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Mathematics anxiety determinants and coping strategies among secondary school students: A mixed methods research

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Abstract
This study set out to determine the mathematics anxiety levels of secondary school students in Kazakhstan, to examine how this anxiety relates to variables such as gender, grade level, mathematics course grade, and daily study time, and to capture students' own accounts of what causes their anxiety, how they cope with it, and how they perceive their teachers' role in it. A convergent parallel mixed-methods design was adopted, with data collected during the 2025-2026 academic year from 353 students across grades 9 through 12 using the brief math anxiety scale alongside a set of open-ended items. Quantitative data were analyzed through t-tests, and analysis of variance, while the open-ended responses were examined using content analysis. The results show that most students (71.7%) reported low levels of mathematics anxiety, with no significant differences emerging by gender or daily study time; ninth-grade students, however, scored significantly higher than upper-grade students on both the numerical task anxiety and math course anxiety subscales. According to the qualitative findings, fear of failure and difficulty grasping mathematical concepts were the anxiety sources students mentioned most often, and the coping strategy they relied on most was simply studying harder or seeking help. A supportive teacher, meanwhile, emerged as the factor students most closely associated with lower anxiety. Taken together, these findings point to several practical steps: early screening as students move into ninth grade, counseling programs that build emotion-focused coping skills rather than relying solely on academic remediation, and greater emphasis in teacher training on creating a supportive classroom climate.

Keywords: mathematics anxiety, mathematics education, secondary school students, coping strategies, mixed methods

INTRODUCTION

Mathematics has an important role in the economic, scientific, and technological progress of modern societies, which is why it sits at the center of education systems worldwide. Mathematical competence has more than individual academic success alone. It is as a strategic factor shaping how competitive a country is on the global stage (Dwijayanti et al., 2026; Omar et al., 2022). Despite this strategic importance, many students experience mathematics as intimidating, abstract, and difficult to learn. Secondary education becomes a perfect breeding ground for negative attitudes and emotions towards mathematics due to the fact that it is at this stage where the use of abstract reasoning, symbols and testing become intense (Molla et al., 2026).

Mathematics anxiety is described as the fear, nervousness and uneasiness that one experiences when

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Contribution to the literature

- Unlike traditional approaches that treat the psychological and pedagogical dimensions of mathematics anxiety separately, this study reveals how these two dimensions intertwine within students' actual classroom experience, reframing mathematics anxiety not as an individual deficiency but as a systemic barrier to learning.
- By clearly identifying ninth grade as a critical inflection point where anxiety spikes significantly, the study offers some concrete, developmentally-timed target for where and when interventions should be concentrated. By directly foregrounding students' own voices regarding their coping mechanisms and the protective role of a supportive teacher, the study generates actionable, evidence-based implications for early screening, emotion-focused counseling interventions, and teacher training programs.
- Conducted with a substantial sample within the Kazakhstani secondary education context, the study extends the geographic and cultural scope of a mathematics anxiety literature that has largely been concentrated in Western and East Asian settings, bringing a distinctive perspective to the field. The mutually reinforcing convergence of the quantitative and qualitative findings powerfully demonstrates that mathematics anxiety is not merely a statistical variable but a multidimensional phenomenon concretely experienced in students' everyday academic live.

dealing with numbers and mathematics questions. It becomes one of the major problems encountered in the academic growth process (El-Far et al., 2024; Hembree, 1990). It does not involve a hatred for the subject but reduces the capacity of a student's working memory and limits his/her ability to showcase abilities (Ramirez et al., 2018). In a case where highly anxious students face any kind of stimuli in mathematics, a reaction in the brain similar to pain sensation occurs along with some physiological responses such as increased heart rate (Sharma & Singh, 2025). If the problem is ignored at an early age, it usually leads to a tendency in students to avoid science, technology, engineering, and mathematics (STEM) fields and limit themselves to certain careers (Molla et al., 2026).

Existing scholarship on mathematics anxiety has predominantly relied on quantitative approaches, with a large share of studies centering on the link between anxiety and achievement outcomes (Simbolon et al., 2026). The psychological and pedagogical aspects of the phenomenon tend to be examined in isolation from one another, and only a limited number of studies have explored how these two aspects converge within students' lived classroom experiences (Nyirabuhoro & Maringe, 2025). Additionally, there is still insufficient research examining the personal strategies students adopt to manage their anxiety, as well as what they expect from their teachers in this regard (Luu-Thi et al., 2021). This study aims to help close that gap by using quantitative data to establish how demographic variables relate to anxiety, and by using open-ended questions to explore, qualitatively, the emotions, causes, and coping mechanisms involved. Rather than treating mathematics anxiety among secondary school students as an individual shortcoming, the study frames it as a systemic barrier to learning that arises from the interaction between students' psychological readiness and the pedagogical conditions of the classroom. The findings that follow are intended to give teachers something to work with as they rethink their pedagogical approach, support students' self-efficacy, and build a safer classroom climate. Putting students' own voices and suggestions at the center allows educators to design interventions that address not just academic performance but student well-being as well. In this sense, the study aims to offer practitioners and policymakers a way forward in turning mathematics from a gatekeeping subject into a learning space that is genuinely accessible to all students.

THEORETICAL FRAMEWORK

Theoretical Foundations and Cognitive Dimensions of Mathematics Anxiety

Mathematics anxiety refers to the behavior displayed by individuals dealing with numbers or a math task (Dwijayanti et al., 2026). Essentially, this type of anxiety occurs across three dimensions cognitive, emotional, and physiological (somatic) (Omar et al., 2022). The cognitive dimension includes the lack of concentration, forgetfulness, and negative self-talk, whereas the emotional one implies experiencing panic, helplessness, and frustration. Finally, the somatic dimension encompasses responses of the autonomic nervous system, namely sweating, rapid heartbeat, and nausea (Molla et al., 2026; Trigueros et al., 2020). It is important to note that anxiety is not a spontaneous phenomenon; rather, it develops gradually and becomes an attitude.

There are several theories that explain the impact of anxiety on the learning process; however, cognitive interference theory is probably the most appropriate for this context (Ramirez et al., 2018). According to this model, the cognitive resources necessary for completing math tasks become occupied by interfering thoughts, caused by anxiety, such as the fear of failure (Molla et al., 2026). When a student's working memory fills up with these negative thoughts, they start making mistakes even on material they actually know how to handle, and this sets off a cycle of failure (Dwijayanti et al., 2026; Nyirabuhoro & Maringe, 2025). At the secondary level in particular, where abstract symbols and multi-step logical processes become more common, the demand for mental resources is higher, which makes anxiety's disruptive effects even more visible. The distinction between state anxiety and trait anxiety is also useful for understanding how mathematics anxiety works (Mann & Walshaw, 2019; Orbach et al., 2019). State anxiety refers to the temporary reaction that arises during a specific exam or a difficult problem, whereas trait anxiety describes a more entrenched tendency to view mathematics as a threat in general. It is well established that state anxiety, once it builds up repeatedly during evaluative moments like exams, can accumulate over time into lasting trait anxiety. This process of anxiety becoming chronic is what tends to push students toward avoiding mathematical tasks altogether and drifting away from STEM-oriented fields of study (Molla et al., 2026).

The other important theory is control-value theory, which explains that the emotional experiences of individuals depend on the equilibrium between the value attributed to the task and control one feels in relation to it. When a student attaches high importance to performing well in mathematics (value) and views his/her competence as inadequate (low control), then anxiety can hardly be avoided (Dwijayanti et al., 2026). This imbalance between control and value may help explain the elevated anxiety levels observed among secondary school students during high-stakes examinations (Molla et al., 2026). Experiences of failure decrease one's perception of control and gradually lead to formation of academic self-concept, causing anxiety during future tasks. There is also literature dedicated to the link between mathematics anxiety and performance using disruption account and reduced competency account (Dwijayanti et al., 2026). According to the disruption theory, anxiety reduces performance due to the fact that it disrupts cognitive functioning, whereas, on the other hand, according to the reduced competency theory, the lack of basic mathematics skills is the reason for the development of anxiety. New findings indicate that those two factors are not independent from each other; instead, they highlight the existence of a cyclical relationship between poor results, leading to anxiety, which then leads to more poor performance (Sharma & Singh, 2025). Therefore, interrupting the vicious circle of failures requires not only academic assistance but also working on personal psychological strength.

Determinants of Mathematics Anxiety Among Secondary School Students

Cognitive, pedagogical, environmental, and demographic variables play a role in the development of math anxiety in middle school students (Mann & Walshaw, 2019). Among cognitive variables, the student's belief in their mathematical ability is important. Students with low self-efficacy perceive the mathematical challenges they encounter not as a normal part of learning, but as an indicator of personal inadequacy. This leads to anxiety. In high school, as abstract concepts accumulate, this lack of belief in one's own ability directly triggers avoidance of the subject and related tasks (Sharma & Singh, 2025). Pedagogical factors and teacher attitudes are among the environmental forces that shape anxiety (Niyi & Oyeleke, 2025). Traditional, teacher-centered teaching, which focuses on finding the correct answer, feeds students' fear of making mistakes, thus increasing their anxiety levels. Classroom time pressure, being forced to solve problems on the board, and punitive grading practices prevent the classroom from feeling like a safe space (Trigueros et al., 2020).

Family expectations and gender stereotypes are yet other key determinants of the development of the condition. The pressure of success placed upon children by their parents, or their parents' mathematics anxiety, may influence the children in such a way that it may normalize the fear of the subject (Ramirez et al., 2018). As regards the studies related to gender, the general conclusion that can be made is that girls experience more mathematics anxiety than boys do (Luu-Thi et al., 2021). While this is usually believed to be connected to the stereotypes associated with gender and the desire for social acceptance, it was also noticed that the difference might be caused by the fact that girls were simply more open about their emotions (Ramirez et al., 2018). As for the temporal determinants of the issue, grade level and academic transition periods deserve particular attention as the factors that define the intensity of the anxiety (Orbach et al., 2019). The development of mathematics anxiety takes place in childhood, though it grows significantly in adolescence (Dwijayanti et al., 2026). Twelfth-grade students in particular experience considerably more stress than students in lower grades, driven by worry about the future and pressure around career choice tied to higher-education entrance exams (Luu-Thi et al., 2021; Molla et al., 2026). Because mathematics functions as a gatekeeping criterion for so many fields, it ends up being perceived less as an academic subject and more as a critical obstacle shaping one's future.

Past negative learning experiences and exam-centered assessment systems are among the main forces that reinforce this anxiety (Molla et al., 2026). Failures experienced in the past, or negative experiences in the classroom, leave mathematics coded in a student's mind as a threatening domain (Dwijayanti et al., 2026). The pressure created by high-stakes testing in education systems makes it harder for students to show what they're capable of and turns avoidance into a chronic pattern. Framing exams as a judgment mechanism rather than as a tool for growth can be seen as a systemic problem that makes it that much harder for students to break out of this anxiety cycle (Scarpello, 2007).

Coping Strategies and Intervention Methods for Mathematics Anxiety

Students' strategies for coping with math anxiety have been classified broadly into adaptive and maladaptive coping strategies (Skaalvik, 2018). Students relying on adaptive coping strategies seek help; engage in deep breathing exercises; and create positive self-talk (Luu-Thi et al., 2021). On the other hand, those relying on maladaptive coping strategies demonstrate defensive mechanisms in the form of procrastination, refusal to participate in classroom activities, or even denying their failure. Such avoidance-based strategies may temporarily alleviate the problem, but in the long run, they will only exacerbate the existing learning gap and allow the anxiety to become chronic. Considering this, helping students develop coping mechanisms must be seen as an inherent part of the education process (Sharma & Singh, 2025). On the individual level, growth mindset and cognitive restructuring appear to be the predominant intervention methods (Ramirez et al., 2018). Having a growth mindset means that the students are aware that intelligence and abilities can be improved through hard work; therefore, failing becomes an intrinsic part of learning (Dwijayanti et al., 2026). Cognitive restructuring techniques help students notice fixed negative beliefs, such as the thought that they will never be good at math, and replace them with more realistic, workable ones (Sharma & Singh, 2025). These psychological interventions, which reshape a person's inner narrative, play a foundational role in breaking the anxiety cycle.

Pedagogical arrangements within the classroom are important for reducing anxiety and are generally under the control of teachers (Niyi & Oyeleke, 2025). Collaborative learning models, gamification, and connecting mathematical concepts to daily life strengthen students' engagement with the subject and reduce anxiety (Dwijayanti et al., 2026). When a teacher views mistakes as learning opportunities and creates a patient, inclusive classroom environment, students become more willing to ask questions and participate in the lesson (Sharma & Singh, 2025). Using formative assessment techniques that focus on the learning process and offer constructive feedback, instead of solely outcome-oriented exams, also reduces pressure. Short-term interventions aimed at reducing cognitive load are also frequently encountered in the literature (Ramirez et al., 2018; Scarpello, 2007). For example, expressive writing exercises conducted immediately before an exam allow students to put their anxieties on paper, which provides mental relief and frees up working memory for the task at hand. Incorporating humor into the classroom, offering short breathing breaks, and using technology-supported personalized learning tools that allow students to progress at their own pace help make the learning environment feel less threatening (Sharma & Singh, 2025).

Purpose of the Study and Research Questions

This study aims to determine the mathematics anxiety levels of secondary school students, to examine how this anxiety relates to demographic variables, and to identify the strategies students use to cope with it. In line with this purpose, the following sub-research questions were formulated.

1. What are secondary school students' mathematics anxiety levels, as measured by the total score on the brief math anxiety scale (BMAS) and its subscale scores for math test anxiety, numerical task anxiety, and math course anxiety?
2. Do students' mathematics anxiety levels differ significantly by gender?
3. Do students' mathematics anxiety levels differ significantly by grade level, daily time spent studying mathematics, mathematics course grade or perceived academic achievement?
4. What do students generally feel before a mathematics class or exam begins?
5. According to students, what are the main factors that cause mathematics anxiety?
6. What strategies do students use to reduce or cope with mathematics anxiety?
7. In students' perception, how does their mathematics teacher's behavior or teaching style affect their anxiety level?
8. What are students' views on the ideal mathematics class design that would reduce anxiety, and what do they expect from their teachers?

METHOD

Research Design

In this study, a convergent parallel mixed methods design was used, in which quantitative and qualitative data were collected from the same group of participants through a single administration and simultaneously, analyzed separately, and then brought together at the interpretation stage (Creswell & Plano Clark, 2018).

Population and Sample

The population of the study consists of students attending secondary education institutions (grades 9, 10, 11, and 12) in Kazakhstan. Participants were recruited from a region secondary schools located in one region of Kazakhstan. The online survey link was distributed to

Table 1. Demographic characteristics of the participants (N = 353)

Variable	Category	f	Percentage (%)
Gender	Female	201	56.9
	Male	152	43.1
Grade level	Grade 9	142	40.2
	Grade 10	107	30.3
	Grade 11	83	23.5
	Grade 12	21	5.9
Mathematics course grade	3 or below (average/insufficient)	38	10.8
	4 (good)	195	55.2
	5 (very good)	120	34.0
Daily mathematics study time	Does not study at all	61	17.3
	Less than 30 minutes	86	24.4
	30-60 minutes	133	37.7
	1 hour or more	73	20.7

students through their mathematics teachers, and participation was voluntary. Of the students who had access to the survey link, 353 provided valid responses. The demographic characteristics of the sample are presented in **Table 1**.

Data Collection Instruments

The data collection instrument was designed as a form consisting of three sections.

Demographic information form

The first section of the form includes questions about participants' gender, grade level, mathematics course grade, and daily time spent studying mathematics.

Brief math anxiety scale

To determine students' mathematics anxiety, the BMAS, developed by Núñez-Peña and Guilera (2023), was used. The BMAS is a nine-item reduction, based on item response theory, of the sMARS (Alexander & Martray, 1989), the abbreviated form of the mathematics anxiety rating scale developed by Richardson and Suinn (1972) (Núñez-Peña & Guilera, 2023). Preserving the original three-factor structure of the sMARS (Núñez-Peña et al., 2013), the scale consists of three subscales: math test anxiety (3 items), numerical task anxiety (3 items), and math course anxiety (3 items). Items are rated on a 5-point Likert-type scale ranging from "not at all" (1) to "very much" (5); higher subscale and total scores indicate greater mathematics anxiety. In the scale's original validity and reliability study, confirmatory factor analysis results supported the three-factor structure, item factor loadings ranged from .81 to .96, and strong positive relationships were found among the subscales (r = .41 to .63) (Núñez-Peña & Guilera, 2023). After the scale's linguistic equivalence was established by two language experts and one subject-matter expert, the form adapted into Kazakh was used within the scope of this study. It should be noted that the Kazakh adaptation of the BMAS was evaluated only in terms of linguistic equivalence and internal consistency; no confirmatory factor analysis was conducted to verify the structural validity of the adapted version in this population. The Cronbach's alpha internal consistency coefficients obtained in this study are reported in the results section.

Open-ended and written opinion items

This section of the form consists of five items prepared to reveal students' subjective perceptions of mathematics anxiety, its causes, coping strategies, perceptions of the teacher, and expectations. The draft items were first prepared as eight questions based on the relevant literature, and the opinions of three experts were sought: a mathematics educator, an educational psychologist, and a qualitative research expert. Following expert feedback, two questions were removed from the form, and two questions with similar content were merged. Afterward, a pilot application was used to check whether the question battery worked, and linguistic adjustments were made to two questions. The final form consists of five questions covering

(1) the emotional state felt before the mathematics class/exam,

(2) the factors causing anxiety,

(3) strategies for coping with anxiety,

(4) the perceived effect of teacher behavior on anxiety, and

(5) expectations regarding an ideal mathematics class design that would reduce anxiety.

Data Collection Process

The data were collected through an online form during the 2025-2026 academic year. Participants were informed about the purpose of the study, voluntary informed consent was obtained, and it was stated that participants' responses would be kept confidential. At the end of the data collection process, data from 353 valid participants were obtained.

Table 2. Descriptive statistics, normality values, and reliability coefficients for the BMAS total and subscale scores

Dimension	N	M	SD	Skewness	Kurtosis	α
Math test anxiety	353	2.28	1.04	.86	.12	.88
Numerical task anxiety	353	1.93	1.23	1.20	.22	.95
Math course anxiety	353	1.99	1.20	1.04	-.18	.93
Total BMAS	353	2.07	1.07	1.10	.17	.96

Note. Scores range from 1-5, higher scores indicate higher mathematics anxiety; Since the skewness and kurtosis values for all dimensions fell within the ±2 range (George & Mallery, 2010), the data were considered approximately normally distributed and parametric tests were applied; & α: Cronbach's alpha internal consistency coefficient

Data Analysis

Analysis of quantitative data

In the analysis of the quantitative data, descriptive statistics (mean [M] and standard deviation [SD]) were first calculated, after which whether the data showed a normal distribution was assessed by examining skewness and kurtosis coefficients. Skewness and kurtosis values falling within the range of -2 to +2 were considered sufficient for the data to be regarded as approximately normally distributed and for parametric tests to be applied (George & Mallery, 2010; Tabachnick & Fidell, 2013). The scale's internal consistency was examined using Cronbach's alpha coefficient, with values of .70 and above interpreted as an acceptable level of reliability (Nunnally, 1978). After examining the descriptive statistics and normality values, care was taken to ensure that the size of each subgroup to be compared exceeded $n = 30$; categories that did not meet this criterion (e.g., small cells in the mathematics grade and study time variables) were merged and recoded (see **Table 1**). Under these conditions, independent samples t-tests were used to examine differences between two groups, and one-way analysis of variance (ANOVA) was used to examine differences among more than two groups. The homogeneity of variances was checked with Levene's test; where variances were not homogeneous, the Welch F test was additionally reported. In comparisons where the ANOVA result was significant, Tukey HSD post hoc tests were applied to identify the source of the difference. Effect sizes were calculated using Cohen's d for the t-test and eta squared (η^2) for ANOVA and were interpreted according to Cohen's (1988) criteria (for d: .20 small, .50 medium, .80 large; for η^2: .01 small, .06 medium, .14 large effect). The significance level was set at .05 for all analyses. The analyses were carried out using Python (SciPy and statsmodels libraries).

Analysis of qualitative data

The results of content analysis were performed regarding the data derived from opinion items in the third part of the form. Student opinions were first coded, and then, these codes were categorized (Elo & Kyngäs, 2008). The themes were created based on the research questions, while the themes and categories were verified by an independent researcher, and the agreement index was determined to be .85 (Miles et al., 2020). As this index is greater than .70, an adequate agreement between the researchers can be stated (Armstrong et al. 1997). Controversial issues were resolved through consensus and thematized. In order to show the data, the number of participants (f) in each category and the ratio (%) of the number of participants to the total number of participants who answered the particular question were calculated. Taking into consideration the fact that one student opinion might belong to several categories, the percentages were calculated on the basis of the total number of participants ($N = 353$), and for this reason, the sum of percentages in these items is greater than 100%.

RESULTS

Descriptive Statistics, Normality, and Reliability

As part of the first research question aimed at determining secondary school students' mathematics anxiety levels, the descriptive statistics, skewness-kurtosis values, and Cronbach's alpha internal consistency coefficients for the BMAS total and subscale scores are presented in **Table 2**.

As shown in **Table 2**, the highest M score was obtained on the math test anxiety dimension ($M = 2.28$, $SD = 1.04$), followed by math course anxiety ($M = 1.99$, $SD = 1.20$) and numerical task anxiety ($M = 1.93$, $SD = 1.23$). The M total BMAS score was found to be 2.07 ($SD = 1.07$). This value corresponds to the lower-to-moderate region of the 1-5 scale range. The reliability coefficients ranged from .88 to .96, indicating that the scale has a high level of internal consistency in this sample (Nunnally, 1978).

In order to categorize students' anxiety levels, scores in the 1-5 range were divided into three equal-interval levels: low (1.00-2.33), moderate (2.34-3.66), and high (3.67-5.00). The results are presented in **Table 3**.

Examining **Table 3**, it can be seen that approximately three-quarters of the students (71.7%) reported a low level of total mathematics anxiety, whereas approximately 11% of students experienced a high level of mathematics anxiety. Among the subscales, the dimension with the highest proportion of students reporting high anxiety was numerical task anxiety (13.0%), while the dimension with the highest proportion of students reporting low anxiety was also numerical task anxiety (74.2%). This indicates that the

Table 3. Distribution of students' mathematics anxiety levels (N = 353)

Dimension	Low f (%)	Moderate f (%)	High f (%)
Math test anxiety	238 (67.4)	74 (21.0)	41 (11.6)
Numerical task anxiety	262 (74.2)	45 (12.7)	46 (13.0)
Math course anxiety	252 (71.4)	58 (16.4)	43 (12.2)
Total BMAS	253 (71.7)	60 (17.0)	40 (11.3)

Table 4. Comparison of mathematics anxiety scores by gender

Dimension	Female (n = 201): M (SD)	Male (n = 152): M (SD)	t(351)	p	d
Math test anxiety	2.33 (0.97)	2.21 (1.12)	1.01	.314	0.11
Numerical task anxiety	1.94 (1.23)	1.93 (1.25)	0.06	.954	0.01
Math course anxiety	2.03 (1.19)	1.94 (1.21)	0.67	.506	0.07
Total BMAS	2.10 (1.05)	2.03 (1.11)	0.59	.553	0.06

Note. d: Cohen's d effect size

Table 5. Comparison of mathematics anxiety scores by grade level

Dimension	Grade 9 (n = 142): M (SD)	Grade 10: (n = 107) M (SD)	Grade 11: (n = 83) M (SD)	Grade 12: (n = 21) M (SD)	F(3, 349)	p	η^2
Math test anxiety	2.39 (1.01)	2.21 (1.04)	2.22 (1.05)	2.06 (1.02)	1.15	.327	.010
Numerical task anxiety	2.17 (1.28)	1.89 (1.27)	1.70 (1.08)	1.43 (0.94)	4.04	.008**	.034
Math course anxiety	2.25 (1.28)	1.96 (1.14)	1.68 (1.05)	1.59 (0.95)	5.02	.002**	.041
Total BMAS	2.27 (1.11)	2.02 (1.06)	1.87 (1.00)	1.69 (0.86)	3.67	.013*	.031

Note. *p < .05; **p < .01; Levene's test showed that variances were not homogeneous for the numerical task anxiety (p = .022) and math course anxiety (p = .006) dimensions; however, because the group sizes (excluding grade 12) were adequate and ANOVA is relatively robust to violations at this level, the results were interpreted with caution; & The size of the grade 12 group (n = 21) is below the criterion of 30 participants, findings related to this group should be interpreted cautiously

score distribution on this dimension shows greater clustering at both extremes compared to the other dimensions.

Mathematics Anxiety by Gender

An independent samples t-test was applied to determine whether students' mathematics anxiety levels differed by gender; the results are presented in **Table 4**.

As shown in **Table 4**, no statistically significant difference was found between female and male students' mathematics anxiety scores, either in the total score ($t[351] = 0.59$, $p = .553$) or in any of the subscales (all p-values > .05). The effect sizes (d = 0.01-0.11) are also negligible according to Cohen's (1988) criteria.

Mathematics Anxiety by Grade Level

A one-way ANOVA was applied to examine whether mathematics anxiety differed by grade level; the results are presented in **Table 5**.

According to **Table 5**, no significant difference was found among grade levels on the math test anxiety dimension (p = .327). In contrast, numerical task anxiety ($F[3, 349] = 4.04$, $p = .008$, $\eta^2 = .034$), math course anxiety ($F[3, 349] = 5.02$, $p = .002$, $\eta^2 = .041$), and the total BMAS score ($F[3, 349] = 3.67$, $p = .013$, $\eta^2 = .031$) differed significantly by grade level. The effect sizes are small to moderate according to Cohen's (1988) criteria. Tukey HSD post hoc comparisons showed that the difference was largely concentrated between ninth-grade students and students in the upper grades. Ninth-grade students' numerical task anxiety scores were significantly higher than those of eleventh-grade (MD = 0.47, p = .029) and twelfth-grade (MD = 0.74, p = .047) students; their math course anxiety scores were significantly higher than those of eleventh-grade students (MD = 0.57, p = .003); and their total BMAS scores were likewise significantly higher than those of eleventh-grade students (MD = 0.40, p = .031). Other pairwise comparisons did not reach significance. This indicates that mathematics anxiety, particularly on the numerical task and course-related dimensions, follows a pattern of being higher in the lower grades (grade 9) and gradually decreasing toward the upper grades.

Mathematics Anxiety by Mathematics Course Grade

Whether mathematics anxiety differed by students' mathematics course grade was examined using a one-way ANOVA; the results are presented in **Table 6**.

Given the borderline p-values obtained for math test anxiety (p = .070) and math course anxiety (p = .060), the observed power for these comparisons was likely below the conventional .80 threshold given the relevant subgroup sizes, suggesting that these comparisons may have been underpowered to detect a true effect consistent with the sample size limitation already noted elsewhere in the manuscript. As shown in **Table 6**, no statistically significant difference was found among the mathematics course grade groups on any dimension (all p-values > .05). Nevertheless, it is notable that the p-values for math test anxiety (p = .070) and math course anxiety (p = .060) were close to the significance

Table 6. Comparison of mathematics anxiety scores by mathematics course grade

Dimension	3 or below (n = 38): M (SD)	4 - good (n = 195): M (SD)	5 - very good (n = 120): M (SD)	F(2, 350)	p	η^2
Math test anxiety	2.55 (1.10)	2.17 (0.84)	2.36 (1.25)	2.67	.070	.015
Numerical task anxiety	2.19 (1.20)	1.90 (1.13)	1.90 (1.38)	0.95	.387	.005
Math course anxiety	2.42 (1.15)	1.96 (1.05)	1.92 (1.39)	2.84	.060	.016
Total BMAS	2.39 (1.01)	2.00 (0.91)	2.07 (1.29)	2.10	.124	.012

Note. Because the assumption of homogeneity of variance was violated for the math test anxiety dimension (Levene's $p < .001$), the Welch F test was additionally calculated for this dimension; Although Levene's test indicated homogeneous variances for the math course anxiety dimension ($p = .555$), the Welch F test was also computed for this dimension as an additional robustness check; For math test anxiety, Welch $F(2, 93.12) = 2.58$, $p = .081$; for math course anxiety, Welch $F(2, 98.00) = 2.98$, $p = .056$; & Both tests produced results consistent with the classical ANOVA findings, at the borderline of significance but not statistically significant

Table 7. Comparison of mathematics anxiety scores by daily mathematics study time

Dimension	None (n = 61): M (SD)	< 30 min (n = 86): M (SD)	30-60 min (n = 133): M (SD)	≥ 1 hr (n = 73): M (SD)	F(3, 349)	p	η^2
Math test anxiety	2.26 (1.02)	2.19 (0.79)	2.31 (1.08)	2.33 (1.21)	0.34	.798	.003
Numerical task anxiety	2.08 (1.22)	1.71 (0.94)	2.03 (1.33)	1.90 (1.32)	1.51	.212	.013
Math course anxiety	2.04 (1.12)	1.87 (1.01)	2.03 (1.26)	2.02 (1.32)	0.39	.759	.003
Total BMAS	2.13 (1.02)	1.92 (0.82)	2.12 (1.15)	2.08 (1.21)	0.71	.545	.006

Table 8. Categories regarding students' emotional state before the mathematics class/exam

Category	f	P (%)
A bit excited, but not anxious	151	42.8
Very calm and confident	128	36.3
Mild tension or worry	41	11.6
Moderate anxiety (heart palpitations, sweating)	24	6.8
Very strong anxiety (fear, shortness of breath, nausea, etc.)	5	1.4
Always feels this way in class	4	1.1
Total	353	100

Note. P: Percentage

threshold, and that the group with the lowest grade average (3 or below) reported the highest anxiety scores at the descriptive level.

Mathematics Anxiety by Daily Study Time

Whether mathematics anxiety differed by daily mathematics study time was examined using a one-way ANOVA; the results are presented in **Table 7**.

Examining **Table 7**, it can be seen that the daily mathematics study time groups did not show a statistically significant difference on any dimension (all p-values > .05; η^2 values ranged from .003-.013, a negligible level). This finding indicates that, in this sample, the amount of study time set aside did not create a statistically significant difference in students' level of mathematics anxiety. Anxiety appears to be influenced by variables other than the amount of studying.

Qualitative Findings

This section presents the content analysis findings regarding students' emotional states before the mathematics class/exam, the causes of mathematics anxiety, coping strategies, perceptions of the teacher, and expectations for an ideal class.

Table 9. Categories regarding the causes of mathematics anxiety reported by students

Category	f	P (%)
Fear of failure	172	48.7
Difficulty understanding mathematical concepts	130	36.8
Inadequate preparation	105	29.7
High expectations (family, teacher, friends)	104	29.5
Exam difficulty/exam pressure	53	15.0
Comparing oneself with classmates	32	9.1
Past negative experience (low grades, being mocked)	31	8.8
Teacher's teaching style or attitude	18	5.1
Other	43	12.2

Note. P: Percentage & Because opinions could fall into more than one category, percentages were calculated based on N = 353 and therefore sum to more than 100% (total number of mentions = 688)

Emotional state before the mathematics class/exam

According to **Table 8**, the large majority of students (79.1%) reported feeling "a bit excited, but not anxious" or "very calm and confident" before a mathematics class or exam. This finding is consistent with the quantitative findings (the low-anxiety rate being 71.7% in **Table 3**). In contrast, approximately 8% of students described anxiety accompanied by moderate to very strong somatic symptoms (heart palpitations, shortness of breath, nausea). This group of students corresponds to a subgroup that overlaps with the high-anxiety category in the quantitative findings (11.3%).

Causes of mathematics anxiety

According to **Table 9**, the most frequently reported cause of mathematics anxiety among students is fear of

Table 10. Categories regarding the strategies students use to cope with mathematics anxiety

Category	f	P (%)
Studying more/using additional resources	185	52.4
Asking for help when not understanding (friend, teacher, tutoring)	138	39.1
Talking to the teacher or a trusted adult	55	15.6
Using positive self-talk ("I can do this," "I will succeed")	53	15.0
Using breathing exercises / relaxation techniques	49	13.9
Has no particular strategy	21	5.9
Avoiding anxiety-inducing situations (skipping class, not doing homework)	16	4.5
Other	39	11.0

Note. P: Percentage & Because opinions could fall into more than one category, percentages were calculated based on N = 353 and therefore sum to more than 100% (total number of mentions = 556)

Table 11. Categories regarding the perceived effect of teacher behavior/teaching style on anxiety

Category	f	P (%)
The teacher's supportive, warm attitude reduces anxiety	150	42.5
The teacher's calm and clear explanation reduces anxiety	112	31.7
The teacher's teaching style does not affect anxiety	59	16.7
The teacher's indifference/inaccessibility increases anxiety	13	3.7
The teacher being strict/critical increases anxiety	7	2.0
Fast-paced lessons/inadequate explanation increases anxiety	7	2.0
Unfair evaluation increases anxiety	5	1.4
Total	353	100

Note. P: Percentage & Because opinions could fall into more than one category, percentages were calculated based on N = 353 and therefore sum to more than 100% (total number of mentions = 688)

failure (48.7%). This is followed by difficulty understanding mathematical concepts (36.8%), inadequate preparation (29.7%), and high expectations from family/teachers/friends (29.5%). It is notable that the teacher's teaching style or attitude is the least frequently cited category as a cause (5.1%). This finding indicates that the source of anxiety is largely associated with students' own perceptions of performance and academic expectations, while external (teacher-related) factors are emphasized comparatively less.

Strategies for coping with mathematics anxiety

As shown in **Table 10**, the coping strategy students turn to most often is studying more or using additional resources (52.4%). This is followed by asking for help with topics they do not understand (39.1%). These two strategies reflect problem-focused (resource-seeking) forms of coping. The comparatively lower preference for emotion-focused strategies such as breathing exercises/relaxation techniques (13.9%) and positive self-talk (15.0%) indicates that students mostly turn to academic/cognitive strategies in managing their anxiety. 5.9% of students stated that they had no clear coping strategy, and 4.5% reported engaging in avoidance behavior (such as skipping class or not doing homework). This last group represents a subgroup that copes with anxiety in a nonfunctional way and may be considered a priority for intervention.

Table 12. Categories of expectations regarding the ideal mathematics class design that would reduce anxiety

Category	f	P (%)
A suitable and fair classroom atmosphere	122	34.6
Teaching methods suited to different learning styles (visual, auditory, hands-on)	62	17.6
A teacher who gives individual attention to every student and communicates openly	45	12.7
A calm, understanding, and motivating teacher	38	10.8
Alternative assessment such as projects/group work instead of exams	24	6.8
An environment where mistakes are treated as part of the learning process	17	4.8
Relating topics to everyday life	12	3.4
A less competitive, cooperation-based environment	5	1.4
Other	28	7.9
Total	353	100

Note. P: Percentage & N = 353

Perceived effect of teacher behavior on anxiety

According to **Table 11**, the large majority of students (74.2%) stated that the teacher's supportive/warm attitude or calm and clear explanation reduced their anxiety. Approximately 9% of students stated that the teacher's indifference, strict/critical attitude, inadequate explanation, or unfair evaluation increased their anxiety.

Expectations regarding the ideal mathematics class design

According to **Table 12**, the expectation students reported most often is a suitable and fair classroom atmosphere that would reduce anxiety (34.6%). This is followed by teaching methods suited to different learning styles (17.6%) and a teacher profile that gives individual attention to students and maintains open communication (12.7%). A relatively small proportion of students (6.8%) requested alternative forms of assessment, such as projects or group work, instead of exams.

DISCUSSION

This study set out to determine the mathematics anxiety levels of secondary school students in Kazakhstan, examine how this anxiety varies across demographic variables, and identify the strategies students use to cope with it.

The conclusions made from the findings are that secondary school students demonstrate low-to-moderate levels of mathematics anxiety, and the overwhelming majority of them attend math classes and exams being relaxed and not tense. These results agree with the existing literature rather well, as the studies conducted around the world indicate that the level of mathematics anxiety may differ significantly under various cultural, educational and demographic conditions. Thus, in a study done with high school students in Vietnam, Luu-Thi et al. (2021) found that there was a significant relationship between mathematics anxiety and grade, academic achievement and career choice, and high-achieving students suffered from mathematics anxiety as well, making their anxiety levels unacceptable to neglect. It means that the low-to-moderate mathematics anxiety in general cannot be considered as the whole answer to the problem. In addition, in a research conducted with Mexican high school students, Barranco et al. (2024) discovered that mathematics anxiety was linked to academic engagement, meaning that the phenomenon was not only emotional but was connected with classroom activities as well. Taken together, these findings from the present study support the idea that mathematics anxiety shows up with different intensity and different patterns across education systems, meaning a single universal intervention model is unlikely to work equally well everywhere.

One more important conclusion to draw from this research is the fact that there were no statistically significant differences found between male and female participants in terms of the total mathematics anxiety score as well as in all subscale scores. This conclusion aligns with the current research trend suggesting that mathematics anxiety should be measured separately from gender-related assumptions. In addition, it is consistent with the results of Mitchell and George (2022) who found no gender-related differentiating effect on mathematics anxiety at the primary school level. One largely qualitative study conducted with female participants in New Zealand by Mann and Walshaw (2019) shows that girls experience mathematics anxiety mostly due to external triggers such as societal expectations, perception of the teacher, and comparisons with peers. In other words, even without the presence of a statistically significant gender difference, girls might experience mathematics anxiety in a qualitatively different manner. From this perspective, the qualitative results of the present study can also be seen as indicating the social comparison process which affects all participants of the study irrespective of gender. It is also worth noting that the absence of a significant gender-based difference does not mean anxiety is experienced identically by male and female students; it only reflects equality at the level of average scores. Future studies would therefore benefit from going beyond quantitative equivalence and using qualitative research to bring out gender-specific differences in experience in more detail.

Concerning grade level, it was found out that students of ninth grade achieved better results compared to the results of upper-grade students especially when it came to their anxiety concerning numerical tasks, mathematics course, and overall BMAS score. This finding confirms the hypothesis that the anxiety of students towards mathematics could increase when they move from primary to secondary education due to some reasons like the increased abstraction of the curriculum, changing teachers and classroom environment, and growing expectations, but then it would decrease over time. However, this conclusion contradicts the findings of Luu-Thi et al. (2021), who reported that students of twelfth grade had higher levels of mathematics anxiety compared to other grades. The importance of this contradiction is that it proves that the link between mathematics anxiety and grade level depends on many factors and differs greatly between different education systems, university entrance examinations, and curriculum density. Indeed, the fact that grade 12 is related to preparation for entrance exams in Vietnam may contribute to the concentration of math anxiety in that grade in comparison to the Kazakhstani education system, where similar pressures might manifest themselves in higher grades instead of grade 9. On the other hand, the reason for the inverted correlation between the variables under analysis can be explained through factors like students' familiarity with the material studied, better relationships with the teachers, and the development of the concepts learned. However, it is important to note that the grade 12 subsample in the present study was considerably smaller ($n = 21$) than the other grade groups and fell below the minimum cell size ($n = 30$) adopted for comparative analyses in this study; this limits the statistical power and stability of the grade 12 estimates and constrains the confidence that can be placed in this cross-study comparison with Luu-Thi et al. (2021). Overall, the nature of the relationship between grade level and math anxiety can be regarded as nonlinear and highly dependent on various contextual factors.

Despite the lack of statistically significant differences according to the mathematics course grade in all subscales, p-values for math test anxiety and math course anxiety are quite near the significance criterion, and the students who obtained the lowest grades scored the highest in terms of anxiety levels, which implies that with a higher number of participants the correlation might become significant. This result can be interpreted as in line with current research on the complex nature of the relationship between mathematics achievement and mathematics anxiety. According to Zuo et al. (2024), the impact of cognitive activation on mathematics achievement is moderated by the mediating factors of self-efficacy and mathematics anxiety, which means that the impact of anxiety on achievement is indirect rather than direct. In the same vein, Pei et al. (2026) showed that the relationship between mathematics anxiety and mathematics performance was also mediated by mathematical engagement, implying that even high anxiety levels could not negatively affect achievement when there was a sufficient level of engagement in the lesson process. Given the mediating mechanisms these two studies point to, the lack of a direct effect from the academic grade variable in the present study may well stem from the multivariate nature of the anxiety-achievement relationship, and testing this relationship in future studies with mediating and moderating variables included would be a useful contribution to the field.

It is evident that the amount of time per day devoted to learning mathematics had no significant correlation with mathematics anxiety, which aligns with the literature review suggesting that mathematics anxiety cannot be described by using just one behavioral variable. Zhang and Zhou (2024), through the research carried out among Chinese middle schoolers in which necessary condition analysis was used along with qualitative comparative analysis, have found that none of the variables considered, namely math grades, parental support, learning motivation, learning planning, and learning interest, serve as a necessary condition for anxiety alone. Furthermore, Wijaya et al. (2022) note that teacher support and parental support, stress levels, and student well-being affect each other, as well as mathematics achievement, and therefore it can be assumed that one-dimensional behavioral indicator cannot explain the phenomenon of anxiety alone.

The results of the qualitative study about the feelings of students immediately prior to attending a math class or taking an exam revealed that the vast majority (79.1%) of students experienced mild feelings of being excited or calm, whereas only a minority subgroup was characterized by severe feelings of anxiety, including physiological symptoms like a rapid heartbeat, perspiration, and nausea. It is worth mentioning that these results correlate with those obtained during the quantitative analysis regarding the level of anxiety being distributed into low-high categories. The presence of the subgroup of individuals experiencing physiological symptoms corresponds to both traditional and modern sources claiming that mathematics anxiety is not only a cognitive state of fear but a multi-component process that includes physiological activation as well. The study carried out by Azzarello et al. (2025) investigating the interrelationship between mathematics anxiety, statistics anxiety, and self-efficacy among university students revealed that students with low self-efficacy tend to have more physiological and emotional responses when doing mathematical assignments. On the contrary, Smith et al. (2026) demonstrated that the connection between mathematics anxiety and mathematics confidence can change over time, such that the right intervention designed to increase confidence may result in a decrease in anxiety. It means that there is great potential for influencing the small subgroup characterized by mathematics anxiety detected in the current research. In this context, the development of psychoeducational awareness programs for schools directed specifically at the students with somatic complaints might provide an efficient way to conduct interventions.

Fear of failure, problems with understanding mathematical concepts, and high expectations from the surrounding people were the factors that students mentioned most often as sources of mathematics anxiety, thus implying that mathematics anxiety is mainly caused by internal sources of performance-related nature. It agrees with findings of Prahmana et al. (2021) who state that in the sample of junior high school students from Indonesia, difficulties with understanding mathematical concepts and exam pressure were among the most significant predictors of mathematics anxiety. According to Mohamed and Tarmizi (2010), the sources of mathematics anxiety vary a lot between different countries; thus, for example, while in some cases it is determined by the teacher's attitude, in other cases – by the family pressure. This implies that the lowest rate of teachers being mentioned in the current research may be caused by something related specifically to the culture of Kazakh families and education rather than being an international trend. What is important is that students perceive themselves as the main sources of mathematics anxiety, while others are perceived as external agents responsible only to a lesser degree. This indicates that students experience mathematics anxiety as an internalized sense of inadequacy, which in turn suggests that interventions need to target not just the teaching environment but also students' own perceptions of achievement and how they attribute their successes and failures.

The use of problem-focused strategies, like studying harder and getting help, by students to cope with their stress shows that the selected group is mostly handling their anxiety in a functional manner. This finding correlates with the results of Muwonge et al.'s (2018) study on secondary school students, where cognitive appraisal style was proven to affect achievement emotions and motivation. The students who were using problem-focused cognitive appraisal had more positive motivation towards mathematics. Nevertheless, it is worth noting that the use of emotion-focused coping mechanisms, like breathing and relaxation techniques, is not as popular among the students as problem-focused strategies, meaning that emotional regulation skills do not play a significant role in the students' anxiety management process, and therefore are not given enough space in school curriculums. Some students claimed that they do not have any coping strategy at all while some other students reported avoiding behavior. It is clear that there is a subgroup of students who manage their anxiety in a nonfunctional way. These findings make clear that school-based intervention programs need to go beyond academic support alone and systematically build students' emotion-focused coping skills, including breathing exercises, cognitive restructuring, and positive self-talk.

The results also indicate the significant influence of teachers' behavior and teaching style on math anxiety in the eyes of students, with over 78% of the students indicating that supportive, warm, and approachable behavior of the teacher serves as an influential factor in decreasing math anxiety. The result is in line with Li et al.'s (2023) longitudinal four-wave study conducted with elementary school students, who demonstrated that teacher support led to engagement in mathematics learning and decreased different aspects of math anxiety. The finding proves that the impact of the teacher-student relationship on math anxiety is not limited to the secondary level of education and functions as a universal mechanism regardless of the educational stage. In Turkey, similarly, the perceptions of the quality of math instruction were significantly related to math anxiety and math achievement, with positive math instruction resulting in decreased anxiety and increased achievement (Çiftçi, 2015).Although the relatively low proportion of students citing teacher indifference, rigidity, or unfair evaluation as anxiety-increasing factors suggests that the teacher-student relationship in the Kazakh secondary school context is generally on positive footing, the experiences of this small subgroup should not be dismissed, and teacher training programs clearly need to devote more attention to classroom climate and empathetic communication skills.

Examining the limitations associated with this study, firstly, the sample used here was selected on the basis of convenience sampling and only included students who could be accessed via the online questionnaire, which affects the generalizability of the findings as the sample does not include students from regions where access to internet is poor. Moreover, the uneven distribution of participants by grades, especially when we consider that the sample of twelfth graders was much smaller than samples in the other groups, reduces the statistical power of these findings. Furthermore, given that the research was conducted in the cross-sectional way, it becomes impossible to make any firm statements regarding causality because the difference between grades can be due either to developmental changes or simply to cohort effects. Finally, the nature of the data collected, i.e., it was obtained solely on the basis of self-reports, suggests that there is a risk of under- or over-reporting of anxiety levels among students due to social desirability bias.

CONCLUSION AND RECOMMENDATIONS

Through combining qualitative and quantitative research data, this study aimed at measuring the mathematics anxiety levels among students in secondary schools in Kazakhstan. Most of the respondents had low anxiety levels about math, however, there was a small but definite group of students who had high anxiety levels accompanied by somatic complaints. While gender and study time per day were not significant variables for measuring the levels of anxiety, grade level emerged as a differentiating variable since anxiety was very concentrated among ninth-graders. Based on the qualitative results, fear of failure and lack of comprehension were identified as the major internal factors causing math anxiety, whereas teacher's support became a perceived protective factor. Thus, based on the results obtained in this study, mathematics anxiety can be regarded as a multivariate and context-dependent issue, which is generally subject to intervention; therefore, teachers and school management have to commit themselves to solving this problem.

Based on these findings, there are a number of suggestions that can be offered to teachers. Math teachers, especially those who deal with ninth graders at that crucial transition period, might consider tracking their students' level of anxiety in class through informal observations and quick tests in order to identify the most anxious individuals and offer them some help. It could also be advisable for schools' counseling departments to create some short psychoeducational programs involving breathing techniques and cognitive restructuring for those students who suffer from somatic reactions before test-taking and lessons, thus complementing the problem-oriented strategies currently used by those who have them by adding some emotion-focused techniques. In addition, training and in-service courses for teachers must necessarily involve not only professional skills, such as knowledge of the subject matter, but also skills associated with creating a positive climate in the classroom, offering constructive criticism and cultivating a teaching culture where mistakes are tolerated. Finally, offering alternative means of assessment, such as project assignments, could be a good practical solution corresponding to the desires of students themselves.

With regard to the future research, longitudinal studies, where one sample is tracked through different grades, could provide stronger support for the claims about causality in the relationship under study, compared to the cross-sectional design used in this project. In addition, further examination of the relationship between mathematics anxiety and academic performance through mediator variables like self-efficacy, cognitive engagement, and teacher support could help to determine the mechanisms involved in the formation of these borderline relationships. Another suggestion is that research using larger stratified samples could be carried out to investigate such underrepresented groups as twelfth graders. Moreover, testing school-based programs of intervention directed at reducing mathematics anxiety using experimental or quasi-experimental designs would make it possible to provide recommendations on implementation of the coping skills and teachers' support perceptions identified in this study.

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