EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 11 Issue. 1, July 2026, pp 344-357
http://ejournal.uki.ac.id/index.php/edumatsains

Levels and Dimensions of Mathematics Anxiety among Students Enrolled in the Linear Algebra and Matrices Course

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Article Info

Article history:
Received: July 5th, 2026
Revised: July 29th, 2026
Accepted: July 30th, 2026
Available online: July 31st, 2026

https://doi.org/10.33541/edumatsains.v11i1.8511

Abstract

This study aimed to describe the dimensions of mathematics anxiety based on gender during the learning of Linear Algebra and Matrices. Mathematics anxiety is a psychological factor that influences students' thinking ability, self-confidence, and academic performance when dealing with mathematical problems. This study employed a quantitative descriptive approach involving 40 fourth-semester students at Universitas Indraprasta PGRI during the 2025/2026 academic year. Data were collected using a questionnaire consisting of 23 Likert-scale items measuring three dimensions of mathematics anxiety: somatic, cognitive, and attitudinal. The data were analyzed using descriptive statistics and classified according to the dimensions and measurement criteria of mathematics anxiety. The findings indicated that students' mathematics anxiety percentages ranged from 54.66% to 63.58%, suggesting that their mathematics anxiety levels were within the moderate to high categories. In the somatic dimension, the mathematics anxiety percentage was 55.00% for female students and 54.66% for male students. In the cognitive dimension, both male and female students exhibited the highest anxiety levels compared with the other two dimensions, with percentages of 62.91% and 63.58%, respectively. In contrast, in the attitudinal dimension, male students demonstrated a slightly higher percentage (56.69%) than female students (55.50%). Overall, students' mathematics anxiety was predominantly influenced by the cognitive and attitudinal dimensions. Therefore, efforts to reduce mathematics anxiety should focus on instructional strategies that enhance students' self-confidence, provide opportunities for gradual learning, foster a supportive and low-pressure classroom environment, and offer constructive support and positive feedback to help students overcome anxiety when solving mathematical problems.

Keywords: Gender; Linear Algebra and Matrices; Mathematics anxiety; Cognitive dimension; Attitudinal dimension.

1. Introduction

Mathematics is a fundamental discipline that serves as the foundation for advancements in science, technology, and engineering. At the higher education level, the Linear Algebra and Matrices course is considered one of the core subjects because it fosters students' logical, analytical, and systematic reasoning skills. Moreover, linear algebra and matrices constitute

essential mathematical tools for modeling dynamic systems across various disciplines, including engineering, economics, computer science, and the natural sciences, particularly in representing and analyzing systems involving multiple variables. Despite its importance, classroom observations revealed that many students demonstrated limited participation during learning activities. They tended to avoid engaging in classroom discussions, were reluctant to ask or respond to questions, and exhibited low levels of self-confidence when solving mathematical problems. These behaviors may indicate the presence of mathematics anxiety among students enrolled in the Linear Algebra and Matrices course.

In addition, the characteristics of the course itself may contribute to the emergence of mathematics anxiety. Linear Algebra and Matrices encompasses abstract concepts, extensive use of symbolic and mathematical notation, multi-step problem-solving procedures, rigorous mathematical proofs, and requires a high degree of accuracy and precision. Furthermore, the concepts within linear algebra are highly interconnected, such that insufficient understanding of foundational concepts may impede students' ability to comprehend more advanced topics. Consequently, students often perceive the course as intellectually demanding, which may increase cognitive burden during the learning process. When mathematics is perceived as a difficult and uninteresting subject, such perceptions may negatively influence students' academic performance and learning experiences. As a result, students are more likely to develop feelings of fear, worry, and anxiety when confronted with mathematical tasks, particularly those involving complex problem-solving situations.

One of the psychological factors that frequently emerges and influences students' academic performance in the Linear Algebra and Matrices course is mathematics anxiety (Handayani, 2019). Mathematics anxiety refers to a condition in which individuals experience feelings of fear, low self-confidence, and excessive worry when learning mathematics. When students encounter mathematics-related tasks or situations, they often experience discomfort, tension, or even fear (Y., 2021). Previous studies have consistently demonstrated that mathematics anxiety adversely affects students' ability to solve mathematical problems. Moreover, mathematics anxiety negatively influences students' self-confidence and interferes with the learning process (N. Mukti., 2022). As an internal psychological factor, mathematics anxiety plays a significant role in determining students' academic achievement. Higher levels of mathematics anxiety are generally associated with lower academic performance, indicating a negative relationship between mathematics anxiety and learning outcomes.

From an emotional perspective, individuals differ in their psychological characteristics, making each person unique in the way they respond to various situations. Some individuals are more emotionally reactive, whereas others demonstrate greater patience or are more prone to experiencing fear when facing challenging situations. Although these emotional characteristics are partly innate, they can also be shaped and developed through learning experiences. Mathematics anxiety is one such emotional factor that may vary among individuals. Across different educational levels, one of the factors associated with variations in mathematics anxiety is gender. Gender differences in mathematics anxiety have long been a subject of educational research. Imro'ah (Imro'ah, 2019) reported that female junior high school students exhibited higher levels of mathematics anxiety than their male counterparts. In contrast, Juniardi et al. (M. Juniardi, 2024) found that although mathematics anxiety was

experienced by both male and female junior high school students, the difference in the mean level of anxiety between the two groups was not statistically significant. However, Akmalia (Ulfah, 2021) reported that during the COVID-19 pandemic, female junior high school students experienced significantly higher levels of mathematics anxiety than male students. Similarly, Liana et al. (Liana J. Rahmatia R., 2025) examined the effects of gender and mathematics anxiety on mathematics achievement among junior high school students and found that the interaction between these variables was associated with students' mathematics performance. Furthermore, Juniardi et al. (M. Juniardi, 2024) suggested that gender also influences how students internalize mathematics anxiety through their mathematical self-concept, defined as students' beliefs about their mathematical abilities, with these differences emerging as early as the junior high school level. Consistent with these findings, Yakub et al. (N. A. Yakub., 2023), in a study involving senior high school students, demonstrated that mathematics anxiety reduced students' mathematics self-efficacy differently for male and female students. Despite the growing body of research on mathematics anxiety, previous studies have predominantly focused on secondary school students and mathematics as a general subject. Relatively little attention has been devoted to mathematics anxiety among university students enrolled in the Linear Algebra and Matrices course. In particular, limited evidence is available regarding students' mathematics anxiety across the somatic, cognitive, and attitudinal dimensions, as well as potential gender differences in these dimensions. Addressing this gap is important for providing a more comprehensive understanding of mathematics anxiety in higher education and for informing the development of instructional strategies that are responsive to students' psychological characteristics.

At the higher education level, students generally demonstrate greater psychological maturity and cognitive development. However, these developmental advances are accompanied by increasingly complex course content and more abstract mathematical concepts. Consequently, university students may experience higher levels of mathematics anxiety as they encounter more demanding academic tasks and problem-solving activities. Understanding gender differences in mathematics anxiety in higher education is essential for designing more personalized and effective educational interventions. For example, instructional strategies may be tailored to accommodate gender-related learning characteristics, while emotional support programs and mentoring initiatives can be adapted to address the distinct psychological needs of male and female students. Through the implementation of inclusive and gender-responsive teaching practices, instructors can help reduce psychological barriers to learning and foster students' confidence and conceptual understanding of Linear Algebra and Matrices.

The present study was conducted to extend the existing body of research by examining mathematics anxiety among university students enrolled in the Linear Algebra and Matrices course across the somatic, cognitive, and attitudinal dimensions, with particular attention to gender differences. The findings are expected to provide empirical evidence regarding patterns of mathematics anxiety within the context of higher education, an area that has received relatively limited scholarly attention. Furthermore, the results are expected to contribute to the development of more effective instructional approaches and student support strategies aimed

at reducing mathematics anxiety and enhancing learning outcomes in Linear Algebra and Matrices.

2. Methods

This study employed a quantitative descriptive research design. The sampling technique used was disproportionate stratified random sampling. A total of 40 students (43% of the study population) were selected and divided into two strata based on gender, consisting of 20 male and 20 female students. An equal number of participants from each gender group were intentionally selected to facilitate a balanced comparison of mathematics anxiety between male and female students. The sample size for each class was determined proportionally according to the number of male and female students enrolled in each class within the total population of 93 fourth-semester students from the Department of Informatics Engineering at Universitas Indraprasta PGRI (Unindra PGRI) during the 2025/2026 academic year who had completed the Linear Algebra and Matrices course. The proportional distribution of the sample is presented in Table 1. Within the male stratum, participants were selected through simple random sampling using a lottery method assisted by Microsoft Excel. In contrast, all female students in Classes A, B, C, and D were included using total sampling because the number of female students in each class was equal to the required sample size. Consequently, all eligible female students from these four classes participated as respondents in this study.

Table 1.
Proportional Disribution of the sample by Class and Gender

Class	Population		Total	Sample		Total
	Male	Female		Male	Female	
A	23	5	28	7	5	12
B	17	5	22	5	5	10
C	14	9	23	4	9	13
D	17	3	20	4	3	7
Total	71	22	93	20	20	40

The research data were collected using a mathematics anxiety questionnaire measured on a four-point Likert scale ranging from 1 to 4. Prior to data collection, the instrument underwent a pilot test, followed by a series of psychometric analyses to evaluate its validity, ensuring that it was appropriate for measuring the construct under investigation. The questionnaire consisted of 23 items representing three dimensions of mathematics anxiety: somatic, cognitive, and attitudinal, with the corresponding indicators presented in Table 1 (Cavanagh, 2010). The questionnaire data were analyzed using descriptive statistical techniques. The results were summarized according to the indicators of mathematics anxiety and classified based on the mathematics anxiety measurement criteria presented in Table 3. Furthermore, inferential statistical analyses

were conducted to examine gender differences in mathematics anxiety. Prior to hypothesis testing, the data were assessed for the assumptions of normality and homogeneity of variance. Subsequently, an independent-samples *t* test was performed to determine whether a statistically significant difference existed in the mean mathematics anxiety scores between male and female students.

Table 2.
Indicators of Mathematics Anxiety

Dimension	Indicator	Item Numbers
Somatic	Heart palpitations	1, 7
	Difficulty of breathing	5
	Feeling uncomfortable and expecting	2, 3, 4,6
Cognitive	Feeling confused	8, 10, 12, 13
	Feeling a loss of control	14, 15
	Having a blank mind	9, 11
Attitudinal	Worrying about being negatively evaluated by others when unable to complete a task successfully	17, 19
	Feeling afraid of one's own actions	16, 18
	Expecting difficulties in performing certain task	20, 21, 22
	Lacking the motivation to perfors tasks that should be completed.	23

Table 3.
Classification Criteria for Mathematics Anxiety Levels

No	Category	Interval
1	Very High	x ≥ 64,06
2	High	55,12 ≤ x ≤ 64,06
3	Low	46,18 ≤ x ≤55,12
4	Very low	x ≤ 46,18

3. Result and Discussion

The findings of the present study on students' mathematics anxiety are presented as follows.

3.1. Instrument Validity and Reliability

The validity of the research instrument was evaluated using item validity analysis based on the Pearson product–moment correlation coefficient. The results of the validity test for the 23 questionnaire items indicated that all corrected item correlation coefficients exceeded the critical value of the correlation coefficient (*r* table=0.312) at the 5%

significance level (n = 40). These findings indicate that all questionnaire items were valid and suitable for measuring the intended construct. The reliability analysis yielded a Cronbach's alpha coefficient of 0.889, indicating a high level of internal consistency. This result suggests that the mathematics anxiety questionnaire demonstrated good reliability, with all items consistently measuring the same underlying construct.

Table 4.
Cronbach's Alpha

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.889	.893	23

3.2. Assumption Testing

3.2.1. Normality Test

In this study, the normality test was conducted to examine the distribution of students' mathematics anxiety scores by gender, as obtained from the questionnaire. The data were considered to be normally distributed when the significance value (p) exceeded .05, whereas a significance value of less than .05 indicated that the data were not normally distributed.

Table 5.
Results of the Normality Test

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelompok	Statistic	df	Sig.	Statistic	df	Sig.
Hasil	laki-laki	.145	20	.200*	.921	20	.106
	perempuan	.085	20	.200*	.990	20	.998

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on the results of the normality analysis, the significance value for the male group was .106, whereas the significance value for the female group was .998. Because both significance values exceeded .05, it was concluded that the mathematics anxiety scores for both the male and female groups were normally distributed.

3.2.2. Homogeneity of VarianceTest

The homogeneity of variance test was conducted to determine whether the data obtained from the two groups exhibited equal variances. Establishing homogeneity of variance is essential to ensure that the assumption of equal variances required for the independent-samples *t* test is satisfied.

Table 6.
Results of Homogeneity of Variance Test

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	1.098	1	38	.301
	Based on Median	.806	1	38	.375
	Based on Median and with adjusted df	.806	1	30.584	.376
	Based on trimmed mean	.874	1	38	.356

The homogeneity of variance was assessed using Levene's test. The analysis yielded a significance value (*p*) of .301. Because the significance value exceeded .05, it was concluded that the variances of the mathematics anxiety scores for the male and female student groups were homogeneous. Therefore, the assumption of homogeneity of variance required for the independent-samples *t* test was satisfied.

3.3. Data Analysis

3.3.1. Hypothesis Testing

Hypothesis testing was conducted using an independent-samples *t* test to determine whether there was a statistically significant difference in mathematics anxiety between male and female students.

Table 7.
Results of an Independent-sample t test

Independent Samples Test

		t-test for Equality of Means							
				Significance				95% Confidence Interval of the Difference	
		t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	-.227	38	.411	.822	-.650	2.863	-6.445	5.145
	Equal variances not assumed	-.227	33.674	.411	.822	-.650	2.863	-6.470	5.170

The results of the independent-samples *t* test indicated that there was no statistically significant difference in mathematics anxiety between male and female students, $t(38) = -0.227$, $p = .822$ (two-tailed). Because the significance value exceeded .05, the null hypothesis was not rejected. These findings indicate that there was no significant difference in the level of mathematics anxiety between male and female students in the Linear Algebra and Matrices course. In other words, gender was not a significant factor influencing mathematics anxiety in the context of this study. This finding is consistent with the results reported by Onyeizugbo (Onyeizugbo, 2010), who also found no significant gender differences in mathematics anxiety. The absence of a significant difference suggests that factors other than gender, such as prior learning experiences, environmental support, and instructional strategies, may play a more substantial role in influencing students' mathematics anxiety.

3.3.2. Categorization of Mathematics Anxiety Levels

Ordinal categorization was employed to classify students' mathematics anxiety levels according to the continuum of the measured construct (Sugiono, 2013). In the present study, mathematics anxiety was classified into four categories: very high, high, low, and very low. The categorization procedure began by calculating the mean and standard deviation of the mathematics anxiety scale, followed by determining the minimum and maximum possible scores of the measurement instrument. These statistical values were then used to establish the score intervals for each category of mathematics anxiety.

3.3.3. Mathematics Anxiety Levels by Gender

The descriptive analysis of mathematics anxiety scores by gender indicated that male students had a mean anxiety score of 54.80 ($SD = 10.55$), whereas female students had a mean score of 55.45 ($SD = 7.25$). Each group consisted of 20 participants. The standard error of the mean (*SE*) was 2.36 for the male group and 1.62 for the female group. The descriptive statistics indicate that the mean mathematics anxiety scores of male and female students were relatively similar, with slightly greater variability observed among male students, as reflected by the larger standard deviation. A summary of the descriptive statistics for the mathematics anxiety questionnaire scores is presented in Table 7.

Table 8.
Deskriptive Statistics of Mathematics Anxiety Scores by Gender

Group Statistics

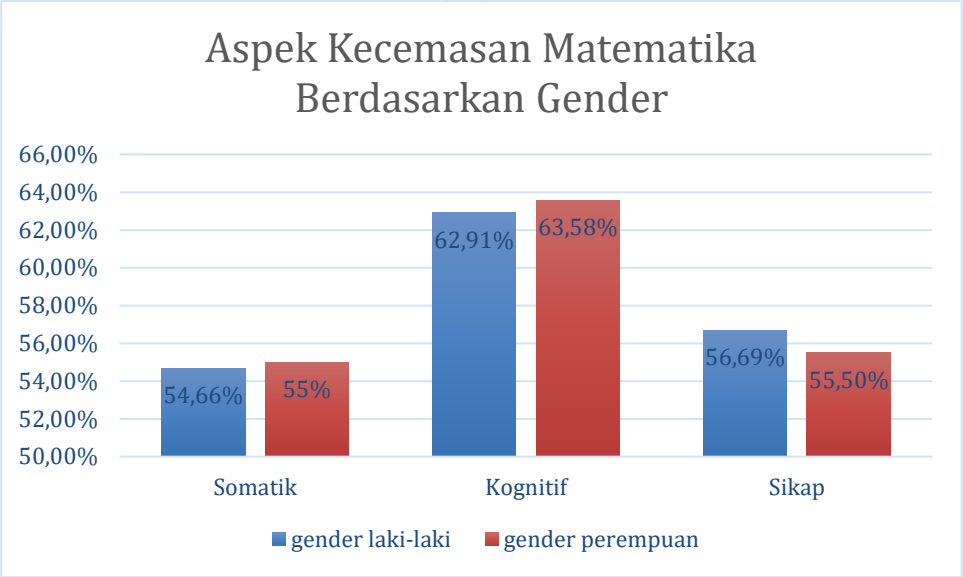
	Jenis kelamin	N	Mean	Std. Deviation	Std. Error Mean
Skor_Total	laki-laki	20	54.8000	10.55113	2.35930
	perempuan	20	55.4500	7.25095	1.62136

Table 7 shows that female students exhibited a slightly higher mean level of mathematics anxiety than male students. However, the difference in the mean anxiety scores between the two groups was relatively small and was not statistically significant. Although female students tended to report slightly higher levels of mathematics anxiety than their male counterparts, the magnitude of the difference was minimal. These findings are consistent with those reported by Pelch (Pelch, 2018), who found that female university students reported significantly higher levels of academic anxiety than male students. Furthermore, Pelch (Pelch, 2018) observed that female students were substantially more likely to report symptoms indicative of high levels of academic anxiety. Nevertheless, in the present study, although female students demonstrated a marginally higher mean mathematics anxiety score, the difference was not statistically significant, suggesting that gender was not a determining factor in students' mathematics anxiety within the context of the Linear Algebra and Matrices course.

3.3.4. Mathematics Anxiety Levels Across the Somatic, Cognitive, and Attitudinal Dimensions by Gender

Following the analysis of students' overall mathematics anxiety scores by gender, a subsequent analysis was conducted to examine mathematics anxiety across its three dimensions—somatic, cognitive, and attitudinal—according to gender. This analysis provides a more detailed description of gender differences within each dimension of mathematics anxiety. The results of the analysis are presented in the following figure.

Figure 1
Dimensions of Mathematics Anxiety by Gender



As shown in Figure 1, the percentages of students' mathematics anxiety across the somatic, cognitive, and attitudinal dimensions are compared by gender. Overall, the analysis revealed that the percentage of mathematics anxiety ranged from 54.66% to 63.58%, corresponding to the low and high categories according to the mathematics anxiety classification criteria.

In the somatic dimension, female students obtained a mathematics anxiety percentage of 55.00%, while male students obtained 54.66%. The difference of only 0.34 percentage points indicates that there was little variation between the two gender groups in terms of the physical manifestations of mathematics anxiety. The somatic dimension includes physiological symptoms such as heart palpitations, difficulty breathing, feelings of discomfort, and cold sweating when solving mathematical problems. This finding is consistent with Hembree (Hembree, 1988), who suggested that somatic symptoms represent common physiological responses experienced by both male and female students when confronted with evaluative situations that induce psychological stress.

In the cognitive dimension, both male and female students exhibited the highest percentages among the three dimensions, with values of 62.91% and 63.58%, respectively. The difference of 0.67 percentage points indicates that female students tended to experience slightly higher levels of cognitive mathematics anxiety than male students. The cognitive dimension encompasses negative thought patterns, including confusion, loss of control, and experiencing a blank mind while solving mathematical problems. This finding is consistent with the study by Zeidner and Schleyer (M. Zeidner., 1998), who reported that female students tend to experience higher levels of test anxiety because they are generally

more vulnerable to self-evaluative concerns and often report lower self-efficacy in science and mathematics-related disciplines. Furthermore, Cassady and Johnson (J. C. Cassady., 2002) argued that the cognitive component of test anxiety is one of the strongest predictors of poor academic performance because it interferes with information-processing processes during examinations.

In contrast to the previous two dimensions, male students exhibited a slightly higher percentage in the attitudinal dimension (56.69%) than female students (55.50%). The attitudinal dimension encompasses concerns about receiving negative evaluations from others when unable to complete academic tasks successfully, fear of engaging in mathematics-related activities, expectations of encountering difficulties when performing certain tasks, and a lack of motivation to undertake academic responsibilities. Although the observed difference was relatively small, it suggests that male students tended to demonstrate slightly more negative attitudes toward mathematics than female students. This finding is consistent with Ellis et al. (J. Ellis., 2016), who reported that male university students were more likely to exhibit negative attitudes toward mathematics because they perceived the subject as less relevant and less engaging.

Overall, the findings indicate that the cognitive dimension constituted the primary source of mathematics anxiety for both male and female students, with substantially higher percentages than those observed for the somatic and attitudinal dimensions. Female students tended to report slightly higher levels of anxiety in the cognitive and somatic dimensions, whereas male students showed marginally higher scores in the attitudinal dimension. However, these differences should be interpreted with caution because the independent-samples t test revealed no statistically significant gender differences in overall mathematics anxiety.

These findings suggest that interventions aimed at reducing mathematics anxiety may benefit from addressing the dominant dimensions of anxiety experienced by students. For female students, interventions could emphasize strengthening self-confidence and developing strategies to manage cognitive aspects of mathematics anxiety. For male students, greater attention could be directed toward fostering more positive attitudes toward mathematics and enhancing learning motivation. This interpretation is supported by the model proposed by Pelch (2018), which suggests that negative academic emotions, such as anxiety, may perpetuate unproductive learning cycles. Accordingly, equipping students with self-regulated learning strategies may help interrupt these cycles and promote more adaptive learning behaviors.

4. Conclusion

Based on the findings and discussion of the analysis of mathematics anxiety across the somatic, cognitive, and attitudinal dimensions by gender, students' mathematics anxiety percentages ranged from 54.66% to 63.58%, indicating that students' mathematics anxiety ranged from the low to high categories according to the established classification criteria. In

the somatic dimension, female students reported a mathematics anxiety percentage of 55.00%, compared with 54.66% for male students, representing a difference of 0.34 percentage points. In the cognitive dimension, both male and female students exhibited the highest percentages among the three dimensions, with values of 62.91% and 63.58%, respectively, resulting in a difference of 0.67 percentage points. In contrast, male students demonstrated a slightly higher percentage in the attitudinal dimension (56.69%) than female students (55.50%).

The results of the independent-samples t test yielded a two-tailed significance value of $p = .822$, which exceeded the significance level of .05. Therefore, the null hypothesis was not rejected, indicating that there was no statistically significant difference in mathematics anxiety between male and female students enrolled in the Linear Algebra and Matrices course.

Overall, the findings suggest that the cognitive and attitudinal dimensions were the predominant contributors to students' mathematics anxiety in learning Linear Algebra and Matrices. Accordingly, efforts to reduce mathematics anxiety should emphasize instructional practices that strengthen students' self-confidence, provide opportunities for gradual and scaffolded learning, foster a supportive and non-threatening classroom environment, and offer constructive feedback and emotional support. Such approaches may help students manage mathematics anxiety more effectively and improve both their engagement and learning outcomes in the Linear Algebra and Matrices course.

5. Recommendations

Based on the findings indicating that students' mathematics anxiety was most pronounced in the cognitive and attitudinal dimensions, with no statistically significant differences observed between male and female students, the following recommendations are proposed.

For Course Instructors. The Linear Algebra and Matrices course should be designed using a gradual instructional sequence, progressing from fundamental concepts to more abstract topics, to help students develop conceptual understanding without becoming overwhelmed. Instructors are also encouraged to foster a supportive classroom environment by providing constructive feedback, encouraging active participation, and minimizing unnecessary evaluative pressure, such as unannounced presentations. These instructional practices may enhance students' self-confidence and reduce cognitive aspects of mathematics anxiety.

For Students. Students are encouraged to develop independent learning habits through regular problem-solving practice, preparing concise learning summaries, and participating in collaborative study groups. They should also cultivate positive beliefs about their mathematical abilities by recognizing that mathematical competence can be improved through sustained effort and practice. Students experiencing persistent mathematics anxiety are advised to seek academic guidance or counseling services available at their institution.

For Higher Education Institutions and Future Researchers. Higher education institutions are encouraged to provide programs aimed at strengthening students' self-efficacy and developing effective strategies for managing mathematics anxiety, particularly in mathematics-related courses. Future research should consider incorporating additional

variables, such as self-efficacy, learning styles, and instructional approaches, to obtain a more comprehensive understanding of the factors associated with mathematics anxiety. Furthermore, qualitative or mixed-methods approaches are recommended to explore in greater depth the underlying causes of anxiety, particularly within the cognitive and attitudinal dimensions.

Implementing these recommendations is expected to contribute to reducing students' mathematics anxiety, creating a more effective learning environment, and ultimately improving students' academic engagement and learning outcomes in the Linear Algebra and Matrices course.

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