (Table 2). Since scree plot inspection (Cattell, 1966) is considered another accurate method for retaining factors (Floyd & Widaman, 1995), a single factor revealed a clear break after the first component (Fig. 1), leading us to retain a single component.

Table 2. Rotated component matrix for 13 items PPMT Scale ($N = 286$)

Item	Component 1	Communalities
1	0.707	0.500
2	0.690	0.476
3	0.585	0.342
4	0.682	0.465
5	0.689	0.474
6	0.743	0.553
7	0.750	0.563
8	0.780	0.609
9	0.710	0.504
10	0.673	0.453
11	0.705	0.497
12	0.745	0.554
13	0.685	0.470
% of variance	49.690	
Cronbach's (standardized) α	.91	

Note. Extraction Method: Principal Component Analysis.

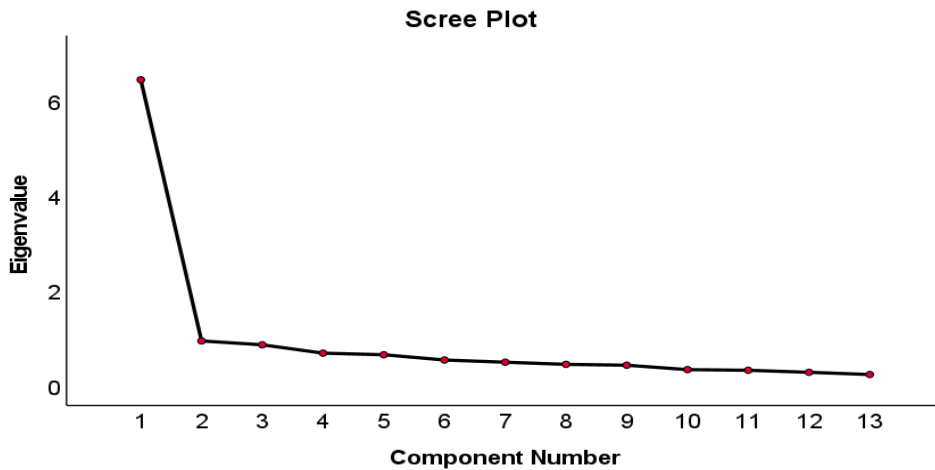


Fig. 1. Scree plot for 13-items PPMT scale generated by principal component analysis.

Validity

Convergent validity. To measure the convergent validity, the correlation (Pearson r) was calculated between the parent-reported Bangla PPMT score and children's arithmetic fluency score. The Pearson correlation (r) showed that both were significant and positively correlated ($r = .27, p < .001$). This indicated that parents who had a positive perception of their child's mathematical ability also had better arithmetic fluency. Thus, this result provides evidence for the construct's convergent validity.

Discriminant validity. In this study, children were asked whether math was their favourite subject, and responses were scored on a 3-point Likert scale, with higher scores indicating a negative attitude towards math. To measure the discriminant validity, the correlation (Pearson r) was calculated between the parent-reported Bangla PPMT score and children's attitude towards math as a favorite subject. The Pearson correlation (r) indicated that both were significantly negatively correlated ($r = -.19, p < .01$). This indicated that parents who had a positive perception of their child's mathematical ability showed smaller negative attitudes towards math. Thus, this result provides evidence for the construct's discriminant validity.

Reliability

Internal consistency. The reliability of the Bangla version of PPMT was calculated using Cronbach's (standardized) α , which yielded a score of .91.

Main Analyses

In this section, the primary analyses are presented. Here, the data are screened for

outliers, followed by preliminary analyses to investigate gender differences, and finally by the primary analysis to examine the association between PPMT and children's arithmetic fluency.

Outlier Screening

286 data points obtained from parent-reported PPMT and children's arithmetic fluency were used to calculate standard deviations to screen for potential outliers (any score outside ± 3 SDs). One participant's data fell outside the required range, so they were removed from further analysis. Then, skewness and kurtosis were measured for PPMT and arithmetic fluency using these 285 data points, and the results showed skewness values of 0.325 and 0.558, and kurtosis values of 0.294 and -0.336, respectively. Both fall within the recommended ± 2 range (George & Mallery, 2010; Tabachnick & Fidell, 2019). These results revealed no problematic outliers and the suitability of the data for further analysis.

Investigating Gender Differences for PPMT and Arithmetic Fluency

To examine whether fathers' and mothers' perceptions of their children's mathematical ability differed between parents of male and female children, descriptive statistics and a 2×2 between-groups ANOVA were used.

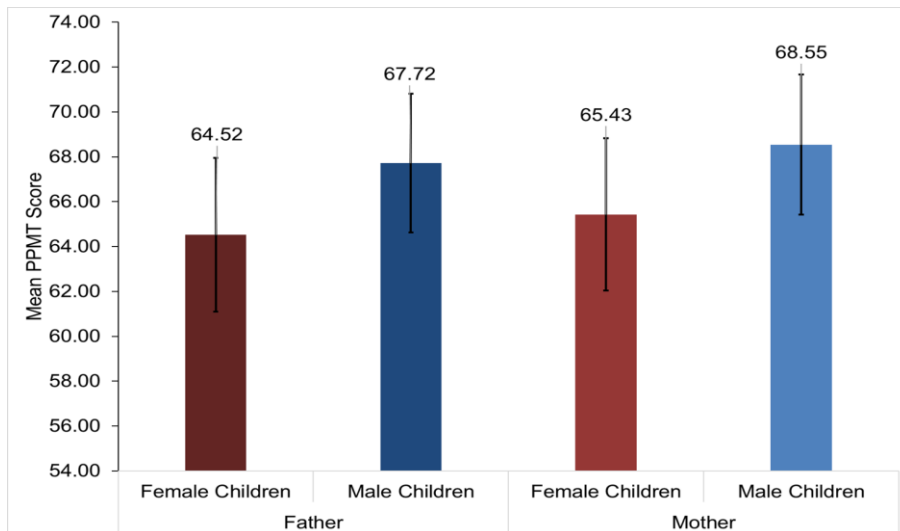


Fig. 2. Mean PPMT score obtained from father and mother about their perception towards their male or female child's mathematical ability, error bars representing 95% CIs.

The bar diagram (Figure 2) above shows that the mean PPMT scores for fathers and mothers of male and female children are slightly higher for fathers and mothers of male children than for those of female children. However, 2×2 ANOVA results suggested no significant group differences between father and mother in perceiving their children's

mathematical ability; $F_{(1, 284)} = 0.28, p = .60, \eta^2_p = .001$. No group differences for the PPMT score also observed from the parent's data obtained for their male or female child; $F_{(1, 284)} = 3.64, p = .058, \eta^2_p = .013$. Similarly, no interaction effect was observed; $F_{(1, 284)} = 0.001, p = .98, \eta^2_p = .000$.

Conflicting with the expectations that we derived from the findings of previous research on gender stereotypes, fathers' and mothers' perceptions of their children's arithmetic ability did not significantly differ on the basis of the child's gender. Although the mean scores were slightly higher for the boys, it was not statistically significant. This finding diverges from earlier studies, which suggested gender-biased parental beliefs in mathematics (e.g., Yee & Eccles, 1988; Rätty & Kasanen, 2007; Xie & Liu, 2023). One possible explanation for this finding is that modern Bangladeshi parents in Dhaka may increasingly hold more egalitarian beliefs about arithmetic ability. Another possibility is that implicit stereotypes still exist, but those were not explicitly expressed by the parents in the self-reported PPMT scale. This highlights the importance of distinguishing between a person's implicit gender bias and their overtly expressed beliefs.

Next, mean arithmetic fluency scores were examined graphically and statistically using a two-sample independent t-test to determine whether they differed between male and female students. Table 3 shows that the arithmetic fluency score significantly varied by gender, with a small effect size, $d = 0.27$, 95% for β [-9.79, -0.70]. From the mean value, we can see that male students slightly outperformed their female classmates ($M = 79.28, SD = 19.53$) in the arithmetic fluency test ($M = 74.04, SD = 19.23$).

Table 3. Mean Differences for arithmetic fluency score between male and female students

		Students	M (SD)	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	CI for β	
								Lower	Upper
Arithmetic Fluency	Female		74.04 (19.23)	-2.27	283	.02	-0.27	-9.79	-0.70
	Male		79.28 (19.53)						

Consistent with the findings of previous research (Vos et al., 2023), boys demonstrated slightly higher arithmetic fluency than girls, but the effect size was small. This indicates that a statistically significant gender difference exists, but the magnitude of the significance is modest. Given the mixed findings in existing literature (Pina et al., 2021; Bautista et al., 2025), the present results support the idea that gender differences in arithmetic fluency are context-dependent rather than universal. In Bangladesh, sociocultural expectations and classroom dynamics may subtly shape the boys' confidence in arithmetic tasks, contributing to the slight performance differences.

Relationship between PPMT and Children's Arithmetic Fluency

Because a significant gender difference was observed on the arithmetic fluency test, a

hierarchical regression analysis was conducted to investigate the relationship between parent-reported PPMT and children's arithmetic fluency, controlling for gender. A Mahalanobis distance test was conducted before the hierarchical regression analysis, indicating no potential outliers ($p < .001$; Tabachnick & Fidell, 2019).

Results from the hierarchical regression analyses showed that (Table 4), for Model I, which included only gender as a predictor, the model accounted for 1.4% of the variance in arithmetic fluency, $F_{(1, 283)} = 5.16$, $p = .024$ (Table 4). The regression coefficient indicated a positive association: male students had better arithmetic fluency than female students ($\beta = 0.134$, 95% CI for β [0.70, 9.79], $p = .024$). In Model II, the addition of PPMT altered the relationships among the variables. The relationship between gender and arithmetic fluency was not statistically significant ($p > .05$). Inclusion of PPMT significantly enhanced the model's explanatory power, $F_{(1, 284)} = 17.44$, $p < .001$, by increasing the total variance explained to 6.9%, which falls within the moderate range of predictive accuracy.

Table 4. Hierarchical linear regression predicting arithmetic fluency from PPMT while controlling for students' gender

Dependent Variable	Arithmetic Fluency	
Predictors	Model I (β)	Model II (β)
Gender	.134*	.107
PPMT		.241**
R ² adj	.014	.069
F for R ² Change	5.16*	17.44**

Note. * $p < .05$; ** $p < .001$

According to Cohen (1988), effect sizes in multiple regression are small (0.02), medium (0.15), or large (0.35). Within this model, PPMT alone accounted for 5.7% of the variance. Only for the PPMT score, the regression coefficient was significantly positive, $\beta = 0.24$, 95% CI [0.18, 0.50], $p < .001$, indicating that for each one-unit increase in parent-reported PPMT, children's arithmetic fluency increased by 0.24 units.

The most important finding of this study is that the parental perceptions of children's arithmetic ability emerged as a significant predictor of arithmetic fluency, after controlling for gender. When parental perception was included in the regression model, the previously significant gender effect became non-significant. This suggests that parental attitudes may account for variance in arithmetic fluency that might otherwise be attributed to gender. In other words, children whose parents perceived them as being mathematically capable demonstrated higher arithmetic fluency, regardless of gender.

These findings strongly align with Social Cognitive Theory (Bandura, 1986), as positive parental perceptions may translate into modeling, reinforcement, and scaffolding behaviors by parents, which will, in turn, promote the child's academic fluency. Furthermore, from

the perspective of Attribution Theory (Weiner, 1986), parental beliefs about their child's ability may affect how success and failure are interpreted in their home, influencing the children's confidence and persistence in arithmetic practice.

Parental perception accounted for a larger proportion of variance in arithmetic fluency than gender alone. Although the overall variance explained by the regression model was moderate (unadjusted $R^2 = 7.5\%$), the contribution of parental perception (5.7%) was meaningful. This suggests that familial beliefs create a significant contextual influence on children's mathematical development in Bangladesh.

Implications

The findings from the study have important practical implications. Interventions designed to improve children's arithmetic fluency could benefit from including parents, particularly by addressing the parents' beliefs about arithmetic ability. Educational programs could focus on helping the parents understand that ability in mathematics can be developed through effort and practice, and that arithmetic ability is not innate. These initiatives might be valuable in high-pressure academic situations where mathematics is strongly linked with future career success.

Limitations and Conclusion

The study sample was selected using convenience sampling within Dhaka city, which limited generalizability to rural and socioeconomically diverse populations in Bangladesh. In addition, only the arithmetic fluency element of the mathematical ability was investigated; research is needed to focus on other areas of mathematical ability.

The present study contributes culturally rooted evidence to the literature by describing how the perception of South Asian parents regarding their child's ability in arithmetic is significantly associated with their child's arithmetic fluency. The findings also suggest that gender differences in arithmetic fluency can be reduced when parental perceptions are taken into account. This emphasizes the important role of familial beliefs in shaping a child's mathematical development and also highlights the need to address parental attitudes in order to promote unbiased and effective mathematics education in Bangladesh.

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Authors' Contributions

Naima Nigar: Conceptualization; Methodology; Formal Analysis and Investigation; Writing – Original Draft Preparation; Supervision. **Mushrat Alam Shama:** Methodology; Formal Analysis and Investigation; Writing – Original Draft Preparation; Writing – Review and Editing. **Irfat Sharmin Humayra:** Methodology; Formal Analysis and Investigation;

Resources; Writing – Original Draft Preparation. **Nasimul Alam:** Formal Analysis and Investigation; Resources.

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