Article

Volume 3 (2025), pp. 105-119
American Journal of STEM Education: Issues and Perspectives

Examining the Influence of Demographic Variables on Mathematics Test Anxiety

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ABSTRACT

Mathematics test anxiety adversely impacts students' performance, engagement, and attitudes toward STEM fields. In this study, we examined how age, gender, and education influence math test anxiety. Results from 102 participants indicate younger students experience higher anxiety than older students, and females report more anxiety than males, especially shortly before a test. Contrary to expectations, educational attainment did not significantly relate to anxiety during surprise quizzes. Findings underscore the complexity of math anxiety, shaped by demographic variables and influenced by parental attitudes, pedagogical approaches, and intergenerational factors. Addressing math anxiety requires targeted strategies that consider individual differences and environmental influences. Interventions to reduce math anxiety can improve learning outcomes, support STEM persistence, and foster positive experiences in mathematics.

Keywords: Math Anxiety, Math Performance, Age Difference, Intervention in Math Education

INTRODUCTION

Mathematics test anxiety is a pervasive issue that adversely affects students across various educational levels, potentially impeding their academic performance and shaping their attitudes toward mathematics (Ashcraft & Krause, 2007; Baral et al., 2024). This form of anxiety is not only prevalent among students but can also affect educators, influencing their pedagogical practices and interactions with students (Galeano et al., 2024). The factors contributing to mathematics anxiety are complex and multifaceted, often linked to working memory constraints and performance pressures (Ashcraft & Krause, 2007). Moreover, recent studies have emphasized the role of demographic variables such as age, gender, and educational attainment in influencing anxiety levels, highlighting a significant gap in understanding the interplay between these factors (Fergus & Smith, 2022).

The familial and educational environment has been shown to play a critical role in the development and perpetuation of math anxiety. The intergenerational transmission of math anxiety from parents to children is a well-documented phenomenon that underscores the importance of addressing anxiety in educational settings to break this cycle (Maloney et al., 2015). Additionally, emerging research suggests that parents' and educators' anxiety can significantly impact children's learning outcomes, forming a complex network of influence that extends beyond the individual (Carkoglu, Eason, & Purpura, 2023).

Given the broad and impactful nature of mathematics test anxiety, this study aims to examine specific demographic factors such as age, gender, and education level that influence this anxiety. This study investigates the effects of demographic factors—specifically age, gender, and educational attainment on mathematics test anxiety.

LITERATURE REVIEW

Math anxiety, characterized by a debilitating fear of engaging with mathematical tasks, can significantly hinder students' academic performance, reduce their engagement in math-related activities, and ultimately deter them from pursuing careers in STEM fields (Ashcraft & Moore, 2009; Beilock, Gunderson, Ramirez, & Levine, 2010; Baral et al., 2024). For this study, 24 related articles were selected to examine the factors influencing math anxiety, its impact on various demographics, and potential strategies for mitigation.

Domain-Specific Nature of Math Anxiety

Past studies recognize math anxiety as a distinct construct, separate from general academic anxiety. This distinction is vital for developing targeted interventions. For example, Sasanguie et al. (2024) found that math anxiety, reading anxiety, and test anxiety are separable constructs, each uniquely affecting performance in their respective domains. This suggests that interventions tailored specifically to address

math anxiety could be more effective than those aimed at reducing general academic stress.

Studies have shown that math anxiety negatively impacts math performance, leading to a vicious cycle where poor performance further increases anxiety, thereby reducing students' willingness to engage with math (Maloney & Beilock, 2012). This phenomenon is particularly concerning because math achievement is a strong predictor of future success in STEM careers, which are critical for innovation and economic growth (Stoet & Geary, 2018).

Interplay between Math Anxiety, Parental Influence, and Pedagogical Practices

Several studies highlight the complex relationship between students' math anxiety, the anxiety experienced by their parents, and the impact of specific teaching methods. Carkoglu et al. (2023) propose a model to elucidate the pathways through which parents' math anxiety affects their children's math achievement. Moreover, Fergus and Smith (2022) suggest that proficiency-based learning in middle grades could alleviate math anxiety, pointing toward the significance of instructional design in managing anxiety. These findings emphasize the need for holistic approaches considering familial and educational environments when addressing math anxiety.

Recent research has expanded this understanding by highlighting the role of parental math anxiety and its transmission to children, as well as how different pedagogical approaches can mitigate or exacerbate these anxieties (Maloney et al., 2015). Carkoglu, Eason, and Purpura (2023) propose the Parent and Child Math Anxiety Network model, which synthesizes research on the relationship between parents' math anxiety and children's math achievement. Their model suggests that parents' math anxiety can affect children's math performance through several pathways, including modeling of anxious behaviors, the math-related interactions parents engage in with their children, and the math attitudes they convey. This model underscores the importance of addressing parental math anxiety in interventions designed to reduce children's math anxiety.

The pedagogical practices employed in teaching mathematics can either alleviate or amplify students' math anxiety. Fergus and Smith (2022) explore how proficiency-based learning, characterized by clear learning objectives, assessment for learning, and opportunities for reassessment, can create a supportive learning environment that reduces math anxiety. Their study indicates that certain characteristics of proficiency-based learning, such as reassessment opportunities, are particularly effective in mitigating math anxiety among middle-grade students. This finding suggests that educational practices emphasizing understanding and mastery over performance can be critical in reducing math anxiety.

Galeano et al. (2024) look into early childhood educators' math anxiety and its relation to pedagogic actions, further illustrating the importance of teacher attitudes and competencies in shaping students' math experiences. They found that

certified preschool teachers with higher levels of math anxiety engaged less frequently in math teaching and discussions, indicating that teacher anxiety can significantly impact the quantity and quality of math instruction students receive. Considering these findings, it is evident that interventions aimed at reducing math anxiety need to adopt a holistic approach that considers the interconnected roles of parents, teachers, and pedagogical practices. Programs that provide support and resources to parents, helping them to address their math anxieties, could prevent the transmission of these anxieties to their children (Maloney et al., 2015). Similarly, professional development for teachers focusing on reducing math anxiety and promoting positive math teaching practices could enhance the learning environment and reduce students' math anxiety (Galeano et al., 2024).

In addition, math anxiety can influence students' self-efficacy and interest in STEM, with higher levels of anxiety associated with lower confidence in one's mathematical abilities and a decreased interest in pursuing STEM disciplines (Ahmed et al., 2012). Addressing math anxiety is thus essential not only for improving individual academic outcomes but also for ensuring a diverse and capable STEM workforce.

Math Anxiety on Performance and Engagement in STEM Fields

Studies such as those by Mesghina et al. (2024) and Szczygieł (2022) explore how math anxiety can deter students from pursuing STEM careers, underscoring the importance of interventions that target both the cognitive and affective domains of math learning.

Studies highlight the multifaceted nature of math anxiety, stressing the need for multidimensional strategies that address individual, familial, and pedagogical factors to combat its negative impacts effectively. Some studies suggest that math anxiety is linked to lower performance in mathematics, which, in turn, can lead to a self-reinforcing cycle of avoidance and decreased competence in STEM subjects (Maloney & Beilock, 2012). Also, math anxiety can significantly deter engagement with STEM fields, particularly among females, contributing to the gender disparity observed in STEM careers (Stoet & Geary, 2018). This gender gap is partly attributed to higher levels of math anxiety reported among women, which affects their confidence and interest in pursuing STEM-related pathways (Else-Quest et al., 2010).

Interventions to reduce math anxiety, such as fostering a growth mindset, incorporating math anxiety reduction strategies into classroom practices, and promoting positive math experiences early on, are critical for enhancing STEM engagement and achievement.

RESEARCH METHOD

This study employs a cross-sectional survey design to explore the relationship between math anxiety and demographic variables. This study will investigate the

effects of demographic factors—specifically age, gender, and educational attainment—on mathematics test anxiety. The following questions will guide this study:

1. What is the relationship between age group and levels of anxiety experienced during mathematics exams?
2. Does gender influence the anxiety level when preparing for a mathematics test, specifically five minutes before the test?
3. How does the educational level correlate with anxiety levels when students are given a "pop" quiz in a mathematics class?
4. How do age, gender, and the highest level of education influence the level of anxiety students experience when thinking about an upcoming mathematics test one week before?

Data Collection

Data were collected through an online survey distributed to participants across different age groups, gender identities, and educational backgrounds. The survey, expected to take approximately 3-5 minutes to complete, includes questions that assess the intensity of math anxiety in specific scenarios (e.g., before an exam, while studying, or when thinking about math courses required for a major). Responses to math anxiety levels are measured on a Likert scale ranging from 1 ("Not at all") to 5 ("Very much"). Additional demographic questions cover age, gender, and the highest level of education completed to explore potential correlations with math anxiety. Participants were recruited via email and social media (Facebook).

Variables

The variable of interest is math anxiety, operationalized through participants' self-reported anxiety levels in predefined math-related scenarios. Independent variables include age group, gender, and educational level, which were analyzed to identify demographic patterns in math anxiety levels.

Results

The survey on mathematics test anxiety was completed by 102 participants. The demographic features of participants related to age, gender, and education have been presented in Table 1.

Most participants fell in the age group between 25 to 34 (48 %). Likewise, 65.7 % of participants were male and 54.9 % of participants had completed their graduate school. This distribution suggests that the sample mainly consisted of young adults with a higher education background, which might influence the interpretation of the math anxiety levels reported.

Table 1. Demographic Characteristics of Participants

		N	%
Age group	18-24	47	46.1%
	25-34	49	48.0%
	above 35	6	5.9%
Gender	Female	35	34.3%
	Male	67	65.7%
Education	Below HS	8	7.8%
	HS	12	11.8%
	College	26	25.5%
	Grad	56	54.9%

Note: HS = High School; Grad: master or higher

Relationship between age group and levels of anxiety experienced during mathematics exams

The one-way ANOVA analysis was computed to investigate if there was a significant relationship between age and levels of anxiety experienced during mathematics exams, and the result is presented in Table 2.

Table 2. Taking an examination (final) in a mathematics course

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15.826	2	7.913	4.937	.009
Within Groups	158.693	99	1.603		
Total	174.520	101			

The one-way ANOVA revealed a significant difference in the level of anxiety experienced during final mathematical exams among various age groups, F (2,99) = 4.937, p=0.009. Additionally, the Tukey post hoc test revealed that there is a statistically significant pairwise difference in anxiety levels between the age group 18-24 and above 35 age group and between the 25-34 and above 35 age group. The students falling in the age group above 35 experience significantly lower average anxiety levels than students falling in the age group 18-24 and 25-35. This indicates that younger students experience higher anxiety levels than older students when taking the final examination of mathematics. The result of the Tukey post hoc test has been presented in Table 3

Table 3. Tukey post hoc test

Age group	Age group	Mean Difference	Std. Error	Sig.
18-24	25-34	-.07642	.25849	.953
	above 35	1.62766*	.54888	.010
25-34	18-24	.07642	.25849	.953
	above 35	1.70408*	.54761	.007
above 35	18-24	-1.62766*	.54888	.010
	25-34	-1.70408*	.54761	.007

Dependent variable: Taking an examination (final) in a mathematics course.

The p-value of the homogeneity of variance test is more than 0.05, indicating an equal variance of anxiety level across the different age groups. This indicates that the assumption of homogeneity of variance for the one-way ANOVA has not been violated.

Table 4 Tests of homogeneity of variance

What is your gender?	N	Mean	Std. Deviation	Std. Error Mean
Female	35	3.9429	0.99832	0.16875
Male	67	3.3433	1.48275	0.18115

Relationship between Gender and levels of anxiety when thinking about math test five minutes before

Independent samples of the T-test were computed to investigate the relationship between gender and anxiety level when thinking about math tests, and the results are presented in Table 5.

Table 5 Independent Samples Test

Independent Samples Test

		Levene's Test		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Thinking about an upcoming mathematics test five minutes before.	Equal variances assumed	14.060	0.000	2.149	100	0.034	0.59957	0.27903
	Equal variances not assumed			2.422	93.529	0.017	0.59957	0.24757

The p-value of Levene's test is less than 0.05, indicating that the variance in anxiety level of males is significantly different than that of females. Thus, results from equal variances, not assumed rows, are referred for the t-test. The T-test

shows that there is a significant relationship between gender and anxiety level (□, $p = 0.017$). The average anxiety level for females (3.9429) was higher than the average anxiety level for males (3.3433), indicating females experience more anxiety than males when they think about mathematics exams. they think about mathematics exams.

Group Statistics

What is your gender?		N	Mean	Std. Deviation	Std. Error Mean
Thinking about an upcoming mathematics test five minutes before.	Female	35	3.9429	0.99832	0.16875
	Male	67	3.3433	1.48275	0.18115

Correlation between educational level and anxiety level when students are given a "pop" quiz in a mathematics class

A Spearman's rank-order correlation was computed to determine the association between educational level and anxiety level, and the result is presented in Table 6.

Table 6. Correlation between education and anxiety level when pop up quizzes in a mathematics class

			Education
Spearman's rho	Being given a "pop" quiz in a mathematics class.	Correlation Coefficient	.063
		Sig. (2-tailed)	.531
		N	102

Spearman's rank-order correlation coefficient was close to zero, indicating no association between education and anxiety level when pop-up quizzes were given in the mathematical class, r(100) = 0.063, p = 0.531. This means that regardless of the level of education attained by participants, it does not change the level of anxiety experienced when pop-up quizzes are given in mathematics class.

Ordinal logistic regression

The study's dependent variable, anxiety level, is ordinal, so ordinal logistic regression was used to analyze the effect of age, gender, and education on the anxiety level. The result of logistic regression has been presented in Table 7.

Table 7 Result of ordinal logistic regression

		Estimate	Std. Error	Wald
Threshold	[Anxiety = Low]	18.317	.347	2783.995
	[Anxiety = Neutral]	19.350	.328	3490.131
Location	18-24	18.013	.598	908.394
	25-34	19.391	.000	.
	Female	.826	.435	3.597
	Below High school	1.143	.924	1.532
	High school	.612	.760	.648
	College	.662	.651	1.033

Reference category
Age: 35 and above
Gender: Male
Education: Graduate

The ordinal logistic regression shows that there is a significant relationship between age and anxiety level at a 5 % significance level and anxiety level and gender at a 10 % significance level.

The positive coefficient value of the age group indicates that students falling in lower age groups have higher odds of experiencing high levels of anxiety compared to the students falling in higher age groups. Similarly, the positive coefficient of females indicates that the female students had higher odds of experiencing higher anxiety levels compared to the male students. Likewise, the positive coefficient of education indicates that students who had lower educational levels have higher odds of feeling a high level of anxiety. However, there was no statistically significant relationship between education and anxiety level.

CONCLUSION

The findings from this study indicate that math anxiety is a major concern among participants, particularly in anticipation of math tests. The increase in anxiety levels as the test approaches underscores the need for interventions that help students manage their anxiety not only during study periods but also in the immediate lead-up to tests.

The survey results show that younger students feel more anxious about math tests than older students. Women reported feeling more anxious than men before math tests. Interestingly, a person's level of education, like whether they finished high

school or college, doesn't significantly affect how anxious they feel during surprise quizzes in math classes. These findings imply multiple meanings, including:
Firstly, the increasing levels of anxiety as the math test approaches (with the highest anxiety reported just one day before the test) underline the domain-specific nature of math anxiety. This specificity echoes past studies suggesting that math anxiety is not merely general academic anxiety but is distinctly tied to mathematics, necessitating targeted interventions (Sasanguie et al., 2024; Carkoglu et al., 2023).

Secondly, the observed differences in math anxiety levels across various situations—ranging from studying for a test to waiting for test results—highlight the complex interplay between individual experiences of anxiety and the broader educational environment. These findings underscore the importance of considering both the cognitive and emotional aspects of learning mathematics, as suggested by Fergus and Smith (2022) and Galeano et al. (2024). Educational practices that provide clear learning objectives and foster a supportive learning environment may mitigate math anxiety's impact, emphasizing the role of pedagogical practices in managing math anxiety.

Lastly, the demographic profile of participants, predominantly young adults with higher education, points to the significant effects of math anxiety on engagement with STEM fields. The prevalence of math anxiety among these demographics suggests that anxiety can persist beyond primary and secondary education, potentially influencing career choices and performance in higher education and professional settings. This connection reinforces the critical need for interventions that address math anxiety early and throughout the educational pipeline to support sustained engagement and success in STEM disciplines (Stoet & Geary, 2018; Beilock et al., 2010).

In conclusion, the survey highlights math anxiety and its nuanced impacts on individuals' experiences in educational contexts. These findings affirm the importance of targeted interventions that address the specific nature of math anxiety and its roots in educational and familial environments.

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Appendix: Online Survey

1. Please describe your experience related to math exams and math anxiety. गणित परीक्षा र **गणित सम्बन्धी चिन्ता** सम्बन्धी तपाईको अनुभवको वर्णन गर्नुहोस्।तपाईको चिन्ताको स्तर कति छ?

	1 Not al all केहि चिन्ता छैन्	2 चिन्ता छैन्	3 न्यूट्रल	4 केहि चिन्ता	5 Very much धेरै चिन्ता
1. Taking an examination (final) in a mathematics course. गणितको पाठ्यक्रममा अन्तिम परीक्षा दिँदा।	○	○	○	○	○
2. Thinking about an upcoming mathematics test one week before. आउँदो गणित परीक्षा बारे एक हप्ता पहिले सोच्दा।	○	○	○	○	○
3. Thinking about an upcoming mathematics test one day before. आउँदो गणित परीक्षा बारे एक दिन पहिले सोच्दा।	○	○	○	○	○
4. Thinking about an upcoming mathematics test one hour before. आउँदो गणित परीक्षा बारे एक घण्टा पहिले सोच्दा।	○	○	○	○	○
5. Thinking about an upcoming mathematics test five minutes before. आउँदो गणित परीक्षा बारे पाँच मिनेट अघि सोच्दा।	○	○	○	○	○
6. Waiting to get a mathematics test returned in which you expected to do well. गणित परीक्षाको परिणाम प्रतीक्षा गर्दै, जसमा तपाईले राम्रो गर्ने आशा गर्नुभएको थियो।	○	○	○	○	○
7. Receiving your final mathematics grade in the mail. अन्तिम गणित ग्रेड प्राप्त गर्दा।	○	○	○	○	○
8. Realizing that you have to take a number of mathematics classes in your major. धेरै गणितका कक्षाहरू लिनु पर्ने सोच्दा	○	○	○	○	○
9. Being given a "pop" quiz in a mathematics class. गणित कक्षामा (क्विज) प्रश्नहरू दिइएको	○	○	○	○	○
10. Studying for a mathematics test. गणित परीक्षाको लागि अध्ययन गर्दा।	○	○	○	○	○
11. Taking the mathematics section of a college entrance examination. कलेज प्रवेश परीक्षाको गणित खण्ड दिँदा।	○	○	○	○	○
12. Taking an examination (quiz) in a mathematics course. गणित पाठ्यक्रममा परीक्षा (क्विज) दिँदा।	○	○	○	○	○
13. Picking up the mathematics textbook to begin working on a homework assignment. गृहकार्य असाइनमेन्टमा काम सुरु गर्नको लागि गणितको पाठ्यपुस्तक उठाउँदा।	○	○	○	○	○
14. Being given a homework assignment of many difficult problems धेरै गाह्रा समस्याहरू भएको गृहकार्य असाइनमेन्ट दिइएको।	○	○	○	○	○
15. Getting ready to study for a mathematics test. गणित परीक्षाको लागि तयारी गर्दै गर्दा।	○	○	○	○	○

2. Age group? तपाईंको उमेर समूह कस्तो हो?

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+

3. What is your gender? पुरुष वा महिला?

- ◯ Female
- ◯ Male
- ◯ Other (specify)

4. What is the highest level of education you have completed? तपाईंले पुरा गरेको शिक्षाको सबैभन्दा उच्च तह ?