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From learning to teaching: A study of mathematics academic and pedagogical anxiety in prospective elementary education teachers

Samsul Pahmi [1], Nanang Priatna [1*], Suhendra [1], Bambang Avip Priatna Martadiputra [1]

[1] Department of Mathematics Education, Universitas Pendidikan Indonesia, Bandung, INDONESIA

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Abstract

Mathematics learning anxiety is a significant issue among prospective primary school teachers, yet it remains underexplored in teacher education. This study investigates the level of mathematics learning anxiety, its influencing factors, and its impact on teaching readiness. The study focuses on two types of anxiety: mathematics academic anxiety, which arises during learning or solving mathematical tasks, and mathematics pedagogical anxiety, which occurs when teaching mathematics to others. Final-year prospective primary school teachers participated in the study, with data collected through questionnaires and interviews. Quantitative data were analyzed using descriptive statistics, while qualitative data were examined through thematic analysis. Results revealed high levels of anxiety, particularly when understanding complex concepts like algebra and geometry, and when teaching, especially in situations requiring in-depth explanations or addressing challenging student questions. Key contributing factors include negative past experiences, such as difficulties in understanding mathematics during earlier education; teaching methods emphasizing rote memorization over conceptual understanding; societal stereotypes portraying mathematics as a subject for the gifted; low self-efficacy in mastering and teaching mathematical concepts; and insufficient social support from peers or lecturers. The impacts of this anxiety include avoidance of difficult topics, impaired communication during teaching, and suboptimal classroom management. This study highlights the need for targeted interventions to address mathematics learning anxiety and improve the preparedness of prospective primary school teachers in mathematics education.

Keywords: mathematics academic anxiety, mathematics pedagogical anxiety, learning anxiety, prospective primary education teachers

INTRODUCTION

Mathematics anxiety among prospective elementary school teachers is a persistent and significant issue, particularly in Indonesia, where primary teachers are required to master and teach all subjects, including mathematics (Mendikbud, 2013; Zein, 2016). Despite this mandate, many teacher education programs (PGSD) in Indonesia provide insufficient depth in mathematics content and pedagogy, resulting in a lack of confidence and heightened anxiety among future teachers (Dewantara, 2020; Ngugi & Thinguri, 2014). This anxiety is further exacerbated by negative perceptions of mathematics, limited pedagogical training, and societal stereotypes that portray mathematics as inherently difficult education (Birgin et al., 2020; Sánchez-Mendías et al., 2024).

Mathematics plays a foundational role in students' cognitive development and future academic success (Demirel et al., 2015; NCTM, 2000). However, both students and prospective teachers often perceive mathematics as intimidating, leading to two distinct but interrelated forms of anxiety: mathematics academic anxiety (anxiety experienced when learning or solving mathematical tasks) and mathematics pedagogical anxiety (anxiety experienced when teaching mathematics). Preliminary interviews with prospective teachers reveal that many lack confidence in both their mathematical understanding and their ability to teach the subject, often due to prior experiences focused on

✉ samsulpahmi@upi.edu ✉ nanang_priatna@upi.edu **(*Correspondence)** ✉ suhendra@upi.edu ✉ bambangavip@upi.edu

Contribution to the literature

- This study provides a comprehensive analysis of both mathematics academic anxiety and mathematics pedagogical anxiety among prospective elementary education teachers, a topic that has been underexplored in teacher education research.
- By integrating these two forms of anxiety within the pedagogical content knowledge (PCK) framework and focusing on the Indonesian context, the study offers new insights into the factors influencing teacher anxiety and its impact on teaching readiness.
- The findings highlight the urgent need for targeted interventions in teacher education programs to reduce mathematics anxiety and enhance the preparedness and confidence of future elementary mathematics teachers.

rote memorization rather than conceptual understanding.

While previous studies have extensively examined mathematics academic anxiety among students at various educational levels (Carey et al., 2017; Dowker et al., 2016; Khasawneh et al., 2021), there is a notable gap in the literature regarding the experiences of prospective teachers, especially concerning mathematics pedagogical anxiety. Most existing research focuses on students' anxiety in learning mathematics, with limited attention to the anxiety experienced by those preparing to teach mathematics. This study addresses this gap by simultaneously investigating both mathematics academic anxiety and mathematics pedagogical anxiety among prospective elementary school teachers in Indonesia. By doing so, the research offers a comprehensive perspective on how these anxieties interact and impact teaching readiness, providing new insights into the factors that influence both learning and teaching anxiety in the context of teacher preparation.

The urgency of this research lies in its implications for the quality of mathematics education at the primary level. High levels of anxiety among prospective teachers can lead to avoidance of challenging mathematical content, impaired communication and classroom management, and ultimately, suboptimal learning experiences for students. Given the central role of elementary teachers in shaping students' foundational understanding of mathematics, addressing these anxieties is critical for improving teacher preparation programs and, by extension, student outcomes in mathematics. Furthermore, the unique challenges faced by Indonesian prospective teachers–such as curriculum demands, resource limitations, and the expectation to teach multiple subjects–underscore the need for targeted interventions that address both academic and pedagogical aspects of mathematics anxiety.

To address these issues, this study is guided by the following research questions:

1. What are the levels of mathematics academic anxiety and mathematics pedagogical anxiety among prospective elementary school teachers?
2. What factors influence these two types of anxiety?
3. How do these anxieties affect prospective teachers' readiness to teach mathematics?

By explicitly examining these questions, the study aims to inform the development of more effective teacher education programs and interventions to reduce mathematics anxiety and enhance teaching competence among future elementary educators in Indonesia.

LITERATURE REVIEW

Learning anxiety in mathematics is a complex and multidimensional psychological phenomenon (Moreno-García et al., 2017) that affects not only students but also prospective teachers who must both understand and teach mathematics (Juniati & Budayasa, 2020). Recent studies consistently show that mathematics anxiety can manifest as physiological, cognitive, affective, and behavioral responses (Ashcraft, 2002; Whyte & Anthony, 2012), and these dimensions are interrelated in shaping both learning and teaching experiences.

A key theoretical framework in understanding mathematics anxiety among prospective teachers is pedagogical content knowledge (PCK) as introduced by Shulman (1986). PCK emphasizes that effective teaching requires not only mastery of content knowledge (CK) but also the ability to deliver that content through appropriate pedagogical knowledge (PK) (Nilsson & Vikström, 2015; Park & Oliver, 2008). The literature indicates that a lack of CK often leads to mathematics academic anxiety, while insufficient PK is associated with mathematics pedagogical anxiety. This duality is supported by Charalambous et al. (2020) and Leijen et al. (2022) who highlight that both types of knowledge are essential and their absence can reinforce each other's negative effects.

Research has synthesized that negative past experiences, rote-based teaching methods, and societal stereotypes about mathematics as a subject for the gifted are major contributors to mathematics anxiety (Ashcraft & Ridley, 2005; Bekdemir, 2010; Chestnut et al., 2018). These factors not only affect students but also persist in teacher education, shaping the attitudes and confidence of prospective teachers. Furthermore, self-efficacy emerges as a critical factor: those with higher self-

efficacy are more resilient to anxiety and more effective in both learning and teaching mathematics (Bandura & Watts, 1996; Çenberci, 2019; Pajares, 1996).

Recent intervention studies have shown that experience-based pedagogical training, microteaching, and supportive learning environments can reduce mathematics teaching anxiety (Boyd et al., 2014; Gresham, 2007; Peker, 2009). However, most interventions still focus more on academic aspects rather than pedagogical ones, even though pedagogical anxiety has a direct impact on teaching effectiveness and student motivation (Brady & Bowd, 2005; Suren & Ali Kandemir, 2020). This highlights a gap in the literature, where the integration of academic and pedagogical anxiety is still limited.

The novelty of this study lies in its comprehensive approach, integrating both mathematics academic anxiety and mathematics pedagogical anxiety within the PCK framework for prospective elementary teachers. Previous studies have tended to separate these aspects, resulting in a fragmented understanding of the challenges faced by future teachers. Moreover, this research addresses contextual factors specific to Indonesia, such as curriculum dynamics, resource limitations, and the demand for multi-subject mastery (Hunaepi & Suharta, 2024; Luschei & Zubaidah, 2012), which are rarely discussed in international literature.

This research divides learning anxiety in mathematics into four aspects: physiological, cognitive, affective (Whyte & Anthony, 2012), and behavioral (Ashcraft, 2002).

1. Physiological aspect: This relates to the body's response to anxiety felt during learning or teaching mathematics (Whyte & Anthony, 2012). Physical conditions and bodily functions can be significantly affected when someone experiences anxiety. Common physiological symptoms include increased heart rate (palpitations), excessive sweating (hyperhidrosis), trembling or shaking, shortness of breath or a feeling of pressure in the chest, headaches or dizziness, and digestive issues such as nausea or stomach pain. These symptoms arise as the body's natural response to stress or fear when facing situations related to mathematics.
2. Cognitive aspect: This involves thought patterns and mental processes that occur during learning and teaching mathematics (Whyte & Anthony, 2012). Cognitive anxiety can affect how an individual processes information, solves problems, and recalls mathematical concepts (Maloney et al., 2014). Some manifestations of this aspect include difficulty concentrating or focusing while learning or teaching mathematics, the emergence of negative thoughts such as "I can't do or teach this" or "I will definitely fail," confusion in understanding mathematical concepts that have already been studied, a tendency to avoid mathematical tasks or teaching mathematics due to feelings of inadequacy, and difficulty remembering formulas or problem-solving steps. This cognitive aspect often exacerbates anxiety because negative thought patterns can create a difficult-to-break cycle.
3. Affective aspect: This pertains to the emotions and feelings that arise during learning or teaching mathematics (Whyte & Anthony, 2012). Affective anxiety is subjective and originates from within the individual (Naragon-Gainey, 2019). Some common emotions include excessive fear or worry about mathematics, frustration or disappointment when unable to solve mathematical problems, feelings of shame or inferiority when feeling less capable compared to peers, excessive stress or pressure when facing mathematics exams or teaching mathematics, and reluctance or aversion to mathematics due to negative past experiences. This affective aspect significantly influences an individual's motivation and attitude toward mathematics, which can ultimately hinder the learning process.
4. Behavioral aspect: This involves the actions or activities an individual engages in as a response to anxiety during learning or teaching mathematics (Whyte & Anthony, 2012). These behaviors can be directly observed and often serve as indicators of anxiety (Spielberger, 2013). Some examples include avoiding situations related to mathematics, such as not completing assignments or skipping mathematics classes, procrastinating on tasks related to mathematics, relying on others to solve mathematical problems, appearing restless or uneasy during mathematics exams or tasks, and changes in study habits, such as overlearning due to fear of failure or, conversely, not studying at all due to a sense of futility (Onatsu-Arvilommi & Nurmi, 2000). These behaviors can reinforce anxiety and make it increasingly difficult for individuals to overcome their issues.

Cognitive Theory and Cognitive Load in Learning Anxiety in Mathematics

Cognitive theory of anxiety suggests that an individual's thoughts and perceptions significantly influence their emotional responses to specific situations. According to Beck (1976), anxiety arises from distorted thought patterns, where individuals tend to exaggerate the threats posed by a situation. In the context of mathematics education, prospective teachers often experience anxiety due to negative self-perceptions of their mathematical abilities. This phenomenon is known as mathematics anxiety, which can manifest as

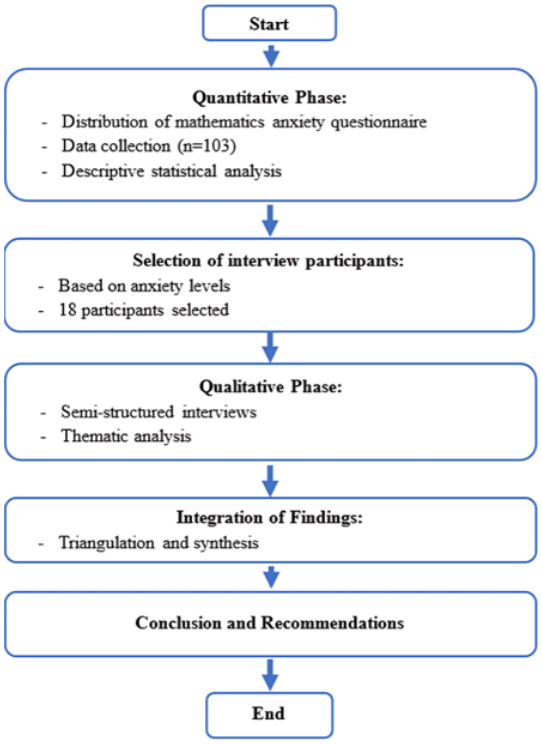

Figure 1. Research process framework (Source: Authors' own elaboration)

fear of failure, low self-confidence, or the belief that one is inherently bad at mathematics (Hembree, 1990). These cognitive distortions often lead to avoidance behaviors, where individuals tend to avoid tasks related to mathematics, ultimately worsening their anxiety (Ashcraft & Ridley, 2005).

Additionally, cognitive load theory, proposed by Sweller (1988), states that individuals have a limited capacity for processing information. When this capacity is exceeded, their performance declines. In the context of teacher education, prospective teachers often face complex mathematical problems, which increase their cognitive load and, in turn, their anxiety levels. Research shows that high anxiety can interfere with working memory, thereby hindering prospective teachers' ability to solve mathematical problems effectively (Ashcraft, 2002). This poses a particular challenge in elementary education programs, where prospective teachers are expected to convey mathematical concepts to students in a simple and understandable manner.

METHODOLOGY

This study employs a sequential explanatory design, which is part of the mixed methods approach. This sequential approach allows quantitative results to inform the qualitative phase, enabling deeper insights into the reasons behind the anxiety levels identified in the first stage (Creswell & Clark, 2018). Additionally, the use of a mixed methods approach is highly valuable in providing a comprehensive understanding of mathematics anxiety among prospective elementary school teachers, allowing researchers to explain quantitative findings through qualitative data (Bowen et al., 2017; Sloane & Wheeler, 2021). This design involves collecting quantitative data to identify general anxiety levels, followed by qualitative analysis to provide deeper insights (Akram et al., 2021; Ivankova et al., 2006). To provide a clear overview of the research process, the framework of this study is illustrated in **Figure 1**.

Table 1. Distribution of participants

Characteristic	N	Percentage (%)
Gender		
Male	27	26.2
Female	76	73.8
Educational background		
Senior high school (general)	48	46.6
Islamic senior high school	15	14.6
Vocational high school	40	38.8

Participants

The study involves a population of prospective teachers enrolled in an elementary school teacher education program at a university in Sukabumi Regency, West Java, Indonesia. The sample was selected using purposive sampling with inclusion criteria being prospective teachers who have taken courses in basic mathematical concepts and mathematics education and are willing to participate in the study. Additionally, participants must be in their final year of study, as this group is likely to have accumulated significant experience related to learning and teaching mathematics. This targeted selection is crucial as it allows for a focused investigation of individuals who are about to enter the teaching profession and may have developed varying attitudes toward mathematics education (Miller, 2015).

The study targets a sample size of 103 prospective teachers, which is considered sufficient for robust statistical analysis, while 18 prospective teachers were selected for in-depth interviews based on quantitative data analysis results showing high, moderate, and low anxiety levels. The participant demographics are diverse, including various regional backgrounds, genders, and high school educational backgrounds. This diversity is important, as research by Duncan and Mckeachie (2015) suggests that demographic factors can influence levels of mathematics anxiety.

For example, female students often report higher levels of mathematics anxiety compared to male students (Else-Quest et al., 2010). By ensuring a varied sample, the study is better positioned to explore how different backgrounds may influence anxiety levels and coping strategies in mathematics education.

Table 1 shows the distribution of participants by gender and educational background.

Table 2. Distribution of questionnaire items based on the aspects examined in mathematics academic anxiety and mathematics pedagogical anxiety

Aspect	Question code	
	Mathematics academic anxiety	Mathematics pedagogical anxiety
Low self-confidence in mathematical ability	1, 4, 9, 12, & 15	3, 6, 9, 13, & 19
Fear of failing to understand mathematical concepts	2, 6, 11, 16, & 20	1, 7, 12, 15, & 20
Negative attitude toward mathematics	3, 8, 14, 17, & 19	2, 5, 11, 16, & 18
General fear of the subject	5, 10, 7, 13, & 18	4, 8, 10, 14, & 17

Research Instruments

The primary instrument used in this study is a mathematics anxiety questionnaire, which consists of two components: mathematics academic anxiety and mathematics pedagogical anxiety, each with 20 items. The questionnaire is designed to measure the anxiety levels of prospective teachers in learning and teaching mathematics. The validity of the questionnaire was tested through content validity by involving three experts in mathematics education and psychometrics, who assessed the relevance and clarity of the items. Construct validity was tested using exploratory factor analysis to ensure the grouping of items according to the measured dimensions, with the Kaiser-Meyer-Olkin and Bartlett tests to ensure sample adequacy. The reliability of the questionnaire was tested using Cronbach's alpha coefficient, with results of 0.85 for mathematics academic anxiety and 0.88 for mathematics pedagogical anxiety, indicating high reliability. A semantic differential scale was used to measure respondents' answers, with a score range of 1 to 5. In addition, to strengthen the measurement of anxiety, this study also employed the Zung (1976) self-rating anxiety scale (SAS) as a supplementary instrument. The SAS is a self-report questionnaire that has been widely used and internationally validated to assess general anxiety levels, including anxiety related to academic situations.

Data Collection and Analysis Techniques

Data collection was conducted sequentially through the sequential explanatory design approach. The first stage involved quantitative data collection by distributing the questionnaire to 103 prospective teachers through an online platform, ensuring anonymity and data confidentiality. The second stage involved qualitative data collection through semi-structured interviews, designed based on the results of quantitative data analysis and related literature. A total of 18 prospective teachers were selected for in-depth interviews, consisting of 10 with high anxiety levels, 5 with moderate anxiety, and 3 with low anxiety. The interviews were conducted online, with each session lasting 30-45 minutes, and all interviews were recorded with respondents' consent for transcription and analysis purposes. Quantitative data were analyzed using descriptive statistics to describe the distribution of anxiety levels, while qualitative data were analyzed using thematic analysis to identify patterns and main themes. The combination of these methods allows for data triangulation, providing a deeper understanding of mathematics anxiety among prospective teachers. This approach offers comprehensive insights into anxiety levels, contributing factors, and their impact on prospective teachers' readiness to teach mathematics.

Research Ethics

This study was conducted in accordance with research ethics standards. Prior to data collection, ethical approval was obtained from the university's research ethics committee. Respondents were provided with an information sheet and a consent form explaining the objectives of research objectives, procedures, their rights as participants, and assurances of data confidentiality.

Research Limitations

Some limitations should be acknowledged. First, the use of self-reported instruments may introduce various forms of bias, such as social desirability bias and recall bias, which could affect the accuracy of the participants' responses. Although the instruments employed in this study have been validated, the results should still be interpreted with caution. Second, the sample was drawn from a single university, which limits the generalizability of the findings to broader populations. These limitations have been considered in the interpretation of the results and are discussed in recommendations for future research.

RESULTS AND DISCUSSION

Research question 1. What are the levels of mathematics academic anxiety and mathematics pedagogical anxiety among prospective teachers?

Mathematics anxiety was first widely associated with the work of Tobias (1993). In her book overcoming math anxiety, Tobias (1993) described mathematics anxiety as a sudden, overwhelming feeling of fear, as if students felt they would never be able to overcome it. Since then, the definition of mathematics anxiety has evolved to include various other aspects, such as low self-confidence in mathematical abilities, fear of failing to understand mathematical concepts, negative attitudes toward mathematics, and a general fear of the subject (Bursal & Paznokas, 2006). **Table 2** shows the distribution of questionnaire items based on the aspects of mathematics anxiety.

Table 3. Description of responses for each item in the mathematics academic anxiety questionnaire

Question item	QC	Number of answers				
		1	2	3	4	5
How pessimistic are you about your ability to solve difficult math problems?	1	0	2	31	47	23
How worried are you that you will not understand complex mathematical concepts?	2	0	3	27	43	30
How often do you dislike mathematics?	3	1	4	41	35	22
How doubtful are you about using mathematics in daily tasks?	4	2	15	35	37	14
How nervous do you feel as a math exam approaches?	5	1	9	38	31	24
How afraid are you of failing to understand new topics in a mathematics course?	6	0	5	23	43	32
How fearful are you when speaking or asking questions in a math class?	7	4	15	36	29	19
How stressed do you feel when working on math assignments or homework?	8	8	20	34	31	10
How pessimistic are you about your ability to succeed in a mathematics course?	9	0	15	44	30	14
How anxious do you feel when interacting with your math teacher/lecturer in class?	10	2	7	25	33	36
How anxious do you feel when faced with math problems involving difficult concepts?	11	0	3	13	44	43
How worried are you about getting a poor grade on a math exam?	12	0	6	18	27	52
How worried are you about making mistakes when answering math problems in front of the class?	13	4	26	35	22	16
How often do you wish you didn't have to study mathematics?	14	4	17	23	22	37
How often do you feel incapable of understanding the math material taught in class?	15	6	20	32	16	29
How stressful do you feel when learning complex mathematical concepts?	16	4	8	29	32	30
How unenthusiastic are you when attending math classes?	17	3	6	21	30	43
How afraid are you of being unable to answer math questions during an exam?	18	0	28	35	24	16
How tense do you feel when preparing for a math exam?	19	9	12	25	31	26
How fearful are you that you won't be able to keep up with math lessons in class?	20	6	20	30	15	32

Note. QC: Question code

Table 4. Description of responses for each item in the mathematics pedagogical anxiety questionnaire

Question item	QC	Number of answers				
		1	2	3	4	5
How afraid are you of not being able to answer students' complex questions about mathematics?	1	1	15	24	29	34
How stressful do you feel when teaching mathematics in front of a class?	2	1	6	29	43	24
How confident are you in clearly explaining difficult mathematical concepts to students?	3	7	12	46	28	10
How nervous do you feel when managing a class that struggles with mathematics?	4	3	10	33	31	26
How anxious do you feel when teaching mathematics in front of a supervisor or principal?	5	2	9	41	28	23
How worried are you about not being able to adapt your teaching methods for students with different abilities?	6	3	7	35	32	26
How anxious do you feel when teaching mathematical concepts that you find difficult to understand?	7	2	17	35	30	19
How worried are you that students may become bored or struggle to follow your math teaching methods?	8	0	6	30	35	32
How confident are you in designing an effective mathematics lesson plan?	9	11	19	45	19	9
How anxious are you that your math teaching methods may not capture students' attention effectively?	10	2	9	34	31	27
How unenthusiastic do you feel when teaching mathematics?	11	6	16	46	24	11
How worried are you about not being able to clearly explain certain mathematical concepts to students?	12	0	7	39	43	14
How confident are you in using technology effectively to support math instruction?	13	0	5	37	42	19
How afraid are you of not being able to cover all mathematics material within the planned time?	14	0	29	50	18	6
How stressful do you feel when preparing to teach a math topic you are less familiar with?	15	0	26	41	23	13
How tense do you feel when dealing with students who are uninterested in mathematics?	16	4	15	25	29	30
How worried are you that students will not understand or fall behind in learning the math material you teach?	17	9	10	29	35	20
How stressful do you feel when assessing students in your mathematics class?	18	0	12	32	33	26
How worried are you about not having adequate resources to support your mathematics teaching?	19	5	16	30	28	24
How afraid are you of not being able to provide accurate explanations of challenging mathematical topics?	20	1	9	35	30	28

Note. QC: Question code

Table 3 and **Table 4** provide a description of the number of responses for each questionnaire item.

Based on **Table 2**, it is known that each aspect consists of five questionnaire items. Each item is scored on a scale of 1 to 5, with the understanding that the higher the selected value, the greater the level of anxiety experienced. A summary of each aspect for mathematics academic anxiety and mathematics pedagogical anxiety can be seen in the visuals provided in **Figure 2** and **Figure 3**.

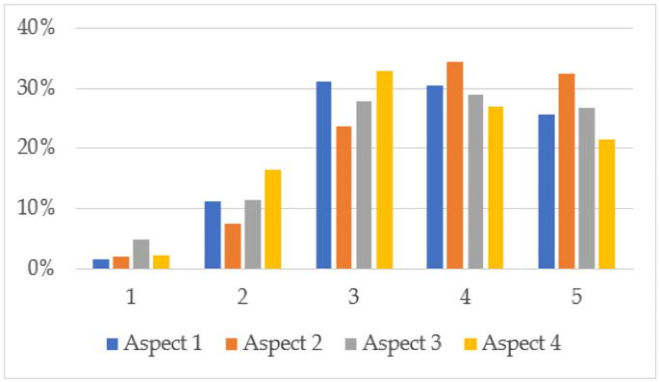

Figure 2. Distribution of mathematics academic anxiety scores (Source: Authors' own elaboration)

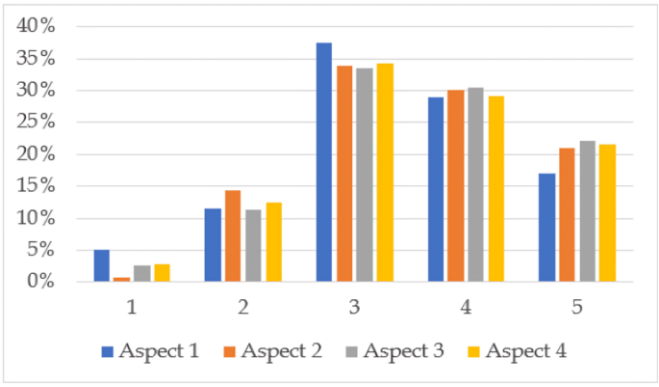

Figure 3. Distribution of mathematics pedagogical anxiety scores (Source: Authors' own elaboration)

Table 5. SAS conversion results

Anxiety level	Original score interval	Converted score interval
Normal range	20-44	20-53
Mild to moderate anxiety levels	45-59	54-73
Marked to severe anxiety levels	60-74	74-92
Extreme anxiety levels	75-80	93-100

In **Figure 2**, the analysis of mathematics academic anxiety reveals that the mode (most frequent score) for each anxiety aspect varies significantly. For the aspect of low self-confidence in mathematical abilities (aspect 1), the mode is a score of 3, indicating that the majority of respondents experience a moderate level of anxiety regarding their confidence in their mathematical abilities. For the aspect of failing to understand mathematical concepts (aspect 2), the mode is a score of 4, suggesting that many respondents experience higher anxiety when faced with challenging mathematical concepts. In the aspect of negative attitudes toward mathematics (aspect 3), the mode is a score of 4, revealing that a significant portion of respondents hold fairly strong negative attitudes toward mathematics. Meanwhile, for the aspect of general fear of mathematics (aspect 4), the mode is a score of 3, indicating a more moderate level of anxiety when dealing with mathematics in general.

In contrast, **Figure 3**, which illustrates mathematics pedagogical anxiety, shows that the mode for all teaching anxiety aspects is a score of 3. This suggests that respondents generally experience a moderate level of anxiety when faced with the challenges of teaching mathematics.

From these findings, it can be concluded that mathematics academic anxiety tends to be higher in aspects related to conceptual understanding and negative attitudes toward mathematics. This indicates that difficulties in understanding mathematical concepts and negative perceptions of the subject are the primary sources of anxiety for prospective teachers. Meanwhile, more moderate levels of anxiety are observed in aspects such as self-confidence in mathematical abilities and general fear of mathematics. On the other hand, mathematics pedagogical anxiety appears more evenly distributed, with a consistent mode score of 3 across all aspects. This suggests that although respondents experience anxiety while learning to teach, their anxiety levels remain relatively stable and moderate.

Furthermore, each student's anxiety level was identified personally using the Zung (1976) SAS. The original SAS scale uses a score range of 20-80. For the purposes of this study, a linear scale conversion was performed to align with the 20-100 range used in the research. This conversion was necessary to maintain the proportionality between anxiety categories without altering the original interpretation and classification. The conversion process involved linear calculations, where each score in the original range (20-80) was transformed into a proportional score in the new range (20-100). As a result, the score intervals for each anxiety category–ranging from normal to extreme anxiety levels–were adjusted to remain consistent with the original SAS classification. **Table 5** presents the conversion results, showing the score intervals for mathematics learning and teaching anxiety levels after adapting the SAS scale.

Based on **Table 5**, it can be observed that the levels of mathematics academic anxiety and mathematics pedagogical anxiety among students vary significantly (see **Figure 4**).

For mathematics academic anxiety, only 1.94% (n = 2) of students fall into the normal category, indicating that a small proportion of students do not experience significant anxiety when studying mathematics. However, the largest proportion, 44.66% (n = 46), falls into the mild to moderate anxiety category, suggesting that they experience moderate anxiety that may affect their learning process. More strikingly, 52.43% (n = 54)

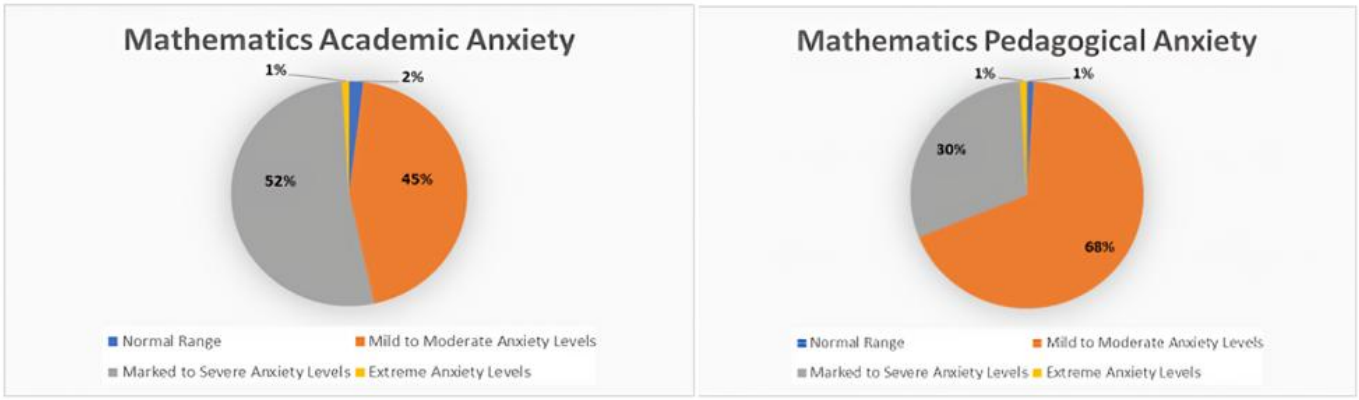

Figure 4. Percentage of mathematics academic anxiety and mathematics pedagogical anxiety levels (Source: Authors' own elaboration)

of students are in the marked to severe anxiety category, showing that more than half of the student population experiences very high levels of anxiety when learning mathematics. This is a significant finding, as anxiety at this level has the potential to greatly hinder conceptual understanding and reduce students' confidence in learning mathematics. Additionally, 0.97% (n = 1) of students fall into the extreme anxiety category, indicating a very severe level of anxiety that may require special intervention to address.

Meanwhile, for mathematics pedagogical anxiety, the results are slightly different. Only 0.97% (n = 1) of students fall into the normal category, showing that very few of them feel comfortable teaching mathematics. The majority of students, 67.96% (n = 70), are in the mild to moderate anxiety category, meaning that most of them experience moderate anxiety related to teaching mathematics. This suggests that while they are anxious, this anxiety may not significantly hinder them. However, there are still 30.10% (n = 31) of students in the marked to severe anxiety category, meaning they experience considerable anxiety when teaching. Similar to mathematics academic anxiety, 0.97% (n = 1) of students fall into the extreme anxiety category, indicating very severe anxiety when it comes to teaching mathematics.

From the data, it is evident that mathematics academic anxiety is more dominant in the severe anxiety category compared to mathematics pedagogical anxiety. A total of 52.43% of students experience severe anxiety in learning, while only 30.10% experience severe anxiety in teaching. This indicates that students are more concerned about understanding mathematical concepts than about the task of teaching them. This is likely due to a lack of deep understanding of the material they are studying, which ultimately affects their confidence in teaching. However, even though mathematics pedagogical anxiety is mostly in the moderate category, this level of anxiety still needs attention. The majority of students feel quite anxious when teaching mathematics, which could potentially affect their effectiveness in the classroom. Therefore, special support is needed, whether in the form of more in-depth teaching training or anxiety management strategies, to ensure that students are better prepared and more confident in teaching mathematics. The characteristics of each anxiety level, both for mathematics academic anxiety and mathematics pedagogical anxiety, are presented in **Table 6**.

These findings indicate that mathematics academic anxiety is a major challenge for students, with more than half of them experiencing severe levels of anxiety. More intensive support is needed to help them overcome this anxiety, whether through deeper academic training or psychological strategies such as relaxation techniques and anxiety management. On the other hand, teaching anxiety, although more moderate, still requires special attention to ensure that students can teach with confidence and high effectiveness. Interventions in the form of teaching training and improved classroom management skills can help reduce this teaching anxiety.

Mathematics anxiety is a well-documented phenomenon that significantly impacts learning outcomes and teaching success, particularly among prospective teachers in elementary education programs. Other studies also show that a majority of prospective educators experience high levels of mathematics-related anxiety, which can negatively affect their confidence and performance in teaching the subject. For example, a study by Peker (2006) found that around 60% of prospective teachers reported moderate to high levels of anxiety when faced with mathematics tasks. These statistics highlight a widespread issue that requires further investigation and intervention in teacher training programs.

The roots of mathematics anxiety among prospective teachers can often be traced back to their own educational experiences. Many individuals enter teacher training with negative memories associated with mathematics, which may stem from early school experiences or societal perceptions of mathematics as a challenging discipline (Ashcraft & Ridley, 2005). For instance, a qualitative study by Beilock et al. (2010)

Table 6. Characteristics of students with associated anxiety categories

Type	Category	Characteristics
Mathematics academic anxiety	Normal	Students in this category do not exhibit significant signs of anxiety when studying mathematics. They tend to feel confident in understanding mathematical concepts, do not feel stressed when facing assignments or exams, and can study calmly without emotional disturbances. These students have a good understanding of mathematics and have had positive previous experiences with the subject.
	Mild to moderate anxiety	Students in this category experience mild to moderate anxiety that may affect their learning process. They feel nervous or worried when encountering difficult math problems or preparing for exams. However, this anxiety is not entirely debilitating, and they are still able to complete math tasks with extra effort. These students often lack confidence, especially when dealing with more complex concepts.
	Marked to severe anxiety	Students in this category experience moderate to severe anxiety when studying mathematics. They often feel fearful or pressured when trying to understand mathematical concepts, even fundamental ones. This anxiety can hinder their ability to concentrate, affect their comprehension of the material, and significantly reduce their confidence. These students tend to avoid math-related tasks or feel hopeless when facing challenges.
	Extreme anxiety	Students in this category experience severe anxiety that can entirely disrupt their ability to learn mathematics. They feel panicked, exhibit physical symptoms such as a racing heart or sweating, and even avoid situations involving mathematics.
Mathematics pedagogical anxiety	Normal	Students in this category feel comfortable and confident when practicing mathematics. They can prepare materials well, explain concepts fluently, and handle questions without fear. These students have positive teaching experiences or a strong understanding of the subject matter.
	Mild to moderate anxiety	Students in this category experience mild to moderate anxiety when teaching mathematics. They feel nervous before teaching or worry about their ability to explain the material effectively. However, this anxiety does not entirely prevent them from teaching, and they are still able to complete their teaching tasks with additional effort. These students often feel anxious when facing critical questions or being evaluated by lecturers or peers.
	Marked to severe anxiety	Students in this category experience moderate to severe anxiety when teaching mathematics. They often fear making mistakes in front of the class or feel incapable of answering questions properly. This anxiety affects their ability to teach confidently, hinders effective communication, and makes them feel unprepared for teaching. These students also feel pressured when being assessed by lecturers or peers.
	Extreme anxiety	Students in this category experience severe anxiety when teaching mathematics. They feel panicked, lose their ability to speak fluently, and may even avoid teaching situations altogether.

revealed that many participants expressed feelings of inadequacy and fear related to their mathematical abilities, often citing previous experiences with unsupportive teachers or a lack of encouragement during their formative years. These experiences contribute to a cycle of anxiety that can persist through generations of educators, ultimately affecting their future students.

Moreover, anxiety levels can vary significantly based on demographic factors, including gender, educational background, and prior experiences with mathematics. Research by Hembree (1990) shows that female students tend to report higher levels of mathematics anxiety than their male counterparts, a trend consistently observed in subsequent studies. This gender gap can have profound implications for the teaching landscape, as female prospective teachers may be less likely to pursue mathematics-related teaching positions or approach teaching with less confidence, potentially influencing their students' perceptions of the subject. Furthermore, prospective teachers who have not extensively engaged with mathematics in their prior education may also exhibit higher anxiety levels, as they may feel unprepared to handle the complexities of teaching the subject (Bekdemir, 2010).

The implications of mathematics anxiety extend beyond individual educators; it can significantly impact classroom dynamics and student learning outcomes. Teachers experiencing high levels of anxiety may inadvertently convey their discomfort to their students, creating an environment where mathematics is perceived as intimidating or inaccessible. Research by Ramirez et al. (2013) shows that students taught by anxious teachers often perform worse in mathematics than those taught by educators with lower anxiety levels. These findings underscore the importance of addressing anxiety not only for the benefit of prospective teachers but also for the educational experiences of their future students.

In response to the widespread issue of mathematics anxiety, it is crucial for teacher education programs to implement strategies aimed at reducing anxiety levels among prospective teachers. Initiatives such as targeted workshops, peer support groups, and practical teaching

experiences can help build confidence and competence in mathematics among prospective educators (Gresham, 2007). Additionally, fostering a positive mathematics culture within teacher training institutions can encourage prospective teachers to confront their anxieties and develop a more positive relationship with mathematics, ultimately benefiting their teaching practices and their students' learning experiences.

Research question 2. What factors influence these two types of anxiety?

This study identifies several key factors influencing mathematics academic anxiety and mathematics pedagogical anxiety among prospective teachers. Based on the data collected, these factors include prior experiences with mathematics, pedagogical approaches, societal and cultural perceptions of mathematics, self-efficacy, and peer dynamics and support systems.

Negative experiences with mathematics during primary and secondary education significantly contribute to the anxiety of students in the marked to severe and extreme anxiety categories. One research subject revealed: "I have always struggled with mathematics since elementary school, and that feeling has carried over to this day. Every time I have to study or practice teaching mathematics, I feel nervous and afraid of making mistakes" (subject 1). This indicates that past unpleasant experiences can shape negative attitudes toward mathematics, which in turn influence their anxiety levels. Meanwhile, students in the mild to moderate and normal anxiety categories tend to have more neutral or even positive past experiences with mathematics. One subject stated: "I never really struggled with mathematics, although some topics were difficult. But I always tried to understand them by asking teachers or friends" (subject 11). These experiences helped them develop a more open attitude toward mathematics, although they still felt anxious when facing more complex topics. This suggests that less negative learning experiences can help reduce anxiety levels.

The teaching approaches used during the teacher training program were also found to influence the anxiety levels of students in the marked to severe and extreme anxiety categories. Traditional approaches focused on memorization and standardized testing often exacerbate anxiety. Subject 2 stated: "In learning, the methods used often focus on memorizing formulas. That makes me even more anxious because I feel like I have to memorize everything correctly." Conversely, more constructivist approaches, where prospective teachers are encouraged to explore and understand concepts deeply, are considered more helpful in reducing anxiety. As one subject in the normal category stated: "I feel more confident when lecturers give us the opportunity to discuss and try to understand concepts rather than just memorize formulas" (subject 15). These more flexible and interactive approaches help them feel more engaged in the learning process, thereby reducing their anxiety. However, they still feel anxious when facing exams or tasks that require memorization.

Societal perceptions of mathematics as a difficult and intimidating subject also significantly influence the anxiety of prospective teachers in the marked to severe and extreme anxiety categories. One interviewee said: "Since I was young, I always heard that mathematics is hard, and that made me feel incapable. Even now, I still carry that feeling" (subject 1). This negative narrative creates additional pressure for prospective teachers, who feel they must meet high expectations for mastering mathematics. Meanwhile, the perceptions of students in the mild to moderate and normal anxiety categories toward mathematics tend to be more balanced. One subject stated: "I know mathematics is difficult, but I also feel that with enough practice, I can understand it" (subject 15). They are less influenced by negative stereotypes about mathematics, although they still feel nervous when facing more challenging topics or explaining concepts to others.

The self-efficacy of prospective teachers also influences the anxiety of students in the marked to severe and extreme anxiety categories. Subject 3 revealed: "I never feel confident enough in teaching mathematics. I am always afraid of making mistakes when explaining concepts in front of the class." This indicates that low self-confidence in their ability to master and teach mathematics contributes to the anxiety they experience. In contrast, students in the mild to moderate and normal anxiety categories have better self-efficacy compared to those in higher anxiety categories. One subject stated: "I feel confident enough to teach mathematics, although I know there are some things I need to study more deeply" (subject 11). This level of self-confidence helps them manage their anxiety better, although they still feel nervous when teaching in front of a class or facing unexpected questions from students.

Social interactions within the learning environment also influence the anxiety levels of students in the marked to severe and extreme anxiety categories. One subject stated: "My friends in this program are very supportive. We often help each other and share tips, so I don't feel alone in facing the difficulties of mathematics." Conversely, a competitive atmosphere can worsen anxiety, as prospective teachers feel pressured to compete with their peers. This aligns with the views of students in the normal category. Strong social support from peers and lecturers was also found to be an important factor in reducing anxiety. A subject in the normal category stated: "I feel calmer because my friends always support me. We often study together and help each other when someone is struggling" (subject 15). This collaborative learning environment helps them feel more comfortable and confident in facing the challenges of learning and teaching mathematics.

The findings of this study show that mathematics academic anxiety and mathematics pedagogical anxiety among prospective teachers are influenced by various interacting factors. Prior experiences with mathematics are one of the main factors influencing anxiety. Negative past experiences, such as difficulties understanding mathematics during primary and secondary education, can shape deeply negative attitudes toward mathematics. This aligns with the findings of Brady and Bowd (2005) and Ashcraft and Ridley (2005), who state that negative past experiences can create ongoing anxiety that persists in higher education. These negative attitudes can hinder prospective teachers from understanding mathematical concepts and affect their confidence in teaching the subject.

The pedagogical approaches used during the teacher training program also play a significant role in shaping anxiety levels. Traditional approaches focused on memorization and standardized testing often exacerbate anxiety, as prospective teachers feel pressured to memorize formulas and concepts without deep understanding. In contrast, constructivist approaches that encourage exploration and deep understanding of concepts can help reduce anxiety. This is supported by Alghani (2019), who emphasizes the importance of teaching methods that encourage exploration of mathematical concepts and practical applications to improve prospective teachers' comfort in teaching mathematics.

Societal and cultural perceptions of mathematics are also significant factors. Social stereotypes that view mathematics as a difficult subject only for gifted individuals create additional pressure for prospective teachers. This aligns with the findings of Chestnut et al. (2018), who note that such negative narratives can create a "self-fulfilling prophecy," where prospective teachers who already fear mathematics continually doubt their abilities. These perceptions need to be changed through more inclusive and supportive approaches, both in formal education and in society at large.

Self-efficacy is also a key factor in mathematics academic anxiety and mathematics pedagogical anxiety. Bandura and Watts (1996) self-efficacy theory highlights that individuals' beliefs in their own abilities significantly influence their anxiety levels. Prospective teachers with low self-efficacy tend to feel less confident in facing challenges, both in learning and teaching mathematics. Pajares (1996) also supports this finding, stating that low self-confidence in mathematical abilities can directly impact performance and anxiety levels.

Finally, peer dynamics and support systems also influence anxiety levels. A collaborative and supportive learning environment can help prospective teachers feel more comfortable and confident in facing challenges. Conversely, a competitive atmosphere can worsen anxiety, as prospective teachers feel pressured to compete with their peers. Peker and Ulu (2018) emphasize that positive social interactions can increase self-confidence and reduce excessive fear related to learning and teaching mathematics.

Overall, these factors interact in complex ways to shape the anxiety levels experienced by prospective teachers. Therefore, a holistic approach is needed to address this anxiety, including building self-confidence, using teaching methods that support deep understanding, and creating a collaborative and supportive learning environment.

Research question 3. How does this anxiety affect their readiness to teach mathematics in the future?

This study reveals that mathematics academic anxiety and mathematics pedagogical anxiety significantly impact prospective teachers' readiness to teach mathematics in the future. Based on the data collected, the effects of this anxiety are evident in the following aspects:

1. **Reluctance to engage with mathematics material:** High anxiety causes prospective teachers to avoid deep interaction with mathematics material. One research subject stated: "Whenever I have to study or teach mathematics, I tend to avoid it. I prefer to focus on other subjects that don't make me feel anxious" (subject 4). This shows that anxiety can hinder the development of important pedagogical skills necessary for effective mathematics teaching.
2. **Avoidance of difficult mathematical concepts:** Anxiety also influences prospective teachers' teaching strategies, leading them to avoid teaching difficult mathematical concepts. One subject admitted: "I feel anxious when I have to teach more complex concepts, like algebra. I'm afraid I might explain it wrong, so I focus more on easier concepts" (subject 3). This avoidance can result in superficial understanding among students.
3. **Impaired communication skills:** Anxiety disrupts prospective teachers' ability to clearly communicate mathematical concepts. One subject stated: "When I'm nervous, I often get confused while explaining something. I worry that students won't understand what I'm saying" (subject 3). This indicates that anxiety can hinder prospective teachers' ability to create a supportive and participatory learning environment.
4. **Impaired classroom management skills:** Anxiety also affects prospective teachers' classroom management skills. One subject revealed: "Sometimes I feel unsure of myself while teaching. I'm afraid students will notice my weaknesses, and that makes it hard to control the class" (subject 5). This shows that anxiety can

create a less structured classroom environment, ultimately disrupting the learning process.

5. **Impact on long-term careers:** If anxiety is not managed properly, its effects can extend beyond classroom teaching and impact prospective teachers' careers. One subject stated: "I'm really not sure if I'll remain a teacher if I keep feeling this anxious every time I teach mathematics" (subject 5). This indicates that high anxiety can lead to mental and emotional exhaustion, potentially causing prospective teachers to leave the profession.

The findings of this study show that mathematics academic anxiety and mathematics pedagogical anxiety have profound effects on prospective teachers' readiness to teach mathematics in the future. One major impact is the reluctance to engage deeply with mathematics material. High anxiety makes prospective teachers avoid activities related to mathematics, as expressed by subject 4. This aligns with research by Hembree (1990), which found that high mathematics anxiety often leads to less participation in mathematics-related activities. As a result, prospective teachers miss opportunities to develop important pedagogical skills, ultimately affecting their teaching readiness.

Additionally, anxiety influences the teaching strategies used by prospective teachers. Beilock et al. (2010) found that anxious teachers often avoid teaching difficult mathematical concepts, as acknowledged by subject 3. This avoidance can lead to superficial understanding among students, as teachers tend not to delve deeply into challenging material. This can also exacerbate the cycle of anxiety, where students who do not receive thorough explanations of mathematical concepts become more anxious and less interested in mathematics. Thus, teacher anxiety not only affects their own readiness but also impacts students' learning experiences.

Anxiety also affects prospective teachers' communication skills. According to Tschannen-Moran and Hoy (2001), anxious prospective teachers often struggle to explain material clearly, leading to confusion among students. This is supported by subject 3's statement that anxiety makes them confused when explaining mathematical concepts. This limitation hinders prospective teachers from creating a supportive and participatory learning environment, ultimately reducing students' motivation to learn mathematics.

Furthermore, anxiety affects classroom management skills. Dewaele et al. (2018) note that anxious prospective teachers often feel less confident in maintaining authority in the classroom, which can disrupt teaching dynamics. This is reflected in subject 5's statement that they find it difficult to control the class because they fear their weaknesses will be noticed by students. Poor classroom management can create a less structured learning environment, ultimately hindering students' learning processes.

The effects of anxiety also extend to prospective teachers' long-term careers. Nowell et al. (2017) found that teachers reporting high anxiety levels are more likely to leave the profession within the first five years. This is supported by subject 5's statement that they are unsure if they will remain a teacher if their anxiety is not addressed. Unmanaged anxiety can lead to mental and emotional exhaustion, potentially causing prospective teachers to leave the profession. This phenomenon not only affects individual careers but also the overall quality of mathematics education.

In conclusion, mathematics academic anxiety and mathematics pedagogical anxiety significantly impact prospective teachers' readiness to teach in the future. This anxiety causes prospective teachers to avoid teaching challenging mathematical concepts, impairs their communication skills, and disrupts their classroom management abilities. Additionally, unmanaged anxiety can lead to burnout and potential career abandonment. To address this issue, teacher training programs need to provide more intensive emotional and pedagogical support, including specialized training in anxiety management and self-efficacy enhancement. Furthermore, creating a supportive and collaborative learning environment can help prospective teachers feel more confident and prepared to face the challenges of teaching mathematics in the future.

CONCLUSION

This study demonstrates that both mathematics academic anxiety and mathematics pedagogical anxiety are prevalent among prospective elementary education teachers, with significant implications for their readiness to teach mathematics. Theoretically, the findings enrich the understanding of how prior negative experiences, rote-based teaching approaches, and low self-efficacy interact to shape both types of anxiety. Practically, the results highlight the urgent need for teacher education programs to implement targeted interventions–such as conceptual-based pedagogy, self-efficacy training, and peer support systems–to reduce anxiety and improve teaching preparedness.

Importantly, this research contributes to the international discourse on mathematics education by providing empirical evidence from the Indonesian context, which shares common challenges with other countries regarding teacher anxiety and mathematics instruction. The insights gained can inform global efforts to design more effective teacher training curricula and support systems, especially in diverse and resource-limited settings. By addressing mathematics anxiety at the pre-service level, educational institutions worldwide can better prepare future teachers to foster positive

attitudes and higher achievement in mathematics among their students.

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