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Multilevel predictors of middle school mathematics anxiety: Roles of students, teachers, and parents

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ABSTRACT This study investigates how student and teacher characteristics predict students' mathematics anxiety using a predictive correlational design and multilevel analysis through Hierarchical Linear Modeling (HLM). The sample consisted of 413 middle school students, their mathematics teachers (n=12) and the parents of these students (n = 413). Mathematics anxiety was measured using validated anxiety scales administered to students, their mathematics teachers, and parents. The results of the HLM analysis indicated that 94% of the variance in mathematics anxiety was at the student level. At the student level, higher parental mathematics anxiety, fewer social opportunities, and lower self-efficacy were significant predictors of higher student mathematics anxiety. At the teacher level, higher teacher mathematics anxiety, male gender and marital status were associated with increased student mathematics anxiety. These findings highlight the multi-layered nature of mathematics anxiety and emphasize the need for interventions addressing both student and teacher influences.

Keywords: *Hierarchical linear modeling, Middle school students, Parental mathematics anxiety, Teacher mathematics anxiety*

Ortaokul öğrencilerinde matematik kaygısının çok düzeyli yordayıcıları: Öğrenci, öğretmen ve ebeveyn rolleri

ÖZ Bu çalışmada, öğrenci ve öğretmen özelliklerinin öğrencilerin matematik kaygısını nasıl etkilediğini belirlemek amaçlanmıştır. Araştırmada ilişkisel desen kullanılmış ve çok düzeyli analiz için hiyerarşik doğrusal modelleme (HLM) yöntemi uygulanmıştır. Çalışma örneklemi, 12 matematik öğretmeni ve 413 ortaokul öğrencisi ve bu öğrencilerin ebeveynlerinden (413) oluşmaktadır. Matematik kaygısı, öğrencilere, matematik öğretmenlerine ve ebeveynlere uygulanan geçerli kaygı ölçekleri aracılığıyla ölçülmüştür. HLM analizi sonuçları, matematik kaygısındaki toplam varyansın %94'ünün öğrenci düzeyinde olduğunu göstermiştir. Öğrenci düzeyinde, yüksek ebeveyn matematik kaygısı, daha az sosyal fırsat ve düşük matematik öz-yeterliği, öğrencilerin daha yüksek matematik kaygısı yaşamasıyla anlamlı şekilde ilişkilendirilmiştir. Öğretmen düzeyinde ise yüksek öğretmen matematik kaygısı, erkek cinsiyet ve bekar olma durumu, öğrencilerin matematik kaygısını artıran faktörler olarak belirlenmiştir. Bu bulgular, matematik kaygısının çok katmanlı doğasını vurgulamakta ve öğrenci ile öğretmen etkilerini dikkate alan müdahalelerin gerekliliğini ortaya koymaktadır.

Anahtar Sözcükler: *Ebeveyn matematik kaygısı, Hiyerarşik lineer model, Ortaokul öğrencileri, Öğretmen matematik kaygısı*

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INTRODUCTION

From the moment an individual is conceived, they are exposed to various stimuli. While some of these stimuli are ignored, others are absorbed to support cognitive, emotional, and physical development. Responses to stimuli can be formed either through direct exposure or through experiences acquired indirectly. The process of receiving stimuli, cognitively processing them, emotionally interpreting them, and physically reacting to them constitutes the fundamental mechanism of experience and learning. Learning is a lifelong process, as individuals continuously influence and are influenced by their surroundings. This dynamic can have both positive and negative consequences.

This study focuses on anxiety as one of the key stimuli individuals are exposed to, discussing its causes and consequences. Anxiety triggers cognitive, emotional, and physical changes in an individual, often leading to performance deterioration, fear, and distress. While anxiety, fear, and concern are sometimes used interchangeably, they represent distinct constructs. Concern is a cognitive process arising from the interaction between performance and anxiety (Taş, 2009), whereas fear is an emotional response to a perceived threat. Anxiety, on the other hand, is related to the anticipation of a potential threat rather than an actual one (American Psyhiatric Association-APA, 2013). Anxiety that emerges through direct or indirect experiences during childhood can persist throughout an individual's educational journey, influencing academic performance, career choices, and even broader life experiences.

Among childhood anxieties that deeply impact educational processes, mathematics anxiety stands out as particularly influential. First, observed by mathematics teachers in the 1950s through individual classroom observations, mathematics anxiety did not attract significant attention from educational researchers until the 1970s. The earliest definition was proposed by Dreger and Aiken (1957), who described it as an emotional syndrome related to arithmetic and mathematics. In 1984, Mitchell conceptualized mathematics anxiety as a process driven by fears of failure, appearing unintelligent, inability to achieve goals, and social rejection. These fears, when reinforced over time, contribute to heightened mathematics anxiety (Truttschell, 1992). Mathematics anxiety threatens self-esteem and manifests as a reaction to any situation involving mathematics (Cemen, 1987).

Given that mathematics is integrated into various disciplines and plays a crucial role in daily life, the issue of mathematics anxiety has become increasingly prominent. Mathematics anxiety typically emerges when students first encounter mathematical concepts. Apart from formal schooling, parents—who serve as children's first teachers—play a significant role in the development of mathematics anxiety. Parental expectations, attitudes, interests, and beliefs contribute to the formation of mathematics anxiety in children (Kung & Lee, 2016). Recent findings have further confirmed this association. Bellon et al. (2022), for instance, demonstrated that parental mathematics anxiety is significantly related to young children's arithmetical performance, even after accounting for socio-economic status and parental education levels Morsanyi et al. (2025) found that higher levels of parental math anxiety were significantly associated with lower numeracy skills in children.

Parents are considered the primary agents responsible for establishing the social and economic foundations of children's learning and development (Zhong, 2011). Additionally, active parental involvement in children's education fosters academic achievement, positive behavior, and emotional development (Henderson, 1987; Stevenson & Lee, 1990). Parents' personal experiences with mathematics and education shape their children's attitudes toward school and their relationships with teachers (Kellaghan et al.1993). Consequently, parents significantly influence their children's academic performance and attitudes toward school and teachers (Soni & Kumari, 2017).

Teachers also play a fundamental role in shaping students' attitudes toward mathematics. It is well-established that students often adopt their teachers as role models, internalizing their attitudes and behaviors. A teacher with a negative attitude toward mathematics can inadvertently transmit their anxiety to students, leading to negative learning experiences (Delice et al. , 2009; Gürbüz & Yıldırım, 2016). Moreover, mathematics anxiety among teachers has been identified as a critical factor contributing to mathematics anxiety in students (Alkan, 2010; Baloğlu, 2001; Peker & Ertekin, 2011). Research indicates that mathematics anxiety, which often begins in early elementary education, is transmitted to students by their teachers (Bekdemir et al.; Harper & Daane, 1998; Lazarus, 1974; Vinson, 2001).

Although introduced at the elementary level, mathematics is not merely an abstract system of numbers and calculations; rather, it is an essential discipline with significant implications for everyday life and technological advancements. Understanding mathematics is crucial for comprehending the modern world. However, compared to other disciplines, mathematics is particularly associated with high levels of anxiety. Mathematics anxiety is defined as a negative cognitive, affective, and physical response toward mathematical tasks. This multidimensional conceptualization is widely accepted in the literature (Nolting, 2010; Tobias, 1990) and similarly echoed in Turkish studies (Bindak, 2005). Recent evidence highlights the value of adaptive cognitive emotion regulation strategies, such as positive reappraisal, in mitigating math anxiety. For instance, Megreya and Al-Emadi (2024) found that students who used such strategies reported significantly lower anxiety levels in both math and science domains. Their findings underscore the potential of emotion-focused interventions in educational contexts. Direct and indirect experiences play a crucial role in the development of mathematics anxiety, with parental mathematics anxiety and teacher mathematics anxiety being the most influential factors.

The literature review in this study reveals that previous research has primarily examined isolated relationships, such as the predictive power of teacher mathematics anxiety on student mathematics anxiety, parental mathematics anxiety on student mathematics achievement, and student mathematics anxiety on academic performance. However, social sciences involve hierarchical and interconnected structures, meaning that a student's mathematics anxiety and performance are influenced not only by individual factors but also by their classroom, school environment, teachers, and parents. A comprehensive investigation of how student and teacher characteristics predict student mathematics anxiety using hierarchical linear modeling (HLM) can offer a significant contribution to the literature.

Beyond individual student characteristics, previous studies have examined a variety of contextual factors influencing students' mathematics anxiety. For example, school-level resources and regional educational conditions were investigated by Acar and Öğretmen (2012) in the context of PISA performance. Similarly, Akyüz (2006) and Çelebi (2010) analyzed the influence of teacher and classroom-level characteristics, including instructional quality and teacher support. Dinçer and Kolaşin (2009) highlighted socioeconomic disparities across schools as predictors of student achievement and anxiety. Tedorović (2011), on the other hand, focused on school effectiveness indicators such as leadership, climate, and academic support systems.

Students attending the same school, learning under the same teachers, and coming from similar socioeconomic backgrounds often share common characteristics. Thus, analyzing such students as if they were independent from one another may lead to Type I errors in statistical analyses. To ensure a more objective, comprehensive, and detailed examination, the use of Hierarchical Linear Modeling (HLM) is recommended (Hox, 2002; O'Connell & McCoach, 2008; Raudenbush & Bryk, 2002; Snijders & Bosker, 1999). Studies employing HLM provide significant advantages in demonstrating relationships between variables at different levels, addressing dependency issues within nested data, and calculating random coefficients across hierarchical levels (Draper, 1995; Ma, 2001).

Considering the above, this study fills a gap by investigating both student and teacher predictors of mathematics anxiety within a single model. We focus on middle school students, a critical period when math anxiety often solidifies. The research question was: Which student-level and teacher-level variables significantly predict students' mathematics anxiety? We hypothesized that student-level factors such as self-efficacy and parental math anxiety, and teacher-level factors such as teacher math anxiety, would be significant predictors. By using HLM on data from students and their teachers, we aim to provide a more complete picture of the contributors to math anxiety. Understanding these multilevel influences can inform more effective interventions – for example, addressing not only students' skills and beliefs but also the learning environment shaped by teachers and parents.

Recent evidence underscores the impact of parental anxiety on students' mathematical engagement and emotional outcomes. Zhou et al. (2025) found that parental anxiety significantly predicts children's math engagement through the mediating role of math anxiety and the moderating role of parental involvement. This highlights the emotional transmission mechanisms within family contexts and strengthens the rationale for including parental factors in multilevel models of mathematics anxiety. The purpose of this study is to examine the multilevel predictors of middle school students' mathematics anxiety by simultaneously considering student-, parent-, and teacher-level variables using hierarchical linear modeling (HLM).

METHODOLOGY

Research Design and Sample

This study employed a predictive correlational design using Hierarchical Linear Modeling (HLM). Although the literature presents various perspectives on sample size determination, a minimum sample size of 384 is recommended for correlational studies when a 95% confidence interval and a 5% margin of error are assumed (Taherdoost, 2017). Accordingly, the sample comprised 413 middle school students, their mathematics teachers (n = 12), and one parent for each student (n = 413).

The student participants consisted of 413 students (52% female, 48% male) enrolled in Grades 5 through 8, with ages ranging from 11 to 14 years. The teacher sample included 12 mathematics teachers, of whom 7 (58.3%) were female, and 5 (41.7%) were male. Teachers' highest educational qualifications ranged from a bachelor's degree (n = 7) to a master's degree or higher (n = 5). In addition, one parent (either mother or father) of each student participated in the study; among the 413 parents, 303 (73%) were female, and 110 (27%) were male. With respect to educational background, the majority of parents had completed at least a high school education.

Although there is no clear consensus in the literature regarding the optimal sample size for HLM, methodological studies suggest that when full maximum likelihood estimation is used, a minimum of 48 groups is required at the second level. In contrast, under the restricted maximum likelihood estimation technique, a group size ranging from 6 to 12 is considered sufficient (Browne & Draper, 2000). In the present study, each mathematics teacher's class (or classes) constituted a cluster of student data, resulting in a two-level hierarchical structure with students nested within teachers. Prior to data collection, all necessary permissions were obtained, and participation was voluntary. Informed consent was secured from all participants.

Ethical approval was obtained from the Ethics Committee of Gaziantep University, dated 05/07/2022, approval number E-87841438-604.01.01-211153. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee.

Measures and Data Collection

Student Measures

Data on student-level variables were collected using a Student Demographic Information Form and standardized self-report scales. Students' mathematics anxiety was assessed using the Mathematics Anxiety Scale for Children, originally developed by Ikegulu (1998) and adapted into Turkish by

Özdemir and Gür (2011). The scale consists of 20 Likert-type items assessing feelings of tension and worry in mathematics-related situations. Students responded on a 5-point scale ranging from 1 (never) to 5 (always), with higher scores indicating greater mathematics anxiety. Students' mathematics self-efficacy was measured using an eight-item scale assessing confidence in learning and performing mathematics-related tasks. An example item is "*I am confident that I can solve difficult mathematics problems.*" Responses were recorded on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores reflecting greater perceived self-efficacy. In addition, students reported on their perceived social learning opportunities related to mathematics, including access to academic support and satisfaction with their learning environment. An index of social opportunities was created from items such as "*I have people who can help me when I struggle with mathematics*." Higher scores indicate greater perceived social and instructional support. This variable was used as a proxy for students' social and learning support context. This scale was selected due to its strong psychometric properties, prior validation in Turkish middle school samples, and its conceptual alignment with the multidimensional nature of mathematics anxiety.

Parental Measures

Parental mathematics anxiety was assessed using the Parental Mathematics Anxiety Scale developed by Mutlu, Sarı, and Çam (2018). One parent per student (typically the primary caregiver) completed the 16-item scale, which measures parental mathematics anxiety across three dimensions: observable anxiety, task-related anxiety, and negative attitudes toward mathematics. Parents rated statements such as "*I feel uneasy when I have to deal with mathematics*" on a 5-point Likert scale. Mean scores were calculated for each parent, with higher scores indicating greater levels of parental mathematics anxiety. This variable was treated as a student-level predictor, as each student was associated with one parental respondent.

Teacher Measures

Teachers' mathematics anxiety was measured using the Mathematics Anxiety Scale for Teachers developed by Yıldırım and Gürbüz (2017). This 33-item instrument assesses anxiety related to teaching mathematics and engaging in mathematics-related instructional practices. Teachers rated the extent to which they experienced anxiety in situations such as introducing new mathematical topics or being observed while teaching mathematics. Mean scores were computed for each teacher, with higher scores indicating higher levels of mathematics anxiety. Additional teacher characteristics were collected using a background information form. Teacher gender (0 = female, 1 = male), marital status (0 = single, 1 = married), and highest level of education (0 = bachelor's degree, 1 = master's degree, 2 = doctorate) were included as level-2 predictors in the hierarchical linear modeling analyses.

Reliability of the Measures

Internal consistency reliability of all instruments was examined using Cronbach's alpha coefficients based on the current study sample. As presented in Table X, the reliability coefficients ranged from .69 to .92 across the scales and subscales, indicating acceptable to excellent internal consistency. The Student Mathematics Anxiety Scale demonstrated high internal consistency (α = .91), with its subdimensions showing satisfactory reliability (αs = .83–.88). The Teacher Mathematics Anxiety Scale also yielded high reliability in the present sample (α = .90), with subscale coefficients ranging from acceptable to high levels (αs = .69–.84). The Parental Mathematics Anxiety Scale exhibited excellent internal consistency (α = .91), with subscale reliabilities ranging between .77 and .92. Overall, these results indicate that the instruments used in this study produced reliable scores suitable for subsequent hierarchical linear modeling analyses. Although the scales include theoretically meaningful sub-dimensions, total scale scores were used in the HLM analyses to ensure model parsimony and to avoid over-parameterization at both levels. This approach is consistent with multilevel modeling practices where composite scores are preferred when the primary interest lies in overall construct effects rather than subscale-level differentiation.

Students completed their questionnaire (anonymously coded) in the presence of the researcher and teacher. Parents received the parent anxiety scale as a take-home form to fill out and return in sealed envelopes. Teachers completed their anxiety scale on paper separately. Thus, we obtained a matched dataset of student anxiety, student attributes (self-efficacy, etc.), parent anxiety, and teacher data. The variables for each level are summarized in Table 1.

Table 1.
First and Second Level Variables

First Level (Student)	Second Level (Teacher)
Student Gender (STUGENDER)	Teacher Anxiety (TCANX)
Student Math Anxiety (STUMANX)	Teacher Gender (TCGENDER)
Student Math Achievement (STUACHIEVE)	Professional Seniority (TCPROF)
Student Math Self-Efficacy Perception (STUSEF)	Teacher Marital Status (TCMS)
Student Ownership of Study Room (STUROOM)	Teacher Age (TCAGE)
Student Class Satisfaction (STUCSAT)	Teacher Education Level (TCED)
Student School Satisfaction (STUSSAT)	
Time Allocated to Math (STUTIME)	
Parent Gender (PAGENDER)	
Parent Anxiety (PAANX)	
Parent Education Level (PAED)	

Table 1 presents the variables included in HLM analysis at both the first (student) and second (teacher) levels. At the first level, variables related to students' characteristics and experiences are listed, while at the second level, variables related to teachers' characteristics are provided. These variables were examined within the HLM framework to explore their relationships with student mathematics anxiety, aiming to provide insights into the factors influencing students' anxiety levels in mathematics.

Data Analysis

Prior to modeling, data were screened and prepared. All variables were examined for outliers and missing values. A few student questionnaires with substantial missing responses (<5% of the sample) were removed. Missing data on item responses were minimal; any missing item on a scale was imputed with that student's mean for that scale. No univariate outlier (beyond 3 SD) was detected for the achievement scores or scale totals. The distributions of math anxiety scores were approximately normal, with a slight right skew for student anxiety (many students reported low anxiety). We used hierarchical linear modeling (HLM) to analyze the data, given the nested structure (students within teachers). HLM is a statistical technique that accounts for the nested structure of data, such as students nested within classrooms (Raudenbush & Bryk, 2002). HLM allows for simultaneous estimation of student-level and teacher-level effects on student outcomes while accounting for the non-independence of students in the same class. We specified a two-level model with students at Level 1 and teachers at Level 2. The outcome variable was the student's math anxiety score. Analyses were conducted with SPSS 26.0, Microsoft Excel 2016, and HLM 8.2 (supported by the Scientific Research Project-BAP) software.

Hierarchical Linear Modeling

HLM is a statistical method used to understand variations at different levels, considering both fixed and random variables. The analysis started with the "One-Way Analysis of Variance Random Effects Model" (null model), which excludes first and second-level variables to determine how much of the variance in students' mathematics anxiety scores is attributed to student and teacher-related variables. Subsequent models included student variables ("Random Coefficients Regression Model"), teacher variables ("Means as Dependent Model"), and both student and teacher variables ("Model with Intersection and Slope Coefficients as Dependent Variables").

One-Way Analysis of Variance Random Effects Model. This null model assesses the variance in students' mathematics anxiety scores without including explanatory variables. The model's purpose is to determine the variance attributable to student and teacher-related factors.

Level-1 (Student Level) Model: $Y_{ij} = \beta_{0j} + r_{ij}$

Y_{ij}: Mathematics anxiety and achievement level of student *i* taught by teacher *j*
β_{0j}: Average mathematics anxiety and achievement scores of students taught by teacher *j*
r_{ij}: Error term for student *i* taught by teacher *j*

Level-2 (Teacher Level) Model: $\beta_{0j} = \gamma_{00} + u_{0j}$

β_{0j}: The average mathematics anxiety and achievement level of students taught by teacher *j*
γ_{00}: The overall average mathematics anxiety across all teachers
u_{0j}: The error term associated with teacher *j*

Random Coefficients Regression Model. This model includes one or more student-level variables to explain differences in mathematics anxiety levels. The intercept and slope of the level-1 variables vary randomly.

Level-1 Model: $Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + r_{ij}$

Y_{ij}: Mathematics anxiety and achievement level of student *i* taught by teacher *j*
β_{0j}: Average mathematics anxiety and achievement scores of students taught by teacher *j*
β_{1j}: The change in mathematics anxiety and achievement corresponding to a one-unit change in the explanatory variable associated with teacher *j*
X_{ij}: The value of the explanatory variable for student *i* taught by teacher *j*
r_{ij}: Error term for student *i* taught by teacher *j*

Level-2 Model: $\beta_{0j} = \gamma_{00} + u_{0j}$ $\beta_{1j} = \gamma_{10} + u_{1j}$

γ_{00}:The overall average mathematics anxiety across all teachers
γ_{10}:The average regression slope for teacher-level variables
u_{0j}:The unique effect of teacher *j* on the Level-1 intercept
u_{1j}: The unique effect of teacher *j* on the Level-1 slope

Means as Dependent Model. This model includes one or more teacher-level variables to predict the mean mathematics anxiety score for each teacher.

Level-1 Model: $Y_{ij} = \beta_{0j} + r_{ij}$

Level-2 Model: $\beta_{0j} = \gamma_{00} + \gamma_{01}W_j + u_{0j}$

Model with Intersection and Slope Coefficients as Dependent Variables. This final model includes both student and teacher variables to explain the influence of these variables on students' mathematics anxiety.

Unified Model: $Y_{ij} = \gamma_{00} + \gamma_{01}W_j + \gamma_{10}X_{ij} + \gamma_{11}W_jX_{ij} + u_{1j}X_{ij} + u_{0j} + r_{ij}$

Descriptive Statistics

Descriptive statistics for the first level and second-level variables are presented in Table 2.

Table 2 presents the descriptive statistics, indicating that student anxiety (STUMANX) and parental anxiety (PAANX) vary within a continuous range, while teacher anxiety (TCANX) is examined at the second level, alongside demographic and professional characteristics, with outliers identified based on standardized residuals exceeding ±2 (George & Mallery, 2010).

Table 2.
Descriptive Statistics of the Variables in the First and Second Level

Variable	n	Mean	SD	Min	Max
STUMANX	413	2.37	0.78	1.00	4.79
PAANX	413	2.63	0.91	1.00	4.81
TCANX	12	2.03	0.62	1.21	3.21

*n: Number of participants, SD: Standard deviation, Min: Minimum, Max: Maximum

Detailed information regarding the Bivariate Outlier Detection is available in Appendix 1, while the Confirmatory Factor Analysis (CFA) results are reported in Appendix 2, to avoid interrupting the flow of the main text.

FINDINGS

This section presents the findings of the HLM analysis conducted on the clustered data, in alignment with the research inquiries, utilizing the validated and reliable scales discussed earlier.

Model-1: One-Way Analysis of Variance Random Effects Model

The one-way analysis of the variance random effects model excluded variables from both level 1 and level 2. Table 3 illustrates the one-way analysis of the variance random effects model, commencing with mathematics anxiety scores, the Level 1 outcome variables.

Table 3.
Estimation of Fixed Effects for One-Way Analysis of Variance Random Effects Model

Fixed Effect	Coef.	SE	*t*	Df	*p*-value
Overall Average Math Anxiety, γ_{00}	2.356	0.069	34.236	11	<0.001

* Coeff: Coefficient, SE: Standard error, df: degree of freedom

As depicted in Table 3 the mean value of the general math anxiety score was computed to be 2.36, with a standard error of 0.07, signifying statistical significance ($p < .0001$). A 95% confidence interval for the mean general math anxiety score was calculated as (2.22, 2.50), using the estimated fixed effect and its standard error obtained from the one-way random effects model. This interval suggests that the true population lies within this range with 95% confidence.

Table 4 illustrates the variance components of the one-way analysis of variance random effects model, which initiated with the mathematics achievement and mathematics anxiety scores, serving as the level 1 outcome variables.

Table 4.
Estimation of Variance Components of One-Way Analysis of Variance Random Effects Model

Random Effect	SD	Var.Com.	*df*	χ^2	*p*-value
Math Anxiety					
Level 2 error term, u_0	0.190	0.036	11	31.733	<0.001
Level 1 error term, r	0.766	0.587			

* SD: Standard Deviation, Var. Com: Variance Components, df: Degree of Freedom, $\chi2$:Ki kare

The within-group variance value of the mathematics anxiety scores among students was approximately 0.59, while the between-group variance value was estimated at 0.04. These estimations, detailed in Table 7, indicate significant variability both within and between groups. Through the estimation of the variance components in the one-way analysis of variance random effects model, a statistically significant difference was observed in students' mathematics anxiety scores across different teachers ($\chi 2= 31.73$, s.d. = 11, $p < .001$). Hence, it can be concluded that mean math anxiety scores vary among students depending on their respective teachers. Furthermore, the ample variability present in the dataset underscores the necessity for multilevel analysis. To comprehensively understand the components contributing to the total variance in students' mathematics anxiety, the correlation coefficient "ρ" value between student and teacher levels was examined.

The analysis of variance components for mathematics anxiety reveals insightful proportions. Between-class variance, represented by the correlation coefficient ρ, is calculated as 0.06, signifying that 6% of the total variance is attributable to differences between teachers. Conversely, within-class variance, ρ, is estimated at 0.94, indicating that 94% of the total variance stems from variations among students within the same class.

Mathematics Anxiety

(between classes) = τ_{00} / (τ_{00} + σ^2) = 0.04 / (0.04+0.59) =0.06

(within class) = σ^2 / (σ^2 + τ_{00}) = 0.59/ (0.59+0.04)=0.94

For math anxiety, 94% of the total variance was due to within-class (between students) differences and 6% was due to between-class (between teachers) differences.

Hierarchical Linear Modelling (HLM) is particularly adept at making precise predictions even with irregularly distributed data across groups. In this study, the number of students per teacher ranged from 11 to 87. The intragroup reliability coefficient of teachers, calculated using the reliability interval, reflects the robustness of their impact on mathematics anxiety. For instance, for a teacher with the fewest students (11), the reliability coefficient is determined as 0.44, while for the teacher with the highest number of students (87), it stands at 0.80. This variance indicates a considerable range in teacher reliability, spanning from 0.80 to 0.96 for mathematics anxiety. Additionally, the overall reliability coefficient for teachers is calculated at 0.89, suggesting a high level of reliability across the sample.

Model-2: Results for the Random Coefficients Model

At this stage, a one-way analysis of variance random effects model was compared with the current model and it was concluded that the variables of mean parental anxiety, student gender, parent education level and student's perception of self-efficacy in mathematics were randomly distributed. The estimation of the fixed effects of the random coefficients regression model with this model is as shown in Table 5.

Table 5.
Estimation of Fixed Effects for the Random Coefficients Regression Model

Fixed Effect	Coef.	SE	*t*	df	*p*-value
Overall Average Math. Anxiety, γ_{00}	2.659	0.097	27.342	11	<0.001
Average Parental Anxiety Effect, γ_{10}	0.375	0.041	9.251	398	<0.001
Average Student Social Facilities Impact, γ_{20}	-0.156	0.074	-2.103	398	0.036
Average Student Efficacy Perception Effect, γ_{30}	-0.466	0.074	-6.335	398	<0.001

* Coeff: Coefficient, SE: Standard error, df: Degree of freedom

According to the random coefficients regression model of the intercept coefficient of the first level over all teachers, the mean value of mathematics anxiety was found to be 2.66. The variance component estimation of the random coefficient’s regression model is shown in Table 6.

Table 6.
Estimation of Variance Components of the Random Coefficients Regression Model

Random Effect	SD	Var.Com.	*df*	χ^2	*p*-value
Math Anxiety					
Level 2 error term, u_0	0.163	0.027	11	36.109	<0.001
Level 1 error term, r	0.595	0.354			

* SD: Standard Deviation, Var. Com: Variance Components, df: Degree of Freedom, $\chi 2$: Ki kare

The variance of students' mathematics anxiety was found to be approximately 0.35. The variance of mathematics anxiety at the second level was found to be approximately 0.03. Therefore, it can be stated that there is a statistically significant difference between teacher averages in student math anxiety ($p<.05$). One-way analysis of variance was conducted between random effects model and random coefficient regression model variance components:

Math Anxiety:

Ratio of variance explained at Level 1 = [σ^2(Model 1)- σ^2 (Model 2)] / σ^2(Model 1)

= [0.59-0.35] / (0.59) = 0.41.

It can be stated that it explains 41% of the student variables related to student mathematics anxiety at the first level.

Student Anxiety:

It can be stated that the true value of the teacher averages within the 95% confidence interval = 2.66±1.96(0.1) = (2.46,2.86).

The reliability value of students' math anxiety levels was calculated as approximately 0.90.

Model-3: Findings Related to the Averages as Dependent Model

The estimation of fixed effects for the model with averages as dependent is shown in Table 7.

Table 7.
Estimation of Fixed Effects for the Averages as Dependent Model

Fixed Effect	Coef.	SE	*t*	df	*p*-value
Math Anxiety					
Math Anxiety Average, γ_{00}	2.462	0.130	18.967	7	<0.001
Mean effect of Teacher Anxiety, γ_{01}	0.144	0.064	2.249	7	0.049
Teacher gender effect, γ_{02}	0.248	0.087	2.865	7	0.024
Teacher Marital Status effect, γ_{03}	-0.400	0.093	-4.321	7	0.003
Effect of Teacher Education Level, γ_{03}	-0.218	0.056	-3.866	7	0.006

* Coeff: Coefficient, SE: Standard error, df: Degree of freedom

Among the teacher-level variables related to student math anxiety, the mean teacher anxiety was statistically significant at 95% confidence interval and the relationship between them was found to be positive (γ_{01}=0.14, $p<.05$). Therefore, it can be stated that an increase of 1 unit in the level of teacher anxiety will increase the student's math anxiety by 0.14 units. The variance components of the model with means as dependent are analyzed in Table 8.

Table 8.
Variance Components of the Means as Dependent Model

Random Effect	SD	Var.Com.	*df.*	χ^2	*p*-value
Math Anxiety					
Level 2 error term, u_0	0.156	0.024	7	16.492	0.021
Level 1 error term, r	0.767	0.588			

* SD: Standard Deviation, Var. Com: Variance Components, df: Degree of Freedom, χ2: Ki kare

When Table 8 is examined, the variance of student mathematics anxiety was found to be approximately 0.59 when the relationships of teacher-level variables related to student mathematics anxiety were examined. When the teacher level variables were controlled, the variance of student math anxiety was found to be 0.02. The reason for obtaining a lower variance than the variance value obtained in the one-way analysis of variance random effects model, which is the HLM initial model, can be expressed as the addition of teacher-level variables to the model.

The actual value range of the teacher level at 95% confidence interval;

Math Anxiety = 2.46 ± 1.96(0.13) = (2.21; 2.71).

When the random coefficient regression model was compared with the model with means as dependent, the explained variance ratio at the second level was calculated.

Math Anxiety

Second level explained variance ratio

= [τ_{00} (Model 1) - τ_{00} (Model 2)] / τ_{00} (Model 1)

= [0.04 - 0.02)] / 0.04 = 0.50

According to this result, the mean anxiety of the teacher, gender of the teacher and marital status of the teacher included in the model analysis explained approximately 56% of the between-teacher variance in student mathematics achievement (χ^2=51.81, s.d.=8, p<. 05); teacher's mean anxiety, teacher's gender, teacher's marital status, and teacher's educational level explained approximately 50% of the between-teacher variance in student math anxiety (χ^2=16.49, s.d.=7, p<.05).

Model-4: Results for the Model with Intersection and Slope Coefficients as Dependent Variables

To determine which student characteristics and teacher characteristics are related to students' mathematics anxiety, a model with intercept and slope coefficients as dependent variables was established. The student-level model is composed of the variables found significant in the random coefficient regression model, while the teacher-level model is composed of the variables found significant in the mean model. The fixed effects of the model in which intercept and slope coefficients are dependent variables are shown in Table 9.

When Table 9 is examined; student level variables (mean parental anxiety, student social opportunity, student mathematics self-efficacy perception) and teacher level variables (mean teacher mathematics anxiety, teacher gender effect, teacher marital status, teacher education level) which are related to student mathematics anxiety were included together in the model where intercept and slope coefficients were the dependent variables.

Table 9.
Fixed Effects for the Model with Intersection and Slope Coefficients as Dependent Variables

Fixed Effect	Coef.	SE	*t*	df	*p*-value
Math Anxiety					
Adjusted Math Anxiety Mean., γ_{00}	2.7530	0.106	26.090	7	<0.001
Effect on mean teacher anxiety, γ_{01}	0.122	0.020	6.051	7	<0.001
Teacher gender effect, γ_{02}	0.091	0.030	3.089	7	0.018
Effect of teacher marital status, γ_{03}	-0.113	0.039	-2.890	7	0.023
Effect of teacher education level, γ_{04}	-0.201	0.030	-6.647	7	<0.001
Effect of mean parental anxiety, γ_{10}	0.385	0.045	8.572	11	<0.001
Student social opportunity impact, γ_{20}	-0.131	0.074	-1.761	387	0.049
Student math self-efficacy effect, γ_{30}	-0.450	0.073	-6.175	387	<0.001

* Coeff: Coefficient, SE: Standard error, df: Degree of freedom

The variance components of the model in which the intercept and slope coefficients were the dependent variables are shown in Table 10.

Table 10.
Variance Components of the Model with Intersection and Slope Coefficients as Dependent Variables

Random Effect	SD	Var. Com.	*df*	χ^2	*p*-value
Math Anxiety					
Level 2 error term, u_0	0.135	0.018	7	19.675	0.007
Level 1 error term, *r*	0.590	0.348			

* SD: Standard Deviation, Var. Com: Variance Components, df: Degree of Freedom, χ2 :Ki kare

It was found that the variance of the second level teacher averages for mathematics anxiety belonging to the absence model of hierarchical linear modeling (one-way analysis of variance random effects model) was (0.04), and the second level variance belonging to the model in which intercept and slope coefficients were dependent variables was (0.02). Therefore, the explained variance ratio of the second level teacher means was calculated as (0.04- 0.02) / (0.04) = 0.50. It can be stated that the variables belonging to the teacher level explain approximately 50% of the variability among teachers (χ^2= 19.68, p<.05). The models for the models established in the hierarchical linear modeling analysis are shown in Table 11.

Table 11.
Models Established in HLM Analysis

	Deviation Statistics	Parameter number
Math Anxiety		
Model 1 (One-Way Analysis of Variance Random Effects Model)	967.618	2
Model 2 (Random Coefficients Regression Model)	767.582	2
Model 3 (Model with Averages as the Dependent Variable)	969.632	2
Model 4 (Model with Exploration and Slope Coefficients as Dependent Variables)	771.014	2

The variance ratios explained in students' mathematics anxiety levels and mathematics achievement levels for the models constructed are shown in Table 12.

Table 12.
Explained Variance Percentages of the Established Models

Models	Student Level	Teacher Level
Math Anxiety		
One-Way Analysis of Variance Random Effects Model	%94	%6
Random Coefficients Regression Model	%41	-
Model with Averages as the Dependent Variable	-	%50
Model with Exploration and Slope Coefficients as Dependent Variables	-	%50

Table 12 summarizes the effectiveness of various statistical models in explaining math anxiety at student and teacher levels. The One-Way Analysis of Variance Random Effects Model explains a substantial 94% of variance in student math anxiety but only 6% at the teacher level. The Random Coefficients Regression Model accounts for 41% of the variance at the student level, with no application to the teacher level. Conversely, models using averages and exploration/slope coefficients explain 50% of the variance at the teacher level but are not used for student data. This indicates the One-Way ANOVA model's strong student-level effectiveness and highlights the moderate teacher-level explanatory power of the latter two models.

DISCUSSION AND CONCLUSION

This study investigated the multilevel predictors of mathematics anxiety in middle school, focusing on both student characteristics and teacher factors. Using HLM, we were able to disentangle how much of students' math anxiety is associated with individual differences versus classroom context. The findings confirm that math anxiety is a multi-faceted phenomenon influenced by personal, familial, and classroom-level factors. In particular, three key predictors at the student level (parent anxiety, self-efficacy, social support) and four at the teacher level (teacher anxiety, gender, marital status, education) were identified as significant contributors to students' math anxiety.

At the student level, mathematics self-efficacy emerged as one of the strongest protective factors against math anxiety. This finding is well-documented in prior research, which suggests that students with greater confidence in their mathematical abilities experience lower anxiety when engaging with math-related tasks (Meece et al., 1990; Pajares & Kranzler, 1995; Pajares & Miller, 1995; Tobias, 1978; Zimmerman & Cleary, 2006). High self-efficacy likely equips students with resilience, enabling them to perceive mathematical difficulties as challenges to overcome rather than threats. The strong inverse relationship found ($\gamma \approx -0.47$) suggests that interventions designed to enhance students' confidence and competence in mathematics could substantially reduce anxiety. Mastery-based learning approaches, positive feedback, and opportunities for early successes in mathematics could serve to strengthen self-efficacy and, in turn, mitigate anxiety. This result is consistent with Bandura's self-efficacy theory, which posits that improving self-efficacy expectations can reduce emotional distress in stressful situations. Complementing this, Pizzie and Kraemer (2023) found that math-anxious students benefit significantly from study-skills interventions that encourage active engagement and self-testing. Their findings showed that, compared to emotion regulation strategies, structured learning approaches led to sustained improvements in math achievement. These results further support the importance of targeting study behavior in efforts to alleviate mathematics anxiety.

Another important finding is the influence of parental math anxiety on student anxiety. Our findings are in line with Zhou et al. (2025), who found that parental anxiety significantly predicts children's math engagement via math anxiety. Maloney et al. (2015) demonstrated that children of highly math-anxious parents not only learn less math over time but also become more math-anxious themselves. Our study adds to this by showing the effect in a Turkish middle school context: even after controlling for a variety of factors, a parent's anxiety level had a measurable impact on the child's anxiety. This is likely operated through both direct and indirect mechanisms. Directly, parents with math anxiety might communicate negative messages about math (e.g. expressing dread or lack of usefulness for math), which children internalize. Indirectly, such parents might avoid math-related activities or be less able to support the child's math learning, leading to the child's increased frustration or insecurity in math. The implication is that addressing parents' attitudes could be an important component of reducing student math anxiety. For instance, parent education programs could be developed to make parents aware of the impact of their words and to equip them with strategies to discuss math in a more positive, encouraging manner. This finding aligns with previous studies (Bindak, 2005; Şenol et al., 2015; Yıldız & Uyanık, 2004).

The role of social opportunities/support was a somewhat novel aspect in our model. We found that students who perceived having richer social and academic support (peers, mentors, or a positive classroom climate) reported slightly lower anxiety. Although the effect size was modest, it resonates with the idea that a supportive learning environment can buffer anxiety. Moreover, the coefficient for student social support ($\gamma 20 = -0.13$, $p < .05$) indicates that students with more perceived support experience significantly lower levels of math anxiety. This suggests a buffering effect of classroom or peer support systems. When students know they have help available or feel a sense of belonging in math class, they may approach challenges with less fear. This finding suggests that educators should cultivate supportive peer interactions and a non-judgmental classroom atmosphere. Group work, math clubs, or tutoring programs could be beneficial in creating these social learning opportunities that make math feel less isolating or intimidating. Similar findings have been reported by Varol (1990) and Yetim (2006), emphasizing the role of social support in mitigating student anxiety. However, our findings contradict those of Yılmaz (2006) and Taşdemir (2008), suggesting that the impact of social support on anxiety might be context dependent.

Beyond individual attributes, our study highlights significant teacher-level influences on student anxiety. Perhaps the most striking is the effect of teacher math anxiety. We provided quantitative evidence that teachers who feel anxious about math tend to have more anxious students on average. This is in line with prior research indicating that teachers' anxieties and attitudes are often "picked up" by students, even if unintentionally (Shodahl & Diers, 1984). An anxious teacher might, for example, rush through explanations, display nervousness during math lessons, or avoid certain topics, which can create a tense classroom environment. Students in such an environment may sense the teacher's discomfort and become anxious themselves. Our findings reinforce calls for supporting teachers in managing their math anxiety. Professional development workshops could help teachers recognize and cope with their anxiety, as well as develop more confidence in teaching mathematics. By reducing teacher anxiety, we may indirectly reduce student anxiety as well.

The finding that male teachers were associated with higher student anxiety is intriguing and warrants discussion. One might have expected the opposite, given that previous studies (e.g. Beilock et al., 2010) often focus on female teachers' anxiety affecting students. In our sample, however, teacher gender itself (independent of anxiety level) had an effect: classes taught by men had higher anxiety levels. One possible explanation is that the male teachers in this context might have used different instructional styles – perhaps more traditional or strict approaches – which could heighten student anxiety. It is also plausible that female teachers, on average, provided more emotional support or created a warmer classroom environment, helping to ease anxiety. This result could be culturally specific or confounded with other factors (for instance, the female teachers might have had more teaching experience on average than the male teachers in our sample). We caution that this finding does not imply a causal relationship or any inherent quality of male vs. female teachers, but it suggests there may be gender-linked teaching dynamics worth exploring. Future research could examine teaching style, communication, or teacher-student relationship quality as factors that might differ by teacher gender and influence student anxiety.

The negative effect of teacher marital status on student anxiety (students of married teachers being less anxious) might also relate to teacher experience and stability. In our data, married teachers tended to be older and possibly more experienced than single teachers. It is conceivable that those married/older teachers had spent more years honing their pedagogical skills and classroom management, resulting in a more relaxed learning environment. Additionally, one could speculate that marital status might proxy general socio-emotional stability; a teacher who has a supportive personal life might manage classroom stress better and transmit less anxiety. Our finding supports the idea that when teachers feel more secure (whether through experience, education, or personal life), their students benefit emotionally. Schools might consider mentoring programs where less-experienced or single teachers (who might be early-career) receive guidance from veteran teachers to cultivate an encouraging classroom climate.

Another notable result is that students in classes of teachers with higher educational qualifications (e.g. a master's degree) had lower anxiety. Advanced education may provide teachers with deeper content knowledge and a variety of instructional strategies, which can help them teach math more effectively and confidently. This, in turn, is likely to reduce student confusion and anxiety. Moreover, teachers who pursue graduate education might also be those who are especially dedicated to teaching or who have learned about educational psychology, making them more adept at recognizing and addressing student anxiety. This finding suggests that encouraging and supporting teachers' continuous professional development (such as obtaining advanced degrees or certifications) could have trickle-down benefits for students' emotional well-being in math classes. It aligns with the notion that teacher quality and preparation are linked not just to cognitive outcomes but affective outcomes as well. Consistent with recent multilevel and multivariate studies (e.g., Zhou et al., 2025; Megreya & Al-Emadi, 2024), our findings confirm that mathematics anxiety is shaped by both individual psychological characteristics and contextual influences.

It is important to note that while our model explained a large portion of the variance in math anxiety, there remain other factors that could be explored. For example, curricular factors or school-level influences (like school culture around math) were not included but might play a role. Additionally, we did not explicitly examine interactions – it is possible that certain teacher effects are more pronounced for some types of students. For instance, a supportive teacher might especially benefit students who have anxious parents, buffering the home influence. Investigating such cross-level interactions could be a fruitful avenue for future studies.

Implications for practice

The multi-level findings of this study suggest that interventions to reduce math anxiety should be holistic. At the student level, building math self-efficacy is paramount. Teachers can incorporate mastery experiences by scaffolding math problems so that students experience successes, and teaching study strategies to handle math challenges. Addressing negative attitudes early, perhaps through math anxiety workshops or counseling for anxious students, can prevent the anxiety from escalating. Also, providing students with social support – like peer tutoring, math clubs, or a classroom culture where mistakes are treated as learning opportunities – can alleviate fear. At the teacher level, professional development programs should raise awareness about how teachers' own anxieties and behaviors affect students. Equipping teachers with anxiety-reduction techniques (for themselves) and student-centered teaching methods may help. For example, teachers can practice mindfulness or stress-management techniques to stay calm during lessons and use positive reinforcement. Schools might also foster communities of practice where teachers share successful strategies to engage and reassure anxious learners.

Furthermore, involving parents is crucial. Schools could offer parent-focused sessions demonstrating how to positively support children's math learning, even if the parent feels anxious. As noted by recent research, when parents with math anxiety are trained in productive homework help strategies, the negative impact on children can be mitigated. Thus, an implication is to create resources for parents – such as guides or family math nights – to improve the home math environment. By tackling the issue on multiple fronts (student skills, teacher training, parent involvement), we stand a better chance of breaking the cycle of math anxiety.

Limitations

This study was conducted in a specific region with a relatively small number of teachers (N=12), which limits generalizability. The teacher-level findings, in particular, should be interpreted with caution given the sample size at level 2. Some results (like the teacher gender effect) may not generalize to other contexts or larger samples. Additionally, the data are cross-sectional, so causal inferences are tentative. It is plausible, for example, that a highly anxious class could influence the teacher's anxiety as well, in a reciprocal way. Longitudinal data would help establish directionality – for instance, measuring anxiety at the start and end of the school year to see how teacher and student anxieties co-evolve. Another limitation is that we relied on self-report measures for anxiety, which could be subject to response biases. However, the anonymity and the use of established scales should mitigate this to some extent.

In conclusion, this study underscores that mathematics anxiety in students is not solely an individual issue but a systemic one. Students bring their own dispositions and home influences, while teachers and classroom contexts significantly color the emotional climate of learning. The significant proportion of variance explained at the student level (around 40%) and teacher level (about 50% of class-level variance) in our model demonstrates that both levels matter. By addressing mathematics anxiety on multiple levels, we can help students build not only proficiency in mathematics but also a positive, fearless mindset toward the subject, which is crucial for their long-term educational and professional journeys.

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APPENDICES

Appendix 1: Outlier Detection

Outliers were identified using the standardized residual value method, with values greater than 2 or less than -2 considered as outliers. The distribution analysis indicates that student anxiety (STUMANX) and parental anxiety (PAANX) were assessed for 413 participants, with STUMANX exhibiting a slight positive skewness (0.494) and near-normal kurtosis (-0.227), while PAANX showed minimal skewness (0.123) and a relatively flatter distribution (-0.716). No outliers were detected in the predictor variables.

Appendix 2. Confirmatory Factor Analysis (CFA)

CFA was conducted to verify the construct validity of the data collection tools. The fit indices for students, parents, and teachers' scales indicated good validity, as shown in Table 13.

Table 13.
Findings Related to Confirmatory Factor Analysis of the Scales Used (Kılıç and Koyuncu, 2017; Schreiber et al., 2006)

Index	Measure of perfect fit	Acceptable fit criterion	Research finding	Result
χ^2 /sd	0-3	3-5	1,40	Perfect fit
RMSEA	.00≤ RMSEA≤.05	.05≤ RMSEA≤.10	.04	Perfect fit
CFI	.95≤ CFI ≤1.00	.90≤ CFI ≤.95	.91	Good fit
TLI	.95≤ TLI ≤1.00	.90≤ TLI ≤.95	.90	Good fit
GFI	.95≤ GFI ≤1.00	.90≤ GFI ≤.94	.81	Acceptable fit
RMR	.00≤ RMR ≤.05	.05≤ RMR ≤.08	.05	Good fit
IFI	.95≤ IFI ≤1.00	.90≤ IFI ≤.95	.91	Good fit

The goodness-of-fit indices for the parent scale were χ^2 / df = 2.74, RMSEA = .104, NFI = .92, NNFI = .94, CFI = .95, IFI = .95, GFI = .82, and AGFI = .76 (Mutlu et al., 2018). For the teacher scale, the goodness-of-fit indices were χ^2 / df = 2.71, RMSEA = 0.07, SRMR = 0.07, GFI = 0.91, CFI = 0.92, NNFI = 0.93, and AGFI = 0.90 (Yıldırım & Gürbüz, 2017). These findings provide evidence of the robustness and reliability of the measurement tools utilized in the study.

TÜRKÇE GENİŞLETİLMİŞ ÖZET

Bu çalışma, öğrenci ve öğretmen özelliklerinin öğrencilerin matematik kaygısını nasıl öngördüğünü incelemektedir. Araştırmada ilişkisel tarama modeli kullanılmış ve çok düzeyli analiz için hiyerarşik doğrusal modelleme (HLM) yöntemi uygulanmıştır. Çalışma, 12 matematik öğretmeni, 413 ortaokul öğrencisi ve bu öğrencilerin ebeveynlerinden (n=413) oluşan bir örneklem üzerinde gerçekleştirilmiştir. Matematik kaygısı, öğrencilere, öğretmenlere ve ebeveynlere uygulanan geçerli kaygı ölçekleri aracılığıyla ölçülmüştür.

Araştırmanın temel amacı, öğrencilerin matematik kaygısının bireysel, ailevi ve öğretmen temelli değişkenlerden nasıl etkilendiğini belirlemektir. Matematik kaygısı, bireyin bilişsel, duyuşsal ve davranışsal düzeyde olumsuz tepkiler geliştirmesine yol açabilen yaygın bir sorundur. Öğrencilerin matematik kaygısını etkileyen faktörler arasında ebeveyn matematik kaygısı, öğrencinin öz-yeterlik algısı, sosyal destek olanakları ve öğretmen matematik kaygısı gibi değişkenler bulunmaktadır. Bu bağlamda araştırma, öğrenci düzeyinde ebeveyn kaygısı, matematik öz-yeterliği ve sosyal fırsatların; öğretmen düzeyinde ise öğretmen kaygısı, cinsiyet, medeni durum ve eğitim düzeyinin matematik kaygısı üzerindeki etkilerini incelemiştir.

HLM analizi sonuçları, matematik kaygısındaki toplam varyansın %94'ünün öğrenci düzeyinde olduğunu göstermiştir. Öğrenci düzeyinde, yüksek ebeveyn matematik kaygısı, daha az sosyal fırsat ve düşük matematik öz-yeterliği, öğrencilerin daha yüksek matematik kaygısı yaşamasıyla anlamlı şekilde ilişkilendirilmiştir. Ebeveyn kaygısı yüksek olan öğrenciler, genellikle matematikle ilgili olumsuz inanç ve tutumlara sahip olup matematik derslerinde daha fazla kaygı hissetmektedir. Ayrıca, öğrencinin öz-yeterlik algısının yüksek olması, kaygıyı azaltan önemli bir faktör olarak belirlenmiştir. Matematikte kendine güvenen öğrenciler, başarısızlık korkusu duymadan problem çözmeye daha açık olup, matematik öğrenmeye karşı daha olumlu bir tutum geliştirmektedir.

Öğretmen düzeyinde ise yüksek öğretmen matematik kaygısı, erkek cinsiyet ve bekar olma durumu, öğrencilerin matematik kaygısını artıran faktörler olarak belirlenmiştir. Matematik kaygısı yüksek olan öğretmenler, öğrencilerle etkileşimlerinde güvensizlik hissi yayabilmekte ve matematik öğretimini daha endişe verici bir süreç haline getirebilmektedir. Erkek öğretmenlerin öğrencilerinin daha yüksek matematik kaygısına sahip olması, öğretim tarzlarının daha geleneksel veya katı olmasından kaynaklanabilir. Ayrıca, bekar öğretmenlerin öğrencilerinde daha yüksek kaygı düzeyine rastlanması, öğretmenlerin deneyim seviyeleri ve sınıf yönetimi becerileriyle ilişkili olabilir.

Çalışmanın bulguları, matematik kaygısının çok katmanlı doğasını vurgulamakta ve öğrenci ile öğretmen etkilerini dikkate alan müdahalelerin gerekliliğini ortaya koymaktadır. Özellikle öğrencilerin matematik kaygısını azaltmaya yönelik müdahalelerin bireysel düzeyde matematik öz-yeterliğini artırmayı hedeflemesi gerektiği görülmektedir. Bu doğrultuda, öğretmenlerin ve ebeveynlerin matematik kaygılarını yönetmeleri, öğrencilerin matematik öğrenme süreçlerine olumlu katkılar sağlayabilir. Ayrıca, öğrencilerin sosyal destek sistemlerini güçlendirmek, matematik kaygısının azaltılmasında etkili olabilir.

Öğretmen düzeyinde ise öğretmen matematik kaygısını azaltmaya yönelik mesleki gelişim programları önerilmektedir. Öğretmenlerin matematik kaygısıyla başa çıkma stratejileri geliştirmeleri, öğrencilerine daha olumlu bir öğrenme ortamı sunmalarını sağlayabilir. Matematik öğretiminde daha esnek ve öğrenci merkezli yaklaşımların benimsenmesi, öğrenci kaygısını azaltmada etkili olabilir. Ayrıca, öğretmenlerin sınıf içinde güven verici bir öğrenme atmosferi oluşturması, öğrencilerin matematik derslerine daha olumlu yaklaşmalarına katkı sağlayacaktır.

Bu çalışmanın sınırlılıkları arasında, öğretmen örneklem büyüklüğünün sınırlı olması yer almaktadır. Öğretmen düzeyindeki bulgular, daha büyük bir örneklemle test edilerek daha geniş kapsamlı sonuçlar elde edilebilir. Ayrıca, çalışmada çapraz kesitsel bir tasarım kullanıldığından, değişkenler arasındaki nedensellik ilişkisi doğrudan kurulamamaktadır. Gelecekteki araştırmaların, öğretmen kaygısının zaman içindeki değişimini ve öğrenci kaygısıyla karşılıklı etkileşimini incelemesi önerilmektedir.

Sonuç olarak, bu çalışma, matematik kaygısının bireysel ve bağlamsal faktörlerle nasıl ilişkilendiğini detaylı bir şekilde ele alarak alanyazına önemli katkılar sunmaktadır. Bulgular, öğrenci matematik kaygısını azaltmaya yönelik politikalar ve eğitim programları geliştirilmesine ışık tutmaktadır. Özellikle öğretmenlerin ve ebeveynlerin matematik kaygılarını yönetmelerini sağlamak, öğrencilerin matematikle olan ilişkilerini güçlendirmek için kritik bir adımdır. Eğitim ortamlarında matematik kaygısını en aza indirgeyerek, öğrencilerin akademik başarılarını ve öz-yeterlik algılarını artırmak mümkün olabilir.