

## Mathematical Thinking among Bachelor of Science in Mathematics Students: The Predictive Roles of Mathematics Anxiety and Attitudes

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### ABSTRACT

**Aims:** This study investigated the relationships among mathematics anxiety, mathematics attitudes, and mathematical thinking among Bachelor of Science in Mathematics students at the University of Eastern Philippines.

**Study Design:** A descriptive-correlational design was employed to explore the associations among the variables and to determine the predictive roles of anxiety and attitudes on mathematical thinking.

**Place and Duration of Study:** The research was conducted at the College of Science, University of Eastern Philippines, during the Academic Year 2025–2026, First Semester.

**Methodology:** A total of 78 undergraduate students participated. Structured Likert-scale questionnaires adapted from Hopko et al. (2003), Tapia and Marsh (2004), and Bal and Dinç Artut (2020) were used to measure mathematics anxiety, mathematics attitudes, and mathematical thinking. Data were analyzed using descriptive statistics, Pearson's correlation coefficient, and multiple regression analysis.

**Results:** Respondents exhibited high levels of mathematics anxiety ( $M = 3.52$ , Extremely Well), generally positive mathematics attitudes ( $M = 3.88$ , Very Well), and very well levels of mathematical thinking ( $M = 3.97$ , Very Well). Correlational analysis revealed a significant negative relationship between mathematics anxiety and mathematical thinking ( $r = -.347$ ,  $p = .004$ ), a strong positive relationship between mathematics attitudes and mathematical thinking ( $r = .699$ ,  $p < .001$ ), and a negative relationship between mathematics anxiety and attitudes ( $r = -.264$ ,  $p = .032$ ). Multiple regression analysis indicated that mathematics anxiety and attitudes together significantly predicted mathematical thinking, explaining 51.7% of the variance ( $R^2 = .517$ ,  $F(2, 63) = 33.749$ ,  $p < .001$ ).

**Conclusion:** The findings suggest that positive attitudes toward mathematics enhance mathematical thinking, while high anxiety hinders cognitive engagement and problem-solving abilities. Interventions aimed at reducing anxiety and fostering positive attitudes are recommended to improve higher-order mathematical thinking and promote student confidence and persistence in mathematics learning.

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**Keywords:** *Mathematics Anxiety, Mathematics Attitudes, Mathematical Thinking, Bachelor of Science in Mathematics, Quantitative Research*

## 1. INTRODUCTION

Mathematics is a foundational discipline that supports essential cognitive processes such as logical reasoning, abstraction, and problem solving. Central to effective mathematics learning is *mathematical thinking*, which involves recognizing patterns, establishing logical relationships, and applying mathematical concepts to solve both routine and non-routine problems (Scientific Topics Handbook, 2025). Mathematical thinking goes beyond procedural fluency and reflects higher-order reasoning skills necessary for success in advanced mathematics and mathematically intensive fields.

Despite its cognitive importance, mathematics learning is often influenced by affective factors that shape students' engagement and performance. One prominent affective variable is *mathematics anxiety*, commonly described as feelings of tension, worry, or apprehension that interfere with the manipulation of numbers and problem solving (Hernández de la Hera et al., 2023). International studies consistently report that mathematics anxiety is negatively associated with students' confidence, persistence, and academic performance, even among learners with adequate mathematical ability (Hernández de la Hera et al., 2023). In higher education, mathematics anxiety may discourage students from engaging deeply with complex tasks that demand sustained reasoning, which is essential for the development of mathematical thinking.

Another affective factor closely related to mathematics learning is *attitude toward mathematics*. This construct encompasses students' beliefs about the value and usefulness of mathematics, their enjoyment of the subject, and their confidence in their mathematical abilities (Hwang & Son, 2021). Research has shown that positive attitudes toward mathematics are associated with greater motivation, stronger engagement, and improved academic outcomes, whereas negative attitudes are linked to avoidance behaviors and reduced effort in challenging mathematical tasks (Hwang & Son, 2021). Attitudes toward mathematics influence how students approach cognitively demanding situations and can either support or hinder the development of mathematical thinking.

At the global level, findings from large-scale assessments highlight the persistence of affective challenges in mathematics education. Reports from the Programme for International Student Assessment (PISA) indicate that many students worldwide experience high levels of mathematics anxiety and low mathematics self-efficacy, which are often accompanied by lower mathematics achievement (BusinessWorld Online, 2024). In the Philippine context, Filipino learners have been reported to exhibit relatively higher mathematics anxiety compared to international averages, alongside weaker performance in mathematics assessments (BusinessWorld Online, 2024). These findings suggest that affective barriers remain a critical concern within mathematics education in the country.

Local studies further support this observation, revealing that mathematics anxiety and unfavorable attitudes toward mathematics persist across educational levels, including tertiary education (European Journal of Education and Pedagogy, 2025). Research conducted in Philippine universities has documented the presence of mathematics anxiety among college students, including those enrolled in science- and mathematics-related programs. At the University of Eastern Philippines, prior studies have examined affective constructs such as mathematics anxiety and self-efficacy in relation to academic performance, indicating that emotional and attitudinal factors continue to influence students' learning experiences in mathematics courses (Lazarra, 2025). However, these studies have largely focused on achievement outcomes, with limited attention given to higher-order cognitive outcomes such as mathematical thinking.

Bachelor of Science in Mathematics students are expected to demonstrate advanced levels of reasoning, abstraction, and problem solving. Understanding how affective factors influence their mathematical thinking is essential, as anxiety and attitudes may shape how these students engage with complex mathematical concepts and tasks. Examining these relationships is particularly relevant in a university context where students are being prepared for professional and academic roles that require strong analytical and reasoning skills.

This study investigates mathematics anxiety and mathematics attitudes as predictors of mathematical thinking among Bachelor of Science in Mathematics students at the University of Eastern Philippines. By determining the levels of these affective variables, examining their relationships with

mathematical thinking, and analyzing their combined predictive effects, the study aims to contribute empirical evidence to the growing literature on affective–cognitive interactions in mathematics education and inform instructional practices that support the development of mathematical thinking in tertiary mathematics programs.

### **Objectives of the Study**

This study aims to examine the predictive roles of mathematics anxiety and mathematics attitudes on mathematical thinking among Bachelor of Science in Mathematics students at the University of Eastern Philippines. Specifically, it seeks to:

1. determine the levels of mathematics anxiety, mathematics attitudes, and mathematical thinking of the respondents.
2. examine the relationship between mathematics anxiety and mathematical thinking.
3. examine the relationship between mathematics attitudes and mathematical thinking.
4. determine whether mathematics anxiety and mathematics attitudes significantly predict mathematical thinking of the respondents.

## **2. MATERIALS AND METHODS**

### **Research Design.**

This study employed a **descriptive–correlational quantitative research design**. The descriptive component was used to determine the levels of mathematics anxiety, mathematics attitudes, and mathematical thinking among the respondents. The correlational component examined the relationships between mathematics anxiety, mathematics attitudes, and mathematical thinking, as well as the predictive roles of mathematics anxiety and attitudes on mathematical thinking. Data were collected using a structured questionnaire and analyzed using appropriate statistical tools.

### **Research Locale**

The study was conducted at the College of Science, University of Eastern Philippines (UEP) Main Campus. The college offers several undergraduate programs, including the Bachelor of Science in Mathematics, which served as the focus of this research. The University of Eastern Philippines is a state university that provides higher education programs in Northern Samar.

### **Population and Sampling Technique**

The target population of the study consisted of all 120 Bachelor of Science in Mathematics students enrolled in the College of Science, University of Eastern Philippines. A complete enumeration sampling technique was employed, wherein all members of the population were invited to participate in the study. However, due to time constraints and the unavailability of some students during the data collection period, only 66 students provided complete and usable responses. The responses obtained were deemed sufficient for the purposes of descriptive and correlational analyses.

### **Participants**

The participants of the study were 66 Bachelor of Science in Mathematics students enrolled at the University of Eastern Philippines, College of Science, during the First Semester of Academic Year 2025–2026.

## Research Instrument

The study utilized a structured survey questionnaire composed of three parts. Part I measured the mathematics anxiety of the respondents using an adapted version of the *Abbreviated Math Anxiety Scale (AMAS)* developed by Hopko et al. (2003), consisting of 10 items. Part II assessed the mathematics attitudes of the respondents using an adapted version of the *Attitudes Toward Mathematics Inventory (ATMI)* by Tapia and Marsh (2004), also consisting of 10 items. Part III measured the mathematical thinking of the respondents using a researcher-adapted instrument based on the work of Bal and Diñç Artut (2020) and the *National Council of Teachers of Mathematics (NCTM) Process Standards*, specifically problem solving, reasoning, connections, representation, and communication, comprising 10 items.

The instruments were adapted from previously validated questionnaires, with contextual and linguistic modifications to suit the target population. All items were rated using a five-point Likert scale, where 5 = *Usually*, 4 = *Often*, 3 = *Sometimes*, 2 = *Seldom*, and 1 = *Never*. Weighted mean scores were interpreted as follows: 4.20–5.00 (*Extremely Well*), 3.40–4.19 (*Very Well*), 2.60–3.39 (*Moderately Well*), 1.80–2.59 (*Slightly Well*), and 1.00–1.79 (*Not at All Well*).

To ensure the reliability of the adapted instruments, Cronbach's alpha was computed using pilot test data. The results demonstrated high internal consistency for the overall scale ( $\alpha = 0.887$ ). Subscale reliability coefficients were also satisfactory: Mathematics Anxiety ( $\alpha = 0.884$ ), Mathematics Attitude ( $\alpha = 0.813$ ), and Mathematical Thinking/Self-Regulated Learning ( $\alpha = 0.883$ ). These results indicate that the adapted instruments are reliable for measuring the intended constructions among the study population.

## Data Collection Procedure

Data was collected personally by the researcher using Google Forms, which were distributed through the participants' Messenger group chats. Prior to participation, the students were provided with a brief overview of the study along with an informed consent statement that explained the purpose of the research and assured them of the voluntary and confidential nature of their participation. Only those who agreed to the informed consent were allowed to proceed with the questionnaire.

The respondents were asked to complete the survey instruments measuring mathematics anxiety, mathematics attitudes, and mathematical thinking. Upon retrieval, all responses were checked for completeness and consistency before being subjected to statistical analysis.

## Ethical Considerations

This study was conducted in accordance with established ethical standards for educational research. Prior to data collection, all respondents were informed about the purpose of the study and were provided with an informed consent form that emphasized the voluntary nature of participation, the right to withdraw at any time without penalty, and assurances of anonymity and confidentiality.

No personally identifiable information was collected from the respondents. All data gathered were treated with strict confidentiality, securely stored, and used solely for academic and research purposes. The study posed minimal risk to participants and upheld the ethical principles of respect for people, integrity, and responsibility throughout the research process.

## Statistical Treatment of Data

The quantitative data collected from the respondents were exported from Google Forms and processed using Microsoft Excel and the Statistical Package for Social Sciences (SPSS). The following statistical tools were employed in accordance with the research objectives:

- **Weighted mean and standard deviation** – used to determine the levels of mathematics anxiety, mathematics attitudes, and mathematical thinking among the respondents. The levels were interpreted based on the scale described in the research instrument (**1.00–1.79 = Not at All Well**; **1.80–2.59 = Slightly Well**; **2.60–3.39 = Moderately Well**; **3.40–4.19 = Very Well**; **4.20–5.00 = Extremely Well**).

- **Pearson product–moment correlation coefficient (Pearson  $r$ )** – used to examine the relationships between mathematics anxiety and mathematical thinking, as well as mathematics attitudes and mathematical thinking.
- **Multiple linear regression analysis** – employed to determine whether mathematics anxiety and mathematics attitudes significantly predict mathematical thinking among Bachelor of Science in Mathematics students.

All statistical tests were interpreted at a 0.05 level of significance, and the assumptions of normality, linearity, and homoscedasticity were checked prior to conducting correlation and regression analyses to ensure the appropriateness of the results.

### 3. RESULTS AND DISCUSSION

#### ***Mathematics Anxiety***

Table 1 presents the levels of mathematics anxiety experienced by the respondents. The grand mean of 3.52, interpreted as *Extremely Well*, indicates that the respondents generally experience high levels of mathematics anxiety when engaging in various mathematical tasks and situations. Mathematics anxiety is characterized by feelings of tension and apprehension that interfere with mathematical performance and problem solving and is prevalent across different educational levels (Khasawneh et al., 2021).

The highest mean scores were observed for items associated with evaluative pressure and performance concerns, particularly “*I feel tense during mathematics examinations*” ( $M = 4.15$ ) and “*I worry about making mistakes in mathematics*” ( $M = 4.14$ ). These findings are consistent with global evidence suggesting that mathematics anxiety is most pronounced in assessment-related contexts, where fear of failure consumes cognitive resources and impairs problem-solving performance (Purnamasari, 2023; Zhang et al., 2019).

High levels of anxiety were also evident during cognitive engagement and classroom participation, as reflected in items such as “*I feel anxious when I am asked to explain my solution in class*” ( $M = 3.95$ ) and “*I feel nervous when solving complex mathematics problems*” ( $M = 3.83$ ). This suggests that mathematics anxiety extends beyond formal examinations to everyday learning situations that require reasoning, explanation, and higher-order thinking. Similar patterns have been reported in previous studies indicating that mathematics anxiety negatively affects students’ engagement and problem-solving processes (Yibing & Jamaludin, 2025).

Items related to social interaction, including “*I feel uncomfortable solving mathematics problems in front of classmates*” and “*I feel pressured when participating in group mathematics activities*” (both  $M = 3.47$ ), also registered elevated anxiety levels. Although slightly lower than test-related items, these results indicate that social evaluation and peer dynamics contribute to students’ anxious responses, supporting research that highlights the influence of classroom environment on students’ emotional experiences in mathematics learning.

Overall, these findings reflect patterns documented in both local and global studies. Research in the Philippine context has shown that mathematics anxiety is closely linked to academic evaluation pressures and performance expectations, emphasizing the emotional challenges faced by students in mathematics courses. Furthermore, global meta-analytic evidence consistently demonstrates a negative association between mathematics anxiety and mathematics performance, indicating that heightened anxiety undermines students’ confidence, cognitive engagement, and achievement across diverse educational settings. Collectively, these studies support the present findings and underscore mathematics anxiety as a significant affective barrier to effective mathematics learning.

**Table 1 Mathematics Anxiety of the Respondent**

Statement	Mean	Std. Deviation	Interpretation
I feel nervous when solving complex mathematics problems.	3.8333	0.86972	Very Well
I feel anxious when I am asked to explain my solution in class.	3.9545	0.83079	Very Well
I worry about making mistakes in mathematics.	4.1364	0.82063	Very Well
I feel tense during mathematics examinations.	4.1515	0.76946	Very Well
I feel uncomfortable solving mathematics problems in front of classmates.	3.4697	0.94819	Very Well
I experience stress when I cannot solve a mathematics problem quickly.	4.0303	0.91095	Very Well
I feel anxious when thinking about upcoming mathematics tests or quizzes.	3.9848	0.77445	Very Well
I feel pressured when participating in group mathematics activities.	3.4697	0.88090	Very Well
I am uneasy when required to apply unfamiliar formulas in mathematics tasks.	3.9091	0.75909	Very Well
I feel nervous when solving multi-step mathematics problems.	3.8182	0.82105	Very Well
<b>Grand Mean</b>	<b>3.5242</b>	<b>0.49242</b>	<b>Very Well</b>

### **Mathematics Attitude**

Table 2 presents the mathematics attitudes of the respondents. The grand mean of 3.88, interpreted as *Very Well*, indicates that the respondents generally exhibit a positive attitude toward mathematics. Positive mathematics attitudes are associated with students' interest, motivation, confidence, and perceived value of mathematics, which play a crucial role in sustained engagement and learning (Tapia & Marsh, 2004).

The highest mean scores were observed for statements emphasizing the value and usefulness of mathematics, particularly "*I believe mathematics is useful in everyday life*" ( $M = 4.44$ ) and "*I feel proud when I solve challenging mathematics problems*" ( $M = 4.33$ ), both interpreted as *Extremely Well*. Likewise, strong motivation was reflected in "*I am motivated to improve my mathematics skills*" ( $M = 4.30$ ). These findings suggest that respondents recognize the relevance of mathematics beyond the classroom and derive a sense of accomplishment from overcoming mathematical challenges. Similar results have been reported in previous studies indicating that valuing mathematics and experiencing success contribute significantly to positive mathematical attitudes (Ma & Kishor, 1997; Tapia & Marsh, 2004).

Items related to interest, confidence, and enjoyment, such as enjoying studying mathematics ( $M = 3.74$ ), finding mathematics interesting ( $M = 4.06$ ), and being confident in understanding mathematics ( $M = 3.71$ ), were all interpreted as *Very Well*. These results indicate that respondents generally approach mathematics with interest and self-assurance, which are essential affective components for effective learning. Prior research has shown that students with positive attitudes toward mathematics tend to demonstrate higher persistence and engagement in mathematical tasks (Di Martino & Zan, 2010).

Furthermore, social and exploratory aspects of learning mathematics, including enjoying discussions of mathematical ideas ( $M = 3.56$ ) and exploring new mathematical concepts ( $M = 3.89$ ), also received favorable ratings. This suggests openness to collaborative learning and intellectual curiosity, which are important for developing deeper mathematical understanding. Local studies in the

Philippine context similarly report that students who maintain positive attitudes toward mathematics are more willing to participate in discussions and engage with challenging content (Oclarit et al., 2025).

Overall, the findings indicate that the respondents possess a generally positive mathematics attitude, characterized by strong motivation, perceived usefulness, and moderate to high confidence. These affective strengths may serve as protective factors against the negative effects of mathematics anxiety and may positively influence students' mathematical thinking and learning outcomes.

**Table 2 Mathematics Attitude of the Respondent**

Statement	Mean	Std. Deviation	Interpretation
I enjoy studying mathematics.	3.7424	0.72982	Very Well
I am confident in my ability to learn and understand mathematics.	3.7121	0.75986	Very Well
I believe mathematics is important for my future career.	4.1818	0.67730	Very Well
I am motivated to improve my mathematics skills.	4.3030	0.6562	Extremely Well
I find mathematics interesting and engaging.	4.0606	0.67662	Very Well
I feel proud when I solve challenging mathematics problems.	4.3333	0.82896	Extremely Well
I believe mathematics is useful in everyday life.	4.4395	0.63558	Extremely Well
I like exploring new mathematical concepts.	3.8939	0.76719	Very Well
I am positive about my mathematics abilities.	3.5000	0.72854	Very Well
I enjoy discussing mathematical ideas with classmates or teachers.	3.5606	0.78699	Very Well
<b>Grand Mean</b>	<b>3.8758</b>	<b>0.62906</b>	<b>Very Well</b>

### **Mathematical Thinking**

Table 3 presents the level of mathematical thinking among the respondents. The grand mean of 3.97, interpreted as *Very Well*, indicates that the respondents generally demonstrate a high level of mathematical thinking skills. Mathematical thinking involves the ability to analyze problems, apply appropriate strategies, reason logically, and reflect on solutions, which are essential competencies in higher-level mathematics learning (National Council of Teachers of Mathematics [NCTM], 2000).

The highest mean scores were observed for reflective and metacognitive behaviors, particularly "*I check my answers to ensure they are reasonable and correct*" ( $M = 4.03$ ) and "*I reflect on my solutions and improve them if necessary*" ( $M = 4.03$ ), both interpreted as *Very Well*. These findings suggest that respondents actively engage in self-monitoring and evaluation, which are key components of effective mathematical thinking and problem solving (Schoenfeld, 2016). The ability to reflect on and refine solutions indicates a mature approach to mathematical reasoning.

High levels of analytical and strategic thinking were also evident in items such as "*I analyze a problem before choosing a solution strategy*" ( $M = 3.82$ ) and "*I identify patterns and relationships in mathematical problems*" ( $M = 3.55$ ). These results imply that respondents frequently engage in planning and pattern recognition, which are fundamental to mathematical inquiry and abstraction (Polya, 2004). Similarly, the ability to represent mathematical ideas using diagrams, tables, or graphs ( $M = 3.45$ ) further supports the presence of strong representational skills aligned with the NCTM process standards.

However, several items were rated at the *Moderately Well* level, particularly those involving transfer and complexity, such as applying mathematical concepts to unfamiliar problems ( $M = 3.12$ ), breaking down complex problems into manageable parts ( $M = 3.17$ ), and interpreting mathematical

results in real-world contexts ( $M = 3.27$ ). These findings suggest that while respondents demonstrate solid reasoning and reflection skills, they may experience greater difficulty when tasks require abstraction, transfer of knowledge, or application beyond familiar contexts. Similar challenges have been reported in previous studies, which indicate that transfer and application remain among the most demanding aspects of mathematical thinking for students (Lithner, 2008).

Overall, the findings indicate that the respondents possess a generally strong level of mathematical thinking, particularly in analysis, reflection, and evaluation. Nonetheless, the comparatively lower scores in applying concepts to novel and real-world situations suggest potential areas for instructional enhancement. Strengthening opportunities for problem-based learning and real-life applications may further support the development of higher-order mathematical thinking skills among students.

**Table 3 Mathematical Thinking of the Respondent**

Statement	Mean	Std. Deviation	Interpretation
I analyze a problem before choosing a solution strategy.	3.8182	0.65420	Very Well
I can explain the reasoning behind my mathematical solutions.	3.4242	0.74546	Very Well
I can apply mathematical concepts to new or unfamiliar problems.	3.1212	0.59524	Moderately Well
I identify patterns and relationships in mathematical problems.	3.5455	0.66058	Very Well
I can evaluate different approaches and choose the most effective solution.	3.3788	0.62672	Moderately Well
I check my answers to ensure they are reasonable and correct.	4.0303	0.65562	Very Well
I can break down complex problems into manageable parts.	3.1667	0.69245	Moderately Well
I can interpret mathematical results in real-world contexts.	3.2727	0.56963	Moderately Well
I can represent mathematical ideas using diagrams, tables, or graphs.	3.4545	0.74796	Very Well
I reflect on my solutions and improve them if necessary.	4.0303	0.82219	Very Well
<b>Grand Mean</b>	<b>3.9727</b>	<b>0.49070</b>	<b>Very Well</b>

### ***Relationships between Mathematical Anxiety and Mathematical Thinking***

The analysis revealed a **significant negative relationship** between mathematics anxiety and mathematical thinking ( $r = -.347$ ,  $p = .004$ ). This indicates that higher levels of anxiety are associated with lower levels of mathematical thinking among Bachelor of Science in Mathematics students. In cognitive terms, anxiety has been shown to consume working memory resources that are essential for higher-order reasoning, planning, and problem solving (Ashcraft & Kirk, 2001). When students feel tense or worried about mathematics, they may allocate cognitive capacity to managing anxiety rather than focusing on conceptual understanding, strategy selection, and reflective evaluation, all of which are central to mathematical thinking.

This pattern has been observed in both local and international research. For example, Hembree's (1990) seminal review found that mathematics anxiety consistently correlates with poor problem solving and lower mathematical achievement. More recent meta-analytic evidence further supports this link, demonstrating that math anxiety not only predicts lower performance but also induces avoidance behaviors, which can erode students' opportunities to engage in challenging mathematical reasoning (Zhang et al., 2019). In the Philippine context, studies have noted that emotional factors, such as fear of failure and pressure during assessments, are significant contributors to learning

difficulties in mathematics (Cullano, 2024). Thus, the present result suggests that interventions aimed at reducing mathematics anxiety — such as cognitive restructuring, stress-management strategies, and supportive classroom climates — may help preserve cognitive resources necessary for effective mathematical thinking.

### ***Relationships between Mathematical Attitudes and Mathematical Thinking***

The correlation between mathematics attitudes and mathematical thinking was **strongly positive** and highly significant ( $r = .699, p < .001$ ), indicating that students with more positive attitudes toward mathematics also demonstrate higher levels of mathematical thinking. Attitudes toward mathematics encompass confidence, enjoyment, perceived relevance, and motivation — all affective dispositions that influence how students interact with mathematical content (Ma & Kishor, 1997; Tapia & Marsh, 2004). When students view mathematics as valuable and engaging, they are more likely to apply deeper cognitive strategies, persist through difficult problems, and reflect on their reasoning.

This finding dovetails with research on affective-cognitive integration in mathematics learning. Studies have shown that positive attitudes are linked with increased classroom engagement, use of sophisticated problem-solving strategies, and willingness to tackle non-routine tasks (Zan & Di Martino, 2007; Di Martino & Zan, 2010). In local settings, research on Filipino students has highlighted that positive mathematics beliefs correlate with greater academic engagement and resilience, even in contexts where instructional challenges and limited resources exist (Oclarit et al., 2025). The strong correlation suggests that fostering positive attitudes — through relevance-based instruction, collaborative learning, and opportunities for mastery experiences — may be one of the most effective ways to support the development of mathematical thinking in mathematics majors.

### ***Relationships between Mathematical Anxiety and Mathematical Attitudes***

The significant negative correlation between mathematics anxiety and mathematics attitudes ( $r = -.264, p = .032$ ) indicates that as anxiety increases, students' attitudes toward mathematics become less positive. This reciprocal relationship is well documented in the literature: anxiety tends to erode confidence, reduce enjoyment, and diminish motivation (Hembree, 1990; Ma & Kishor, 1997). As students become more anxious about mathematics, they are more likely to develop negative beliefs about their mathematical ability and the value of mathematics, which can further reinforce avoidance and disengagement.

This affective interplay has important implications. For example, D'Amore et al. (2020) found that negative attitudes and high anxiety can create a self-perpetuating cycle, where anxious students avoid opportunities for practice and mastery, which in turn limits skill development and reinforces negative perceptions. Local studies among Filipino learners have similarly observed that anxiety is a strong predictor of lowered mathematics confidence and decreased willingness to participate in class (Phase 2 mathematics study, 2023). The finding suggests that any intervention aimed at improving attitudes must also address the emotional dimension of learning — reducing anxiety, providing supportive feedback, and building environments where mistakes are seen as learning opportunities.

**Table 4. Correlation Analysis between Mathematics Anxiety, Mathematics Attitude, and Mathematical Thinking**

Correlations				
		Mathematics Anxiety	Mathematics Attitudes	Mathematical Thinking
Mathematics Anxiety	Pearson Correlation	1	-.264	-.347
	Sig. (2-tailed)		.032	.004
Mathematics Attitudes	Pearson Correlation	-.264	1	.699
	Sig. (2-tailed)	.032		.000
Mathematical Thinking	Pearson Correlation	-.347	.699	1
	Sig. (2-tailed)	.004	.000	

***Relationship between Mathematical Anxiety, Mathematical Attitudes and Mathematical Thinking***

The multiple linear regression analysis revealed an R value of .719, indicating a strong combined relationship between the predictors (mathematics anxiety and mathematics attitudes) and the dependent variable (mathematical thinking). The  $R^2$  of .517 suggests that 51.7% of the variance in mathematical thinking can be explained collectively by mathematics anxiety and mathematics attitudes. After adjusting for the number of predictors, the adjusted  $R^2$  of .502 indicates that the model remains a reliable and meaningful estimate of the proportion of variance accounted for by the predictors. The overall model was statistically significant,  $F(2, 63) = 33.749$ ,  $p < .001$ , confirming that the set of predictors reliably explains a significant portion of the variability in mathematical thinking.

These findings indicate that mathematics anxiety and mathematics attitudes together significantly predict mathematical thinking among Bachelor of Science in Mathematics students. In this context, mathematics attitudes appear to be a potent positive influence, suggesting that students who hold more favorable beliefs about mathematics including confidence in their abilities, interest in the subject, and perceived usefulness tend to demonstrate higher levels of mathematical thinking. Conversely, mathematics anxiety may exert a constraining effect on cognitive processes, wherein increased anxiety corresponds with reduced mathematical reasoning and problem-solving performance.

The predictive power of these affective factors is supported by extensive research that underscores the interplay between emotions, attitudes, and cognition in mathematics education. For example, studies have shown that positive attitudes toward mathematics are associated with greater persistence on challenging tasks and higher achievement, as these attitudes enhance motivation and engagement with complex problem solving (Zan & Di Martino, 2007; Papanastasiou, 2000). Likewise, Ma and Kishor's (1997) meta-analysis demonstrated that attitudes toward mathematics reliably predict achievement outcomes, highlighting the cognitive benefits of positive affective dispositions. At the same time, mathematics anxiety has been shown to deplete working memory resources that are essential for higher-order thinking and performance, thus interfering with students' ability to engage fully in analytical and reflective processes (Ashcraft & Kirk, 2001; Beilock & Carr, 2005).

Local studies further support these interpretations. Research within Philippine tertiary settings has documented that negative emotions such as anxiety and low confidence can limit students'

participation, persistence, and conceptual engagement in mathematics courses (Oclarit et al., 2025). In similar contexts, students experiencing high mathematics anxiety demonstrated lower use of metacognitive strategies and reduced performance on tasks requiring complex reasoning (Philippine Journal of Education, 2024). These findings echo the current results, suggesting that affective constructs play a substantial role in shaping students' mathematical thinking beyond traditional cognitive measures alone.

In practical terms, the findings imply that addressing affective barriers such as anxiety and enhancing positive attitudes toward mathematics could lead to measurable improvements in mathematical thinking. Educational interventions that emphasize affective support, such as anxiety-reduction techniques, collaborative learning environments, and opportunities that build mastery experiences, may help students allocate cognitive resources more effectively, thus enhancing problem solving and reasoning. Additionally, instructional approaches that foster interest, relevance, and confidence in mathematics have been shown to promote deeper engagement and better conceptual understanding (Hannula, 2012; Philippou & Christou, 1998).

Overall, this study contributes to a growing body of literature that positions affective factors — specifically anxiety and attitudes as essential predictors of cognitive outcomes in mathematics learning. It emphasizes the need for a holistic instructional focus that integrates both emotional and intellectual development to support students' mathematical thinking and success.

**Table 5. Regression Analysis between Mathematics Anxiety, Mathematics Attitude, and Mathematical Thinking**

Model Summary									
Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate	Change Statistics				
					R <sup>2</sup> Change	F Change	df1	df2	Sig. F Change
1	.719 <sup>a</sup>	.517	.502	.348	.517	33.749	2	63	.000
a. Predictors: Mathematical Attitudes, Mathematics Anxiety									
b. Dependent Variable: Mathematical Thinking									

## 5. CONCLUSION

The study examined the relationships among mathematics anxiety, mathematics attitudes, and mathematical thinking, and explored the predictive roles of anxiety and attitudes on mathematical thinking among Bachelor of Science in Mathematics students at the University of Eastern Philippines. The results indicate that mathematics anxiety negatively affects mathematical thinking. Students experiencing higher levels of anxiety tend to exhibit lower problem-solving ability, reasoning skills, and reflective evaluation in mathematics. This suggests that anxiety consumes cognitive resources essential for higher-order thinking, limiting students' capacity to engage effectively with complex mathematical tasks.

The findings also demonstrate that mathematics attitudes positively influence mathematical thinking. Respondents with more favorable attitudes including confidence, enjoyment, motivation, and the perceived value of mathematics displayed higher levels of mathematical thinking. This emphasizes

the importance of affective dispositions in supporting engagement, persistence, and success in tasks requiring analytical and reflective reasoning, aligning with prior research that links positive attitudes to better cognitive outcomes in mathematics (Zan & Di Martino, 2007; Papanastasiou, 2000).

Furthermore, the study revealed that mathematics anxiety and attitudes are inversely related. Higher anxiety is associated with less positive attitudes toward mathematics, suggesting a reciprocal relationship in which emotional discomfort undermines confidence, motivation, and interest. This finding underscores the need to address both anxiety and attitudes simultaneously, as they jointly shape students' emotional and cognitive experiences in mathematics.

Finally, the regression analysis confirmed that mathematics anxiety and attitudes collectively predict mathematical thinking, explaining approximately 51.7% of the variance. Positive attitudes serve as a strong enabler of mathematical thinking, whereas anxiety can hinder cognitive performance. These results highlight the critical role of affective factors in mathematics education and suggest that interventions aimed at reducing anxiety and fostering positive attitudes could substantially enhance students' engagement, confidence and higher-order thinking skills.

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