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Examining the Relationship between Parenting Styles and Parental Math Involvement: The Role of Parental Math Beliefs

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Abstract

Although some studies have investigated the mechanisms connecting parenting styles to parental math involvement in older age groups, no research has specifically examined this relationship during early childhood (ages of 36–71 months). This study examined the relationships between parenting styles, parental math beliefs, and parental math involvement. A cross-sectional quantitative study design tested a mediation model, hypothesizing that parenting styles indirectly influence parental math involvement through parental math beliefs. Participants included 746 parents from various cities across Türkiye. Validated scales, including the Parental Attitude Scale, and the Early Math Questionnaire were used to measure parenting styles, parental math beliefs, and parental math involvement. The results revealed that parental math involvement was positively associated with authoritative parenting styles but negatively associated with authoritarian styles. Parental math beliefs mediated the relationship between authoritative parenting styles and math involvement; however, this mediation effect was not observed for authoritarian styles. This mediation held after controlling for children's age, parents' education, and math storybook presence. Additionally, children's age was positively associated with parental math involvement, whereas parents' education levels and the presence of a math storybook at home were negatively associated. These findings suggest that promoting authoritative parenting styles and enhancing parental math beliefs can positively influence parental math involvement. This highlights the importance of educational programs designed to improve both parenting practices and math-related beliefs. Specifically, such programs should encourage parenting practices that combine emotional warmth and minimal rejection with strong parental math beliefs, thereby fostering more effective involvement in children's math learning.

Keywords Authoritative parenting style · Authoritarian parenting style · Parental math beliefs · Parental math involvement · Mediating role · Quantitative study · Early childhood

Introduction

Quality education is fundamental to sustainable development and a primary goal within the United Nations' 2030 Sustainable Development Goals (United Nations, 2015). Achieving this goal requires collaboration between schools and families to support children's development. Mathematics, as a fundamental component of early cognitive development, represents a critical area where this partnership is particularly essential. Effective early math education relies on both educational institutions and active family involvement, which fosters positive attitudes toward math and builds a foundation for long-term academic success, ultimately supporting the goal of quality education. Therefore, identifying the factors that lead to parental math involvement and understanding the mechanisms that mediate these relationships is crucial.

Parental involvement is a significant predictor of preschool children's school readiness (Barnett et al., 2020; Lau et al., 2011) and is positively linked to academic abilities (Roopnarine et al., 2006). Additionally, parental involvement in early childhood education has been shown to enhance children's math success in later years (Cui et al., 2021). Specifically, parental math involvement improves children's math skills (Mayer et al., 2023; Pan et al., 2023; Ribeiro et al., 2024; Starkey & Klein, 2000; Susperreguy et

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al., 2020; Vasilyeva et al., 2018). This study explores factors influencing parental math involvement, focusing on the mediating role of parental math beliefs, and examines the impact of parenting styles and math beliefs on math involvement. To investigate these relationships, a quantitative research design was employed, allowing for statistical analysis of the data collected from parents.

Theoretical Framework

Parenting styles, shaped by the quality of the parent-child relationship, significantly influence children's cognitive, behavioral, and academic development. These are defined as the combination of parents' attitudes and behaviors toward their children (Darling & Steinberg, 1993). Parenting styles are categorized by levels of responsiveness and demandingness. Authoritative parents balance high responsiveness and demandingness, while authoritarian parents emphasize demandingness over responsiveness, leading to strict control and limited autonomy for their children (Baumrind, 1991).

Parenting styles have been extensively researched, connecting them to cognitive abilities (Rudasill et al., 2013). Additionally, parenting styles significantly influence parental involvement, with different styles leading to varying levels of engagement. These variations, in turn, shape learning and socialization environments, ultimately impacting child outcomes (Lin et al., 2023). Some studies correlate parenting styles with parental involvement (Gaertner et al., 2007; Karabulut & Şendil, 2018; Lin et al., 2023; Paquette et al., 2000; Pratt et al., 1992; Yoleri & Taşdelen Karçkay, 2015).

The authoritative parenting style has been shown to positively influence young children's academic performance (Garn et al., 2010; Pinquart, 2016; Lin et al., 2023; Roopnarine et al., 2006), particularly by supporting effective scaffolding practices and improving math achievement among fifth-grade students (Pratt et al., 1992). In contrast, authoritarian parenting is often linked to negative outcomes (Lin et al., 2023; Roopnarine et al., 2006) and has demonstrated no significant predictive effect on academic performance in second-grade children (Ren et al., 2024). While the indirect effect of parenting styles on parental involvement—particularly in relation to mathematics—has become a compelling focus of this study, there is still a lack of research examining the specific connection between these styles and parental math involvement. This study is grounded in Baumrind's theory of parenting styles (Baumrind, 1971) and Bandura's social cognitive theory (Bandura, 1986) to examine the effect of parenting styles on parental math involvement through parental math beliefs. Baumrind's theory highlights how different parenting styles (authoritative, authoritarian) influence child development. In this context, it is suggested that parenting styles shape how parents approach educational processes and the extent to which they are involved in their children's developmental and early learning experiences (Baumrind, 1971). Additionally, Bandura's social cognitive theory posits that individuals' beliefs play a critical role in shaping their behaviors (Bandura, 1986). In this study, parental math beliefs are considered to play a key mediating role in determining parents' involvement in their children's mathematics learning. Therefore, the proposed mediation model suggests that parenting styles influence parental math involvement indirectly through parental math beliefs.

Parenting Math Beliefs and Parental Math Involvement

Parental math beliefs encompass parents' views about mathematics and how their children learn it, including their attitudes, value judgments, and perceptions of self-efficacy. These beliefs involve the perceived importance of mathematics in daily life, its learnability at an early age, and parents' self-assessments of their ability to teach it (Missall et al., 2015). Parental math involvement refers to interactive math-related activities that parents engage in with their children during daily routines, such as counting, comparing objects, recognizing shapes, playing with blocks, and measuring (Missall et al., 2015, 2017). Recent studies have increasingly highlighted the pivotal role of parental math beliefs and attitudes in fostering children's early math development. Parents' beliefs in their children's math-specific competence are significant predictors of children's mathematical outcomes (Aunola et al., 2003; Fiskerstrand, 2022). Parents' beliefs about mathematics play a pivotal role in influencing their children's later math achievement performance (Jacobs & Bleeker, 2004). Similarly, research by Sonnenschein et al. (2016) emphasized the critical impact of parents' math-related beliefs and active involvement on children's mathematical success.

Parents had positive views on early math skill acquisition and recognized their responsibility in helping children develop these skills (Ergel & Aydoğan, 2021). Research has also identified a relationship between parents' math beliefs and their math involvement (Missall et al., 2015). Parents' knowledge about early math development shaped their math beliefs, which subsequently influenced the support they provided for math (Douglas & Rittle-Johnson, 2024). Parents' beliefs about their children's academic abilities significantly predicted their involvement in math activities (Epstein, 2007). Similarly, parents with positive attitudes toward mathematics were more likely to engage in such activities with their children (Blevins-Knabe et al., 2000). Additionally, numeracy beliefs—particularly those concerning parents' expectations and values regarding their children's numeracy development, as well as their beliefs

about their children's numeracy-related abilities and interests—the numeracy support parents provided in early childhood education (Douglas et al., 2021).

However, studies have also shown a relationship between parents' beliefs about the importance of mathematics and and how often they are involved in math-related activities with their preschool-aged children (Cannon & Ginsburg, 2008; LeFevre et al., 2009; Muenks et al., 2015; Sonnenschein et al., 2012; Zippert et al., 2017). Parents who hold stronger beliefs about the importance of math tend to engage more frequently in math activities with their children, which positively impacts children's math achievement (Eason & Ramani, 2018; Keating et al., 2021; Silver et al., 2020). Vasilyeva et al. (2018) stated parental math involvement mediated the relationship between parental beliefs and children's numeric skills. Providing parents with simple math activities can enhance their beliefs about early math's importance and boost their involvement, leading to improved child outcomes (Holtzman et al., 2023). Consequently, parents' enjoyment and the significance of mathematical activities are essential for consistent participation in math-related activities. These findings emphasize the importance of aligning parental beliefs with supportive practices to create a nurturing environment for children's learning.

The Present Study

Although the connections between parental math beliefs and parental math involvement are well-documented, the associations among parenting styles, parental math beliefs, and parental math involvement have not been researched directly. Understanding how parenting styles and parental math beliefs shape their involvement in children's math education plays an important role in the development of educational policies. This could offer valuable insights into improving parenting approaches that promote parental involvement in math-related activities. This study aims to contribute to the development of strategies for achieving more effective and sustainable outcomes in early childhood education by enhancing parental math involvement. Specifically, it examines whether parental beliefs mediate the relationship between parenting styles and parental involvement. Consequently, the following hypotheses are proposed:

H1: There are significant relationships between parenting styles, parental math beliefs, and parents' math involvement.
H2: Parenting styles will have a direct effect on parental math involvement.
H3: Parental math beliefs will mediate the relationship between parenting styles and parental math involvement.

Method

This research utilized a cross-sectional design with quantitative data collected from parents. Authoritative and authoritarian parenting styles served as independent variables, parental math beliefs functioned as the mediating variable, and parental math involvement was the dependent variable.

Participants

The second version of the R package semPower was utilized to determine the required sample size in the structural equation model (SEM), as described by Moshagen and Bader (2024). An a priori power analysis was conducted using semPower 2 to estimate the sample size assuming an effect size of 0.05, α of 0.05, and a power of 80%. The semPower 2 results indicated that a sample size of 243 participants was necessary.

The sample of the study consisted of 746 parents from various cities across Türkiye, representing different income levels. The participants were parents of children enrolled in preschool education in Türkiye. The majority of the parents were 30–34 years old (37.7%), and had a bachelor's degree (36.5%). Most children were girls (52.9%), and between 66 and 71 months old (36.1%; see Table 1). Participants were selected through convenience sampling, a type of non-probability sampling where participants are chosen based on their easy accessibility (Fraenkel et al., 2012).

Measures

Early Math Questionnaire

Developed by Missall et al. (2015) and adapted to Turkish by Karakuş (2022) to obtain information about the math activities parents of preschool children complete with the children and to determine their parents' beliefs about math. The scale includes two parts: Math Activities, and Math Beliefs.

The Math Activities Section consisted of 36 items and four sub-scales: numbers and operations, geometry, measurement, and pattern. Each item was rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (more than once a day). The Cronbach's alpha (α) reliability coefficient of this section is 0.96 (Missall et al., 2015, 2017). In the Turkish adaptation of the scale, the reliability coefficients were 0.97 for Cronbach's alpha (α) and 0.99 for McDonald's omega (ω) (Karakuş, 2022). In this study, Cronbach's alpha (α) was 0.94 for the numbers and operations, 0.91 for the geometry, 0.82 for the measurement, 0.90 for the pattern, and 0.96 for the overall scale.

Table 1 Characteristics of parents and children

Parents	**Total (*N*=746)**	
	N	%
Parents' gender		
Female	679	91.0
Male	67	9.0
Parents' age		
25–29 years	135	18.1
30–34 years	281	37.7
35–39 years	215	28.8
40 years and older	115	15.4
Parents' educational levels		
Primary school degree	42	5.6
Secondary school degree[1]	69	9.2
High school degree[1]	183	24.5
College/technical school degree	102	13.7
Bachelor's degree	272	36.5
Master's or doctorate degree	78	10.5
Perceived income status		
Low	133	17.8
Middle	583	78.2
High	30	4.0
Presence of a math storybook at home		
Yes	370	49.6
No	376	50.4
Children	**Total (*N*=746)**	
	N	%
Children's gender		
Girl	395	52.9
Boy	351	47.1
Children's age		
36–41 months	56	7.5
42–47 months	39	5.2
48–53 months	101	13.5
54–59 months	65	8.7
60–65 months	216	29.0
66–71 months	269	36.1

[1]In the context of the Turkish education system, a "High School Degree" corresponds to the completion of grades 9–12, while a "Secondary School Degree" corresponds to grades 5–8. Thus, "High School Degree" refers to graduation from upper secondary education, and "Secondary School Degree" refers to the completion of lower secondary education

The Math Beliefs Section consisted of eight items and two sub-scales: Child Math Beliefs (4 items), and Adult Math Beliefs (4 items). The Child Math Beliefs subscale reflects parents' views on their children's learning of mathematics, while the Adult Math Beliefs subscale represents parental beliefs about their role in supporting children's mathematics learning. Each item was rated on a 4-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree) (Missall et al., 2015). In the Turkish adaptation of the scale, reliability coefficients were 0.84 for Cronbach's alpha (α) and 0.88 for McDonald's omega (ω) (Karakuş, 2022). In this study, Cronbach's alpha (α) was 0.76 for the Child Math Beliefs, 0.77 for the Adult Math Beliefs, and 0.82 for the overall scale.

Parental Attitude Scale

Developed by Karabulut Demir and Şendil (2008), it evaluates parenting attitudes in raising children aged 2–6 years. The scale consisted of 46 items and four sub-dimensions: authoritative attitude (17 items), authoritarian attitude (11 items), permissive attitude (9 items), and overprotective attitude (9 items). Sample items for each sub-dimension include the following: for the authoritative attitude, "I accept that my child has a unique point of view"; for the authoritarian attitude, "When I am angry with my child, I punish them"; for the permissive attitude, "I allow my child to sleep whenever they want"; and for the overprotective attitude, "I protect my child from tasks that may be difficult for them". Scores for these sub-dimensions were calculated separately, with higher scores reflecting a stronger inclination toward the respective parenting style. Items were rated on a 5-point Likert scale ranging from 1 (never) to 5 (always). The original scale's Cronbach's alpha (α) were 0.83 for authoritative attitude, 0.76 for authoritarian attitude, 0.74 for the permissive attitude, and 0.75 for the overprotective attitude (Karabulut Demir & Şendil, 2008). In this study, the sub-dimensions of authoritative and authoritarian attitudes were examined. The Cronbach's alpha (α) values in this study were 0.86 for authoritative attitudes and 0.81 for authoritarian attitudes.

Data Collection and Analysis

Ethical Approval was obtained from the ***University Human Research Ethics Committee dated ***0.20***, numbered 20**/***. Following ethical approval, the researcher collaborated with school principals and teachers to invite parents to complete the scales via a Google Form, which included a "Voluntary Participation Form". The inclusion criterion had a child between the ages of 36–71 months. The first statement of the Google Form is about the voluntary participation of parents in the study. Participation was entirely voluntary, and no personal identifying information was collected. Participants were required to complete all scale items for their submissions to be accepted, ensuring no missing data during the analysis.

Data analysis was conducted using the IBM SPSS Statistics 27.0, semPower 2.1.1 of R version 4.4.1, and AMOS Graphics software. Initially, the normality of the data distribution was assessed. Subsequently, the assumptions for multivariate analyses were evaluated. To this end, descriptive statistics including mean, standard deviation, skewness, and kurtosis were calculated using SPSS. Following this,

the multiple linear relationships among the variables were analyzed. The Variance Inflation Factor (VIF) values were below 10 and the correlation values were under 0.90. There were no multiple linear relationships, according to these results (Kline, 2023). Descriptive statistics were employed to identify the demographic characteristics of the participants, while bivariate correlations were used to explore the relationships between variables. The semPower package was used to calculate the necessary sample size and assess statistical power. A post hoc power analysis showed that, with a sample size of $N=746$, a model with RMSEA$\geq$0.05 at an alpha level of 0.05 achieved 99.9% statistical power.

Structural equation modeling (SEM) was used to explore the mediating role of parental math beliefs in the relationship between parenting styles and parental math involvement. This hypothetical model was tested with maximum likelihood estimation using AMOS version 22.0. Direct and indirect effects within the mediation model were assessed using 95% bias-confidence intervals obtained through the bootstrap method with 5,000 resamples.

Various fit indices are used in SEM. In this study, the fit indices $\chi 2$/df, CFI, TLI, RMSEA, and S-RMR were used. According to Hu and Bentler (1999), a good model fit is indicated by RMSEA values below 0.06, S-RMR values below 0.08, and CFI and TLI values above 0.95. The effect sizes of the standardized path coefficients (β) in the structural equation model were evaluated based on Keith's (1993) classification, where coefficients between 0.05 and 0.10 were considered small, those between 0.11 and 0.25 medium, and those above 0.25 large.

Results

Preliminary Analyses

Descriptive statistics were conducted to calculate the means, standard deviations, skewness, and kurtosis values, which are presented in Table 2.

As shown in Table 2, the skewness values of the variables ranged from −0.81 to 0.75, while the kurtosis values ranged from −0.83 to 0.85. An examination of these values indicated that the variables showed a normal distribution (Kline, 2023). Table 3 provides the zero-order correlations among the indicator, the dependent, and the mediating variables.

Table 2 Descriptive statistics

Latent construct variables	M (SD)	Skewness	Kurtosis
Authoritative attitude	74.52 (7.10)	−0.81	0.85
Authoritarian attitude	19.58 (5.27)	0.75	0.69
Math beliefs	25.52 (3.68)	−0.12	−0.30
Math involvement	118.52 (33.53)	−0.06	−0.83

Table 3 Correlation matrix of variables

	Variables	1	2	3	4	5	6	7	8	9	10	11
1.	Children's gender	-										
2.	Children's age	−0.02	-									
3.	Parents' gender	0.02	−0.03	-								
4.	Parents' age	−0.03	0.10**	0.19**	-							
5.	Parents' educational levels	0.02	−0.26**	0.15**	0.17**	-						
6.	Parents' income status	0.04	−0.05	−0.05	−0.02	0.19**	-					
7.	Presence of a math storybook at home	0.02	0.07	−0.02	−0.10**	−0.29**	−0.10**	-				
8.	Authoritative attitude	0.00	−0.03	−0.02	−0.04	0.13**	0.05	−0.04	-			
9.	Authoritarian attitude	0.02	−0.02	0.00	−0.01	0.01	−0.05	0.09*	−0.36**	-		
10.	Math beliefs	0.04	−0.09*	0.06	0.03	0.26**	−0.00	−0.30**	0.23**	−0.05	-	
11.	Math involvement	−0.02	0.14**	−0.02	0.00	−0.04	−0.02	−0.16**	0.24**	−0.13**	0.24**	-

* $p<.05$; ** $p<.01$

As shown in Table 3, there was a weak positive correlation between parental math involvement and parental math beliefs (r=.24, p<.01). Additionally, a weak positive relationship was found between parental math involvement and authoritative parenting attitude (r=.24, p<.01), while a weak negative relationship was observed between parental math involvement and authoritarian parenting attitude (r=−.13, p<.01). Despite being statistically significant, the correlation was weakly positive, indicating that although parenting style and beliefs are associated with parental math involvement, other factors likely contribute as well. Table 3 also highlights significant relationships between certain demographic variables and latent variables.

Consequently, variables such as children's age, parents' educational levels, and the presence of a math storybook at home were controlled by adding pathways from these variables to both the predictors and outcomes in the model. To test the models, confirmatory factor analysis was conducted on the measurement variables.

Latent Mediation Models

Model Specifications

The mediating role of parental math beliefs in the relationship between parenting styles (authoritative and authoritarian) and parental math involvement was examined using the SEM. Separate mediation analyses were conducted for each parenting style category: authoritative and authoritarian. Three models were examined: the baseline models (Model 1: authoritative parenting style; Model 2: authoritarian parenting style) and the conditional model (Model 3: authoritative parenting style). In the baseline models, parental math beliefs were specified as a mediator between parenting styles (authoritative and authoritarian) and parental math involvement. For the conditional model, several important factors —children's age, parents' education levels, and the presence of a math storybook at home—were included to assess whether the mediational relationship persisted.

Before analyzing the parameter estimates, the goodness of fit for the baseline and conditional models was assessed to ensure data compatibility. The bootstrap method was employed to evaluate both the indirect and direct effects within the mediation models. The standardized direct, indirect, and total effects for all variables are presented in Table 5.

Goodness of Fit

The fit indices for the baseline and conditional models are shown in Table 4.

Table 4 Fit indices about models

Model	χ2/df	CFI	TLI	RMSEA	S-RMR
Model 1 (Baseline model)	2.185	0.95	0.95	0.040	0.037
Model 2 (Baseline model)	2.263	0.97	0.96	0.041	0.035
Model 3 (Conditional model)	2.172	0.95	0.94	0.040	0.039

Table 4 indicates that the models demonstrated a good fit according to the criteria suggested by Hu and Bentler (1999).

Parameter Estimates for the Baseline Model

The results for the mediating effect of parental math beliefs on the relationship between authoritative parenting style and parental math involvement are presented in Fig. 1.

Figure 1 shows that authoritative parenting style was positively associated with math beliefs (β=0.29, p<.001) and also positively predicted math involvement (β=0.20, p<.001). Additionally, math beliefs were positively associated with math involvement (β=0.24, p<.001). Controlling for math beliefs as a mediator, the authoritative parenting style remained a significant predictor of math involvement (β=0.07, p<.001), demonstrating partial mediation. The total effect of the authoritative parenting style on math involvement was 0.27 (see Table 5). When evaluating the total predictive effects of variables on math involvement and their effect sizes (Keith, 1993), it is seen that an authoritative parenting style (β=0.27, p<.001) exerted a large and statistically significant total effect on math involvement. Similarly, math beliefs (β=0.24, p<.001) demonstrated a moderate and statistically significant total effect on math involvement. According to MacKinnon (2008), the proportion of the effect mediated was calculated by dividing the indirect effect by the total effect. For math involvement, 25.93% of the total effect of the authoritative parenting style was mediated by math beliefs, with the remaining 74.07% reflecting a direct effect.

Then, the mediating role of math beliefs in the relationship between authoritarian parenting style and parental math involvement was examined. Figure 2 presents the baseline

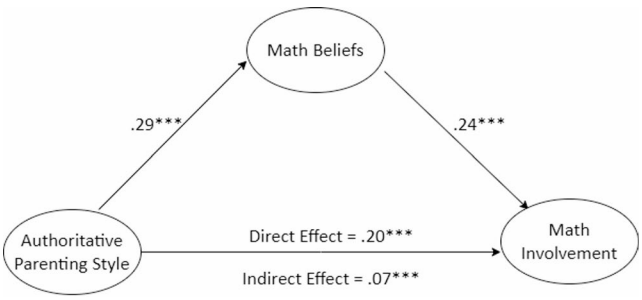

Fig. 1 Model 1 (Baseline model)- Mediation analysis between authoritative parenting style, parental math beliefs, and parental math involvement *** p<.001

Table 5 Direct, indirect, and total effects of all variables

Model	Predictor	Dependent Variable	Total effect	Direct effect	Indirect effect
1	Authoritative parenting style	Math involvement	0.27	0.20***	0.07
			0.29	0.29***	-
	Authoritative parenting style	Math beliefs	0.24	0.24***	-
	Math beliefs	Math involvement			
2	Authoritarian parenting style	Math involvement	−0.17	−0.15***	−0.02
			0.07	0.07	-
	Authoritarian parenting style	Math beliefs	0.29	0.29***	-
	Math beliefs	Math involvement			
3	Authoritative parenting style	Math involvement	0.27	0.22***	0.05
			0.23	0.23***	-
	Authoritative parenting style	Math beliefs	0.24	0.24***	-
	Math beliefs	Math involvement	0.10	0.11**	−0.01
	Children's age	Math involvement	−0.09	−0.14***	0.05
	Parents' educational levels	Math involvement	−0.17	−0.10*	−0.07
	Presence of a math storybook at home	Math involvement			

Note: Significance tests are provided for direct effects only. *p<.05; **p<.01; ***p<.001

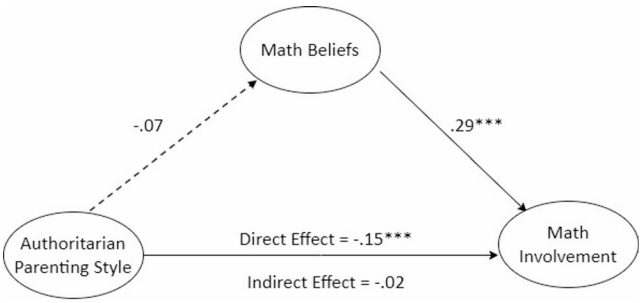

Fig. 2 Model 2 (Baseline model)- Mediation analysis between authoritarian parenting style, parental math beliefs, and parental math involvement *** p<.001

mediation model results for the mediating effect of parental math beliefs on this relationship.

Figure 2 shows that authoritarian parenting style negatively predicted math involvement (β = −0.15, p<.001), while math beliefs positively predicted it (β=0.29, p<.001). However, authoritarian parenting style was not significantly related to math beliefs (β = −0.07, p<.001), indicating that math beliefs do not mediate the relationship between authoritarian parenting style and math involvement. Although the direct effects of authoritarian parenting style and math beliefs on math involvement were statistically significant, the indirect effect was insignificant (β = −0.02), indicating no mediation.

Parameter Estimates for the Conditional Model

The conditional model accounted for key covariates—children's age, parents' education levels, and the presence of a math storybook at home—to provide a more rigorous evaluation of the mediating role of math beliefs. All possible correlations among the covariates and their associations with math beliefs were included. As shown in Fig. 3, children's age was positively associated with parental math involvement, while parents' education levels and the presence of a math storybook were negatively associated with parental math involvement.

Figure 3 shows that the authoritative parenting style was positively associated with math beliefs (β=0.23, p<.001) and math involvement (β=0.22, p<.001), while math beliefs were also positively associated with math involvement (β=0.24, p<.001). Controlling for covariates, math beliefs still partially mediated the relationship (β=0.05, p<.001). The total effect of authoritative parenting style on math involvement was 0.27 (see Table 5), with 18.52% of this effect mediated by math beliefs and the remaining

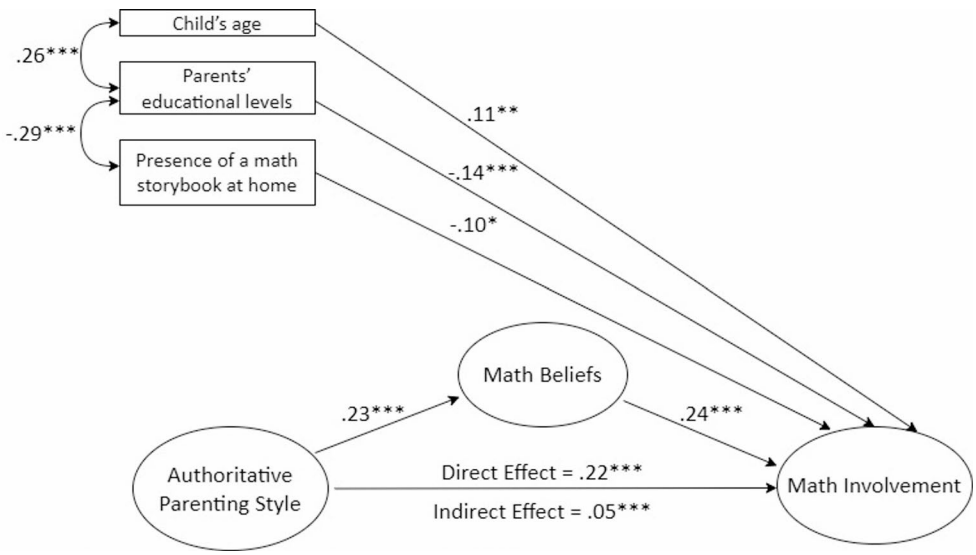

Fig. 3 Model 3 (Conditional model)- Examining the meditational role of parental math beliefs after controlling for children's age, parents' educational levels, and the presence of a math storybook at home. *** p<.001

81.48% being direct. According to Keith (1993), authoritative parenting style ($\beta = 0.27$, $p < .001$) had a large effect, and math beliefs ($\beta = 0.24$, $p < .001$) a moderate effect on math involvement.

Discussion

This study investigated whether parental math beliefs mediate the relationship between parenting styles and parental math involvement. It also explored whether this mediating effect remains significant after controlling for the children's age, parents' educational levels, and the presence of a math storybook at home.

According to the results of the correlation analysis, there were significant positive relationships between parental math involvement and authoritative parenting, and negative relationships with authoritarian parenting, as expected. The findings of this study align with previous research, which consistently demonstrates that authoritative parents exhibit high levels of family involvement (Karabulut & Şendil, 2018; Lin et al., 2023; Paquette et al., 2000; Yoleri & Taşdelen Karçkay, 2015). This finding could be explained by the fact that this parenting style fosters a supportive and interactive learning environment for children.

As predicted, the authoritative parenting style emerged as a significant predictor of parental math involvement in this study, consistent with empirical evidence highlighting its positive relationship (Pratt et al., 1992). This finding aligns with the notion that authoritative parenting fosters a "positive emotional context" conducive to parental math involvement (Berk, 2006, p. 567). The total effect of authoritative parenting on math involvement remained significant, even with the mediator, and influenced parental math beliefs. After considering child and parent characteristics, parental math beliefs significantly mediated this relationship, indicating that stronger math beliefs promote greater parental involvement in math activities. This underscores the importance of fostering positive math attitudes to support children's learning experiences.

Another noteworthy finding is that the authoritarian parenting style was found to have a negative effect on math involvement, with parental math beliefs not mediating this relationship. This indicates that authoritarian parents tend to engage less in math-related activities with their children, regardless of their math beliefs. Research has shown that authoritarian parents exhibit lower levels of involvement (Gaertner et al., 2007; Karabulut & Şendil, 2018; Lin et al., 2023; Paquette et al., 2000; Yoleri & Taşdelen Karçkay, 2015). These parents are often described as emotionally distant and less responsive to their children, and this study supports that view by showing they spend less active time with their children. This may stem from their tendency to enforce strict rules and expect children to work independently rather than collaborating to meet expectations. Consequently, it can be concluded that parental math beliefs do not influence the effect of authoritarian parenting on parental math involvement.

Moreover, consistent with previous research (Cannon & Ginsburg, 2008; Eason & Ramani, 2018; Keating et al., 2021; LeFevre et al., 2009; Missall et al., 2015; Muenks et al., 2015; Silver et al., 2020; Sonnenschein et al., 2012; Zippert et al., 2017), the results of this study show that there is a relation between parental math beliefs and parental math involvement. This can be explained by the role of beliefs as a motivator for behavior. Parents with strong, positive beliefs about the importance of math are more likely to engage in their children's math learning due to increased confidence and reduced anxiety in recognizing opportunities for math activities and teaching concepts. These positive beliefs often lead to enthusiastic behaviors, motivating parents to participate actively and spark their child's interest. They shape attitudes and actions, fostering a supportive approach to math engagement, such as helping with activities, providing resources, and encouraging math talks at home.

The study findings were consistent with prior research, showing that parental math beliefs significantly predict math involvement (Epstein, 2007; Douglas et al., 2021; Douglas & Rittle-Johnson, 2024; Vasilyeva et al., 2018). Parental math beliefs and their influence play a significant role in shaping children's math activities at home (Sonnenschein et al., 2012). The current findings suggest that preventive interventions targeting parental math beliefs —such as a 12-week text-based program providing parents with short, developmentally appropriate math activities (e.g., identifying shapes or using spatial language) —can increase parental math involvement (Holtzman et al., 2023). Take-home math bag interventions can increase family mathematics play interactions, shift parents' beliefs about their role in math play, and increase motivation for engaging in math activities with their children. The "Take-Home Math Bags" (MathPacks), developed as part of Project MathPack, were specifically designed. Each bag focused on a different mathematics domain—such as numeracy, geometry, measurement, algebra, or data analysis. It included a related storybook, hands-on materials (e.g., rhythm sticks, measuring cups, pattern blocks), and a task guide to encourage meaningful parent–child interaction. The activities were designed to build essential early math skills such as counting, sorting, recognizing patterns, and making predictions (Linder & Emerson, 2019). Providing low-income families with analog materials or math apps, combined with text reminders, enhances parent-child math engagement and preschoolers' math skills (Mayer et al., 2023). These findings emphasize

the importance of fostering positive math beliefs in parents to enhance their involvement and improve early childhood mathematics education. They also highlight the potential of interventions targeting parents' math beliefs to support children's mathematical development.

An important finding of this study was the significant positive relationship between children's age and parental math involvement. This suggests that as children grow older and encounter more advanced math concepts, parents tend to offer more support and take a more active role in their mathematical development. Older children often engage in activities that necessitate parental help, and schools can contribute by encouraging parents to support academic skills at home.In this study, the negative relationship between parents' education, and parental math involvement is a striking finding that contradicts previous literature. There are several possible explanations for this. Higher-educated parents may be more inclined to delegate math activities to schools, which may reduce the frequency of providing one-on-one support at home. In addition, highly educated parents may not be able to spend enough time on one-on-one interactive mathematical activities with their children due to their busy work schedule. This explanation is supported by Yeung et al.'s (2001) finding, which showed a negative relationship between fathers' working hours and the time spent with their children on weekdays. However, this finding contrasts with previous studies that reported a positive relationship between parental education levels and their involvement in home activities during early childhood (Douglas & Rittle-Johnson, 2024; Epstein, 2007; Kong & Yasmin, 2022). This discrepancy suggests that the relationship between parental education and involvement may be more context-dependent than previously assumed.

A math storybook was defined as a picture book or narrative-based children's book that explicitly incorporates mathematical content such as counting, shapes, patterns, measurements, or basic arithmetic concepts within the storyline. Whether families had one or more math storybooks in their homes was determined based on parental reports. Additionally, the study did not include questions about whether parents actually read these books with their children. This study also found that the presence of math storybooks was significantly negatively associated with parental math involvement, which is a striking finding. There are several possible explanations for this finding. Some parents may feel inadequate to provide direct mathematics activities for their children and instead prefer math storybooks as a passive means of support. In this case, the books may be physically present in the home but not being used effectively. In addition, some parents may perceive the mere presence of math storybooks as sufficient for supporting their child's mathematical development and may view these books as an alternative to interactive math activities, which may lead to less active involvement. Moreover, while math storybooks can be useful for encouraging children's independent exploration, they can inadvertently lead to a reduction in parental involvement in the learning process.

The findings of this study broadly support and expand upon existing research, providing new insights into how parenting styles influence early childhood development, particularly in the less explored area of math skills development. By applying a mediation model, this study offers a methodological contribution to exploring the mechanisms underlying the relationship between parenting styles and parental math involvement. However, some limitations of the study are discussed further below.

Limitations and Future Directions

This study presents both notable strengths and certain limitations. One of the main strengths of this study is its substantial contribution to understanding the relationship between parenting styles and parental math involvement. According to available evidence, it is the first study to explore the mediating role of parental math beliefs using SEM. The analyses employed a rigorous methodology, advancing existing research on this topic. The SEM was employed to account for measurement error, using Full Maximum Likelihood estimation to include all available data from the current sample.

The second strength of the current study was the inclusion of a large and diverse parent sample, representing a range of parents' age, income levels, education levels, and children's age, which enhances the generalizability of the findings. The reliability of the measurement scales used in the study can be considered as another strength. Finally, data in this study was collected online. While online data collection is often considered a disadvantage, it provides several benefits, such as the ability to quickly reach a large number of participants at a lower cost. Additionally, it allows participants to engage at their convenience and in a comfortable setting, which can enhance sample diversity and improve the generalizability of the findings.

Although this study makes significant contributions, it is essential to exercise caution when interpreting its conclusions. First, the present study primarily focused on direct assessments of parental math involvement, relying on standardized tests that were directly administered. While standardized measures offer certain advantages, they also present limitations in capturing the full scope of parental involvement. To address this, future studies could incorporate researcher observations of activities within the home environment or other settings where parents interact with

their children. Such an approach would provide a more comprehensive understanding of parental involvement in mathematics. In addition, the cross-sectional design of the data restricted our ability to analyze changes in the variables and their interrelationships over time. Since the data used in this study were collected cross-sectionally, the relationships among variables cannot be interpreted as causal. This limitation requires caution when interpreting the findings and formulating recommendations.Therefore, future research should employ longitudinal studies to investigate these changes and relationships across different time points, contributing to a deeper understanding of dynamic relationships. Moreover, an intervention program designed to improve parental math beliefs and parenting styles could clarify this causal process by assessing the impact of participation on these constructs, leading to more definitive conclusions about their relationships. One limitation of this study is that it did not examine children's mathematical skills. Future research could incorporate these skills into the model alongside other variables to assess their impact. Additionally, early intervention programs could be developed to enhance children's mathematical skills. Another limitation in the study, it was determined based on parental reports whether families had one or more math storybooks at home. The survey did not include items questioning whether parents actively read these books with their children. Rather, the focus was on the availability of math storybooks in the home. This is acknowledged as a limitation, and future research may consider not only the presence of such materials but also the quality and frequency of parent-child engagement involving them.

Conclusions

This study offers a valuable contribution to both the practice and theory of early math education by examining the mediating role of parental math beliefs. Understanding the factors and mechanisms underlying parental math involvement is crucial, with the findings emphasizing the importance of authoritative parenting and parental math beliefs as key contributors to this process. Notably, this study is the first to examine how parental math beliefs mediate the link between parenting styles and math involvement. The findings highlight that parental math beliefs significantly influence the link between authoritative parenting and math involvement, even when controlling for variables such as children's age, parental education levels, and the presence of a math storybook at home.

These findings may serve as important targets for preventive interventions aimed at boosting parental math involvement, ultimately supporting children's math development in the early school years. From a practical perspective, these findings suggest that family interventions promoting parental math involvement could be highly beneficial. Programs should foster authoritative parenting by encouraging emotional warmth in math-related interactions, and responsiveness. This approach not only promotes a positive emotional climate but also enhances children's involvement and persistence in mathematical activities with parents. Consequently, practitioners should focus on helping parents adopt more authoritative parenting styles to facilitate greater involvement in early learning and development.

Increased parental math involvement has been consistently linked to a range of positive developmental and educational outcomes for children. Research shows that enhancing parental math involvement improves children's early math skills and school readiness. Therefore, interventions aimed at enhancing parental math involvement have the potential to improve children's long-term academic trajectories. These implications align with global educational priorities, including Sustainable Development Goal 4 (Quality Education), by emphasizing the crucial role of families in providing equitable and effective early math learning opportunities that lay the groundwork for lifelong learning and academic success. This emphasis reinforces the global relevance of the study and its potential contribution to early childhood education policy and practice. The findings of this study carry distinct implications for various stakeholders. For educators, understanding that parenting styles shape parental math involvement through parental math beliefs can inform more effective and meaningful communication with families. Teachers and school counselors can develop strategies to increase family involvement by taking into account parenting approaches and emphasizing the importance of positive mathematics beliefs in the home. For researchers, this study provides a theoretical model suitable for examining the relationships between parenting styles, beliefs and involvement in different cultural or longitudinal contexts. It also creates new opportunities for research into the potential mediating or moderating functions of educational systems within these relationships. For policymakers, these findings can guide the design of broadly applicable parent involvement programs and the review of existing education policies. In particular, policymakers may be interested in the scalability of such program designs, as the data also provide insights into the sustainability and broader applicability of structures that promote parental involvement.

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Declarations

Ethical Approval The data collection process for this study was carried out with the highest regard for ethical principles. Ethical approval was

obtained from the Sinop University Human Research Ethics Committee (Approval No: 2024/9, dated January 30, 2024).

Informed Consent Written informed consent was obtained from all participants prior to data collection.

Competing interests The author confirms that there is no conflict of interest.

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