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Research article

Mathematics anxiety as a moderator between self-esteem and mathematics achievement among Filipino Grade 8 students

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Abstract: Mathematics achievement is influenced not only by cognitive ability but also by psychological and emotional factors such as self-esteem and mathematics anxiety. Among these factors, self-esteem has been consistently linked to academic achievement. However, the relationship is not always simple. Recent studies suggest that anxiety, particularly mathematics anxiety, may play a moderating role, potentially weakening or affecting how self-esteem influences mathematics achievement, making it an important factor to explore in this relationship. This study examined the moderating effect of mathematics anxiety on the relationship between self-esteem and mathematics achievement. Understanding the factors that influence students' mathematics achievement is crucial for improving educational outcomes. Using a random sampling and descriptive–correlational research design, 612 students were surveyed utilizing a two-part survey questionnaire, and data were analyzed through frequency counts, percentage, weighted means, standard deviations, Pearson's r, and multiple regression analysis. The results showed that the respondents have moderate self-esteem and mathematics anxiety. Moreover, the respondents have satisfactory mathematics achievement. Furthermore, there was a significant but negligible negative correlation between self-esteem and mathematics achievement, while mathematics anxiety had a significant positive correlation with mathematics achievement. Mathematics anxiety moderates the relationship between self-esteem and mathematics achievement. These findings suggest that self-esteem alone does not strongly predict mathematics achievement but interacts with anxiety in meaningful ways. It is also recommended that school administrators and educators develop programs addressing both self-esteem and mathematics anxiety to improve students' mathematics achievement. Implementing strategies that foster confidence and reduce mathematics anxiety may lead to better academic outcomes in mathematics.

Keywords: self-esteem, mathematics anxiety, mathematics achievement

1. Introduction

Research shows many reasons why students often dislike or find mathematics hard. An eighth-grade student shared that mathematics felt particularly challenging because they could not fully grasp the lessons and were unwilling to ask for help, worried that both their classmates and the teacher would perceive them as unintelligent [1]. Students see mathematics as needing a lot of effort, which can make it feel overwhelming [2]. Since mathematics builds on earlier concepts, falling behind can make students feel discouraged and unable to catch up. The students often do not see mathematics as useful in their daily lives, which can make them question why they need to learn it [3]. This lack of purpose can make students less willing to put in effort. As a result, students miss out on seeing how mathematics can be interesting or creative [4]. Students may feel pressured when comparing themselves with their classmates or hearing stereotypes about who is "good at math" [5]. This can lead to self-doubt and the belief that mathematics is difficult and only for certain people [6].

A lot of Filipino students no longer seem to be interested in mathematics. According to the Programme for International Student Assessment (PISA) [7], with an average score of 353 points in mathematics literacy, which indicates below Level 1 proficiency as the standard averaged score of 489 points for the Organization for Economic Cooperation and Development (OECD) [8], the Philippines came in sixth from the bottom in the 2022 PISA results. Students performed among the lowest-performing student groups across all participating countries. As a result, the Filipino education system seeks to find effective ways to improve students' abilities, make learning accessible, and foster greater skills, which has sparked the researcher’s interest in investigating the potential contributing factors.

One key factor contributing to these difficulties is how students perceive themselves. Self-esteem plays a critical role in academic contexts, particularly in mathematics [9]. Students who maintain high self-esteem tend to take on challenging mathematics problems, persist through difficulties, and utilize effective problem-solving strategies [10]. In contrast, those with low self-esteem may avoid mathematics tasks out of fear of failure, entering a cycle of negative experiences that further erode their confidence that can affect their mathematics achievement [11].

Mathematics achievement is also influenced by a complex interplay of psychological factors, notably mathematics anxiety. Mathematics anxiety refers to the feelings of worry, fear, or tension that students may feel when handling or dealing with activities, tasks, or situations that involve mathematics [12]. High mathematics anxiety can negatively affect students' ability to concentrate and perform the cognitive processes necessary for understanding and solving mathematical problems [13]. Anxiety can affect cognitive functions such as working memory, which is very significant for learning and problem-solving by students. When students experience high mathematics anxiety, they may find it more difficult to focus, remember important information, and carry out problem-solving strategies, which ultimately results in lower performance in mathematics [14].

Consequently, self-esteem generally has a positive effect on mathematics achievement, but this relationship is not always direct or simple. One important factor that can influence this relationship is mathematics anxiety. The presence of high mathematics anxiety can weaken or limit the positive influence of self-esteem on mathematics achievement. Even when students believe in their abilities, if they experience high anxiety in mathematics-related situations, they may not be able to apply their knowledge effectively or perform to the best of their ability. On the other hand, when mathematics

anxiety is low, students with high self-esteem are more likely to use their skills and confidence to achieve better results in mathematics [15].

Likewise, if the relationship of the variables is taken into account, high anxiety weakens the positive influence of self-esteem, whereas low anxiety allows self-esteem to more effectively translate into better achievement. This approach allows a significant understanding of how emotional and cognitive factors interact to influence academic success, offering critical insights for developing targeted interventions. Such interventions could help create supportive, failure-tolerant learning environments that will reduce anxiety while enhancing and boosting self-esteem, ultimately leading to improved mathematics achievement [16].

Across educational settings worldwide, research consistently shows that gender patterns diverge for the two affective factors at the heart of the present study. Large-scale syntheses report that girls typically experience more mathematics anxiety than boys, even when prior achievement and general test anxiety are considered [17,18]. In contrast, boys tend to hold slightly higher global self-esteem, a difference first quantified in a meta-analysis of 216 comparisons covering more than 97,000 participants and later replicated in a survey of nearly one million people across 48 nations [19,20]. Taken together, these complementary trends imply that female students often confront mathematics with both elevated anxiety and marginally lower self-esteem, whereas male students are comparatively buffered by lower anxiety and higher self-esteem. This asymmetry underscores why exploring gender-specific dynamics in the interplay among self-esteem, mathematics anxiety, and mathematics achievement is essential: The same level of self-esteem may protect boys' mathematics achievement more rigorously than girls', making mathematics anxiety a potentially stronger moderator for female learners.

This study investigated the moderating effect of mathematics anxiety in the relationship between self-esteem and mathematics achievement among Grade 8 students. The findings are expected to inform educators and policymakers about the conditions under which self-esteem can effectively boost mathematics achievement and focus the development of strategies to support students facing mathematics anxiety. Specifically, this study sought to answer the following questions:

1. What is the level of self-esteem among the respondents?
2. What is the level of mathematics anxiety among the respondents in terms of:

    2.1 Learning mathematics anxiety?
    2.2 Mathematics evaluation anxiety?

3. What is the level of mathematics achievement of the respondents?
4. Is there a significant relationship between the respondents' self-esteem and their mathematics achievement?
5. Do mathematics anxiety levels significantly moderate the relationship between the self-esteem and mathematics achievement of the respondents?

2. Literature review

This study explores how mathematics anxiety moderates the relationship between the self-esteem and mathematics achievement of the students. This exploration is anchored in theories such as the cognitive load theory by Sweller [21], cognitive behavioral theory (CBT) as developed by Aaron Beck [22], and the control-value theory of Pekrun [23]. Cognitive load theory suggests that our brain

can only handle a limited amount of information at one time. When students feel anxious about mathematics, their working memory becomes occupied with negative thoughts—such as fear of failure or self-doubt—leaving fewer cognitive resources available for learning and problem-solving [14]. This emotional interference increases the overall cognitive load, making it more difficult to concentrate on the task at hand. As a result, students may struggle to process instructions, apply strategies, or complete mathematical operations efficiently. This added burden can significantly affect their performance in school, lowering their mathematics achievement. Cognitive behavioral theory explains how our thoughts, feelings, and actions are connected. Mathematics anxiety can lead students to think negatively about their abilities, which affects how they feel and behave during mathematics tasks [24]. Even students with high self-esteem may panic or avoid mathematics if their mathematics anxiety is strong, which harms their achievement in mathematics. This idea is also strengthened by control-value theory, which focuses on how students' emotions in learning depend on how much control they feel they have and how important they think the task is. High self-esteem can help students feel more in control and do better in mathematics, but anxiety can weaken this effect [11]. If anxiety is low, self-esteem can have a more positive impact on mathematics achievement.

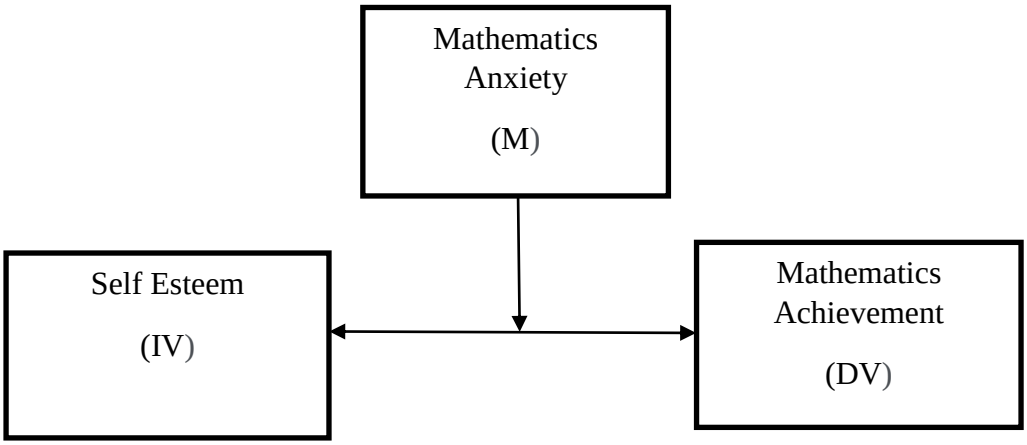

Figure 1. Conceptual framework.

Based on these theories, the study aimed to test the following null hypotheses:

Ho1: There is no significant relationship between the respondents' self-esteem and their mathematics achievement.
Ho2: Mathematics anxiety does not significantly moderate the relationship between the respondents' self-esteem and mathematics achievement.

2.1. Self-esteem

Self-esteem is the state of appreciation that arises from a person's approval of their self-concept based on their self-assessments [25]. Self-esteem is a person's thoughts, feelings, and perspectives toward him/herself [26]. Self-esteem is built on how much a person appreciates, accepts, and loves themselves. This sense also refers to the self-assessments that a person makes of her/himself based on her/his interpersonal relationships. Self-esteem is not formed entirely from internal factors but is also influenced by the external environment. Social constructs around the individual contribute to the modern perspective of self-esteem [27]. High self-esteem means that a person believes in him/herself

and knows that they are an extraordinary being in this world. They recognize that they might have a few weaknesses and many strengths that shape who they are. Low self-esteem means people do not believe in themselves and often compare themselves with others. They tend to focus on their weaknesses over showing their strengths.

2.2. Mathematics anxiety

Mathematics anxiety is a concern that affects many aspects across multiple countries and regions [28]. It refers to worry or fears about solving math problems or the subject as a whole. According to West [29], a person with mathematics anxiety might experience anxiousness or uneasiness any time they have to use math skills in classes at school or even outside the premises. It often arises around middle school or junior high as students encounter more complicated mathematics concepts. Studies show that it can happen even among students with strong math skills. In longitudinal studies, students' mathematics anxiety tends to increase over the years, especially in Grades 7 to 9 , as math lessons become more difficult and increasingly abstract [30].

2.3. Mathematics achievement

Mathematics achievement implies the competency exhibited by the students in mathematics and is usually measured through the use of standardized assessments or tests. It includes various skill-based and cognitive factors that contribute to the presentation of mathematics tasks [31]. As mentioned in the study by Baybayan and Lacia [32], creating standardized tests for students helps improve their academic performance, especially in math. This points out that being good at math is not just about being able to solve math problems but is also about being able to understand the concepts and knowing how to apply them in real-life settings like in business or in the workplace. It also involves their problem-solving skills, reasoning, and how they use math in real-life situations, emphasizing the need for varied evaluation methods to cover all the details.

2.4. Self-esteem and mathematics achievement

In the area of mathematics achievement, a positive correlation between self-esteem and performance has consistently been suggested in the studies. A positive correlation between self-esteem and mathematics achievement has been consistently reported in modern studies. As an illustration, a study by Bahufite et al. [33] showed that students performing remarkably better in mathematics have higher levels of self-esteem; in the same manner, they are less likely to experience anxiety-related setbacks, since they lean toward persevering through difficult tasks.

Building self-esteem has been shown to help reduce mathematics anxiety. Ismet Temaj et al. [34] found that students who participated in confidence-boosting activities before their mathematics tests felt less nervous and performed better than those who did not. Students see mathematics as challenging. That is why studies have emerged relating self-esteem as a component in academic success. According to Tengaa [35], self-esteem influences the relationship between mathematics achievement and academic self-efficacy, showing that those students who achieve better in mathematics with high self-esteem are more likely to feel confident in their abilities.

Socioeconomic status (SES) plays a role in how self-esteem influences a student's mathematics achievement. Yıldırım [36] found that students from lower-income backgrounds often have lower self-esteem, which negatively affects their mathematics achievement. This aligns with other research

stating that parental support, acquiring resources, and educational opportunities help in building students' confidence so that they can focus on honing their mathematics abilities.

Gender differences in self-esteem have likewise been examined in recent studies. A study by Magee and Upenieks [37] found that boys generally reported higher self-esteem in mathematics contexts compared with girls, which may explain part of the gender gap in mathematics achievement. The good news is that the study also found that we can close the gap between boys and girls in math. When we help girls feel more confident, they do better in mathematics. This means we can make a real difference with the right strategies.

2.5. Self-esteem and mathematics anxiety

Various studies stress that students with lower self-esteem tend to experience higher levels of mathematics anxiety. Let us consider self-esteem as the foundation on which a student's academic performance is built. The structure becomes fragile when the foundation is not strong enough, which means the student's education is compromised. In their study, Singh & Jethwani [11] revealed that a student's learning process reaches a vulnerable point when they have low self-esteem, making them more easily distracted by mathematics anxiety. This anxiety strains the confidence and abilities they have, leading them to focus less and making it harder for them to succeed. Over time, the weakness grows, making things even more complex. Labeling themselves as "bad at math" and believing that "I cannot do this" may be perceived by the students as having difficulty adjusting to the lessons presented to them. When students internalize their struggles, seeing math difficulties as a reflection of their overall worth, it can trigger a fear of trying and a fear of failure that affects their approach to learning. This fear can lead to an avoidant pattern, where they do not want to deal with challenges and welcome opportunities to foster them, as they are afraid that what they thought was right from the beginning was incorrect. This can ultimately sabotage their progress, maintaining the cycle of anxiety and underachievement. They get stuck in a cycle where their fear of failing causes problems and worsens them. This idea is further supported by the study of Gurung et al. [38], which found that students with high self-esteem are more likely to cope effectively with stressful life events, such as academic pressure, social challenges, family problems, and physical or emotional changes, and are less likely to experience emotional problems like anxiety, depression, or disruptive behavior in school.

Wahyuni et al. [39] explained that students with higher self-esteem usually faced mathematics challenges with much greater confidence, which protected them from the cognitive and emotional damage of anxiety. As a result, these students were better able to focus on problem-solving and honing their abilities in math. They were less likely to experience the damaging effects of mathematics anxiety.

2.6. Mathematics anxiety and mathematics achievement

The relationship between mathematics anxiety and mathematics achievement has been well documented, with most studies indicating that math anxiety is a strong negative predictor of mathematics achievement. According to Suárez et al. [40], mathematics anxiety gets in the way with cognitive processes necessary for mathematics problem-solving, particularly working memory. Anxiety can overwhelm a student's thinking ability with negative thoughts. This results in weak cognitive ability needed in concentrating on and solving math problems, which can then lead to poorer academic results.

The cognitive interference caused by mathematics anxiety, particularly in high-stakes situations such as exams, can lead to poor performance [41,42]. Many people assume that students struggle with math simply because they lack basic skills. However, this is usually a misconception. Often, it is not a shortage of skill that affects students' mathematics achievement but the anxiety they experience, particularly in test situations where pressure is high. This anxiety can drain the mental resources needed for logical reasoning, which can cause what is known as "choking under pressure" in stressful environments. Ashcraft and Moore [43] explored this issue and highlighted how anxiety can interrupt a student's clarity of thought and ability to analyze and solve mathematics problems efficiently. When students are anxious, it impacts not just their thinking ability but also their emotions.

In addition, there is gender difference in mathematics anxiety. Girls exhibit higher mathematics anxiety than boys [18]. Addressing the anxiety experienced by the girls caused by stereotypes will be of great help in lessening girls' mathematics anxiety.

2.7. Self-esteem, mathematics anxiety, and mathematics achievement

Previous studies have outlined that the level of mathematics anxiety in students determines their academic achievement. The survey of Álvarez & Szücs [44] found that high self-esteem is usually associated with better mathematics achievement. The presence of mathematics anxiety weakens this relationship, causing even confident students to struggle with math-related problems. This suggested that students with low mathematics anxiety and with high self-esteem tend to excel in mathematics. In contrast, students with high mathematics anxiety, even with high self-esteem, often perform worse due to cognitive interference and avoidance behaviors.

Mathematics anxiety determines how weak or strong this relationship between self-esteem and mathematics achievement is. When students have low levels of mathematics anxiety, the positive effects of high self-esteem on mathematics achievement are successfully reached, as they are more likely to participate in problem-solving with confidence. On the other hand, Ashcraft and Kirk [45] found that when mathematics anxiety is high, even students possessing high self-esteem may struggle due to the heightened stress it brings, reducing working memory capacity and leading to avoidance of the subject. The negative effects become even worse for students who have high anxiety and low self-esteem, leading to significantly lower mathematics achievement [15].

In conclusion, the review of the existing literature provides a strong foundation for understanding the relationship among self-esteem, mathematics anxiety, and mathematics achievement. Considering the studies mentioned above, it is evident that self-esteem is an important psychological factor that impacts students' confidence and academic achievement, with mathematics anxiety as a moderator that shapes the connection between self-esteem and their achievement in mathematics. This study sought to deepen the understanding of this moderating effect by examining how different levels of mathematics anxiety influence the relationship between self-esteem and mathematics achievement among Grade 8 students. By identifying this interaction, educators can develop more targeted interventions to help students manage anxiety, maximizing the benefits of high self-esteem in mathematical learning.

3. Methodology

3.1. Research design

The study employed a descriptive correlational design to examine how self-esteem, mathematics

anxiety, and mathematics achievement interact in Grade 8 students. This design, which involves collecting, summarizing, and presenting data without manipulating any variables [46], was ideal for exploring the patterns that exist naturally within the dataset. Data were collected through survey questionnaires administered using a random sampling technique and analyzed with Pearson's r to determine the strength and direction of the relationships between the variables.

Moreover, the study tested the following alternative hypotheses:

Ha1: The respondents' self-esteem is significantly related to their mathematics achievement.
Ha2: Mathematics anxiety significantly moderates the relationship between the respondents' self-esteem and mathematics achievement.

3.2. Respondents

The study focused on Grade 8 students from public high schools. The researchers aimed to include early adolescents in the study, with most respondents being 13 and 14 years old. This age group is important because it is a developmental stage where self-esteem and anxiety can significantly impact mathematics achievement. The gender distribution of the participants was relatively balanced between female and male students.

Table 1. Distribution of the respondents.

Profile	f	%
Age		
>18	3	0.50
17	7	1.14
16	9	1.47
15	29	4.74
14	201	32.84
13	362	59.15
12	1	0.16
Total	**612**	**100.00**
Gender		
Female	315	51.47
Male	297	48.53
Total	**612**	**100.00**

3.3. Data collection tools

Two questionnaires were utilized to examine the relationship among self-esteem, mathematics anxiety, and mathematics achievement. The Rosenberg self-esteem scale (RSE) [47] measured students' self-esteem using a 10-item, 5-point Likert scale (1, strongly agree; 2, agree; 3, neutral; 4, disagree; 5, strongly disagree), demonstrating strong reliability (Guttman coefficient: 0.92, test–retest: 0.85–0.88) and validity. Moreover, to assess mathematics anxiety, the mathematics anxiety rating scale (MARS) developed by Plake and Parker [48] was used, consisting of 24 items categorized into learning mathematics anxiety (16 items) and mathematics evaluation anxiety (8 items), also rated on a 5-point Likert scale (1, never; 2, rarely; 3, sometimes; 4, regularly; 5, always). Validity and reliability were confirmed using AMOS 20.0 Composite Reliability(CR): 0.784; Average Variance Extracted (AVE): 0.151, Cronbach's alpha: 0.81 for Learning Mathematics Anxiety, 0.67 for Mathematics Evaluation Anxiety. Despite some limitations, the Revised Mathematics Anxiety Rating

Scale (RMARS) was deemed suitable for measuring mathematics anxiety and its role as a moderator between self-esteem and mathematics achievement.

3.4. Data collection process

The data collection process involved several stages. Initially, the researchers obtained permission from the school superintendent and the school head to conduct the study. They also oriented the school head, teachers, and students about the study's purpose, methods, and data use, ensuring confidentiality. The researchers followed local ethical guidelines requiring both written informed consent from the parents or legal guardians and written assent from the student participants. Consent forms were sent to the parents or guardians, detailing the study's purpose, procedures, potential risks and benefits, data confidentiality, and the voluntary nature of participation. Only students with duly signed consent forms from their parents or guardians and who provided their personal written assent were included in the study. Students were also informed that they had the right to withdraw from the study at any point without facing any negative consequences. The researcher administered the survey, which served as the primary data collection instrument. This consisted of standardized, validated questionnaires designed to assess mathematics anxiety, self-esteem, and mathematics achievement. The questionnaire was presented in English, and the researchers ensured that they were available throughout the data collection process to provide necessary clarifications and explanations. The presence and guidance of the researchers helped ensure that participants fully understood the survey items, promoting the accuracy and reliability of the collected data. After acquiring the survey questionnaires, the researchers expressed their appreciation to the teachers and students for their participation. In the post-data gathering stage, the researchers sorted and tabulated the data, using graphs and tables for easier interpretation. The data were then compiled and statistically analyzed to determine the moderating influence of mathematics anxiety on the relationship between self-esteem and mathematics achievement.

3.5. Data analysis

The collected data were analyzed using various statistical tools and software, including Excel and Jamovi software [49]. Frequency counts were used to tally the number of students in each mathematics achievement category. Percentages were used to show the proportion of students achieving specific scores. The weighted mean was calculated to determine the levels of self-esteem, mathematics anxiety, and mathematics achievement among the respondents. Standard deviation (SD) was used to measure the variability of the responses. Pearson’s r was used to measure variability and explain the relationships among self-esteem, mathematics anxiety, and mathematics achievement.

4. Results

This section outlines the results derived from the collected data, aligned with the study's objectives, which sought to examine the relationship between self-esteem and mathematics achievement as moderated by mathematics anxiety. The weighted mean for each scale item was computed using the formula Weighted Mean = $(\Sigma fx)/n$, where f represents the frequency of each response, x is the scale value, and n is the total number of responses. This approach provided a more accurate measure of central tendency for Likert-scale data.

The analysis of self-esteem levels among the respondents (Table 2) revealed an overall moderate rating (mean (M) = 3.03, SD = 0.09). Each of the 10 self-esteem indicators also fell within the moderate range, except for one which received a high rating (M = 3.90, SD = 1.22), suggesting a

pronounced desire for greater self-regard. Notably, the item "not feeling good about oneself" also had a relatively elevated mean (M = 3.18, SD = 1.14), highlighting some internal negative self-appraisal.

Table 2. Level of self-esteem of the respondents.

S/N	Indicators	M	SD	Verbal description
1	On the whole, I am satisfied with myself.	2.63	1.14	Moderate
2*	At times, I think I am no good at all.	3.18	1.14	Moderate
3	I feel that I have a number of good qualities.	2.87	1.02	Moderate
4	I am able to do things as well as most other people.	2.90	1.10	Moderate
5*	I do not have much to be proud of.	2.92	1.33	Moderate
6*	I certainly feel useless at times.	3.25	1.25	Moderate
7	I feel that I'm a person of worth.	2.96	1.13	Moderate
8*	I wish I could have more respect for myself	3.90	1.22	High
9*	All in all, I am inclined to think that I am a failure.	3.07	1.22	Moderate
10	I take a positive attitude toward myself.	2.64	1.18	Moderate
	Aggregate mean	3.03		Moderate
	Aggregate standard deviation		0.09	

Legend: 4.21–5.00, very high; 3.41–4.20, high; 2.61–3.40, moderate; 1.81–2.60, low; 1.00–1.80, very low
*Reverse scoring

Table 3. Level of mathematics anxiety of the respondents.

S/N	Indicators	M	SD	Verbal description
	A. Learning mathematics anxiety			
1.	Watching a teacher work an algebraic equation on the blackboard	3.65	1.26	High
2.	Buying a math textbook	2.74	1.34	Moderate
3.	Reading and interpreting graphs or charts	3.06	1.09	Moderate
4.	Signing up for a course in statistics	2.72	1.25	Moderate
5.	Listening to other students explain a math formula	3.35	1.34	Moderate
6.	Walking to school and thinking about a math course	3.02	1.29	Moderate
7.	Looking through the pages on a math text	3.10	1.17	Moderate
8.	Starting a new chapter in a math book	3.02	1.25	Moderate
9.	Walking into a math class	2.83	0.91	Moderate
10.	Picking up a math textbook to begin working on a homework assignment	3.37	1.27	Moderate
11.	Reading the word "statistics"	2.82	0.93	Moderate
12.	Working on an abstract mathematical problem, such as "if x = outstanding bills, and y = total income, calculate how much you have left for recreational activities"	2.74	0.97	Moderate
13.	Reading a formula in chemistry	2.72	1.01	Moderate
14.	Listening to a lecture in a math class	3.57	1.43	High
15.	Having the use of the tables in the back of a math book	2.75	1.02	Moderate
16.	Being told how to interpret probability statements	2.88	0.97	Moderate
	B. Mathematics Evaluation Anxiety			
1.	Being given a homework assignment with many difficult problems which is due the next class meeting	3.31	1.14	Moderate
	Thinking about an upcoming math test one day before	3.46	1.34	High
3.	Solving a square root problem	2.90	1.00	Moderate
4.	Taking an examination (quiz) in a math course	3.19	1.30	Moderate
5.	Getting ready to study for a math test	3.35	1.33	Moderate
6.	Being given a pop quiz in math class	2.90	1.00	Moderate
7.	Waiting to get a math test returned in which you expected to do well	3.19	1.30	Moderate
8.	Taking an examination final in a math course	3.24	0.90	Moderate

Mean	**3.12**	**Moderate**
Standard deviation	**0.01**	

Legend: 4.21–5.00, very high; 3.41–4.20, high; 2.61–3.40, moderate; 1.81–2.60, low; 1.00–1.80, very low.

Table 3 exhibited a moderate level of mathematics anxiety (M = 3.12, SD = 0.01). It shows the respondents' mathematics anxiety, displaying both moderate anxiety for learning mathematics and for mathematics evaluation. In learning mathematics anxiety, students felt most anxious when watching a teacher solve problems on the board (M = 3.65, SD = 1.26) and listening to lectures (M = 3.57, SD = 1.43). In mathematics evaluation anxiety, the highest anxiety was when thinking about a math test the day before (M = 3.46, SD = 1.34). Despite being moderate, these anxiety levels could potentially interfere with students' academic performance, especially during tests and classroom discussions. It shows that some students feel more nervous in certain math situations than others, which may affect their focus, confidence, and participation.

Table 4 shows how mathematics achievement was assessed using the students' final grades in mathematics, obtained from school records. The grading scale ranged from 0 to 100, with higher scores reflecting better academic performance. These scores were treated as continuous variables for the correlation and regression analyses. The average score was 83.11 (SD = 5.52), categorized as satisfactory. A significant proportion of respondents (31.05%) fell within the satisfactory range (80–84), followed closely by those categorized as fair (26.63%) and very satisfactory (25%). Only a small fraction (1.47%) of students scored below expectations. These results suggest that the majority of students are performing at or above expected levels, although there is still a considerable segment in the fair performance range that may benefit from academic support to reach higher levels of achievement.

Table 4. Level of math achievement of the respondents.

Level	Numerical range	f	%
Outstanding	90–100	97	15.85
Very satisfactory	85–89	153	25.00
Satisfactory	80–84	190	31.05
Fair	75–79	163	26.63
Did not meet expectations	Below 75	9	1.47
Total		**612**	**100.00**
Mean		83.11	
SD		5.52	

Table 5 indicates the results of the correlation analysis between the respondents' self-esteem and their mathematics achievement. The Pearson's r coefficient indicates a significant negative relationship between the two variables ($r = -0.288$, $p < 0.001$). Interestingly, mathematics anxiety showed a weak negative correlation with self-esteem ($r = -0.047$, not significant) and a weak but significant positive correlation with mathematics achievement ($r = 0.124$, $p < 0.001$). These findings indicate a complex interplay between affective factors and academic outcomes, wherein self-esteem does not straightforwardly enhance academic performance and may be modulated by other psychological variables such as mathematics anxiety. Internal consistency was assessed using

Cronbach's alpha. The self-esteem scale yielded an alpha of 0.603, and the mathematics anxiety scale had an alpha of 0.777, indicating acceptable reliability [50,51].

Table 5. Correlation analysis.

	Variables	1	2	3	M	SD	Cronbach's alpha
1	Self-esteem	1			3.03	0.09	0.603
2	Mathematics anxiety	-0.047	1		3.12	0.01	0.777
3	Mathematics achievement	-0.288***	0.124***	1	83.11	5.52	

*significant at $p < 0.05$; **significant at $p < 0.01$; ***significant at $p < 0.001$

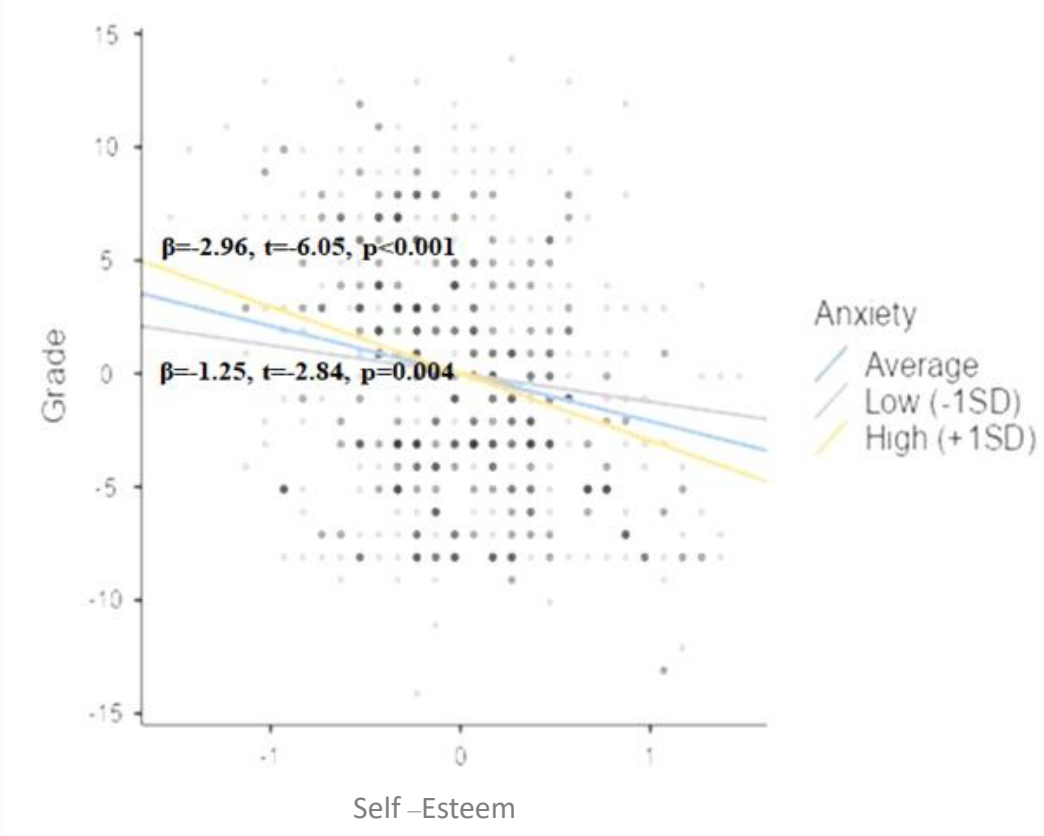

Figure 2. Simple slope analysis.

Figure 2 shows that the data were subjected to moderation analysis using the approach of Hayes and Rockwood [52] to examine whether mathematics anxiety moderates the relationship between self-esteem and mathematics achievement. Additionally, a bootstrapping technique was applied with up to 5000 samples to ensure the validity of the results. The statistical values in the figure indicate that the relationship is significant, with the highest negative effect seen in the high-anxiety group (ß = -2.96, t = -6.05, $p < .001$) and the lowest in the low-anxiety group (ß = -1.25, t = -2.84, p = 0.004). The findings suggest that students with higher levels of mathematics anxiety are most likely to have a stronger association between self-esteem and mathematics achievement, indicating that fluctuations in self-esteem are more closely linked to lower grades in this group. This emphasizes the importance

of concurrently addressing both self-esteem and anxiety, as these emotional factors appear to significantly influence mathematics achievement at a single point in time, particularly among highly anxious students.

5. Discussion

The data gathered explored the moderating role of mathematics anxiety in the relationship between self-esteem and mathematics achievement among Grade 8 students. With the use of statistical analyses, the study indicates that self-esteem has a moderate overall rating, showing that moderate self-esteem is associated with lower mathematics achievement [53]. This suggests that a student with moderate self-esteem can have low mathematics achievement. While this finding appears contrary to the existing literature, which often links higher self-esteem to better academic outcomes [54,55], it may indicate that in this particular sample, elevated self-esteem does not necessarily enhance mathematics achievement. Some studies propose that other factors, such as anxiety levels or external support [56], may play a more significant role in academic performance. Due to the students self-overreliance, they would not exert more effort on academic activity, resulting in poor academic achievement [57]. This explains that it is not just because a student has higher mathematics anxiety that he or she cannot perform well in class as well as those students with high self-esteem, or can do better in class. Students might have an average belief in their ability generally, but specific disinterest in mathematics might lead to low effort [58]. This means students with a low level of interest in mathematics have weaker achievement in the subject because they do not tend to spend effort on it

Conversely, mathematics anxiety has a significant positive effect on mathematics achievement. The findings also reveal that students experience a moderate level of mathematics anxiety in both the learning and evaluation contexts, with slightly higher anxiety in evaluation situations. This finding is unexpected, as mathematics anxiety is typically associated with poorer academic achievement [17]. However, in some cases, a moderate level of anxiety may act as a motivational factor, encouraging students to put in more effort to improve their achievement [59]. These results show how mathematics anxiety, as a moderator, affects the relationship of self-esteem and mathematics achievement in a positive way. It explains how mathematics anxiety can increase the academic achievement of a student by prompting them to apply more effort [60,61].

Furthermore, mathematics achievement reveals that students' achievement falls within the satisfactory range. It indicates that most of the respondents are in the average classification. The distribution of grades shows that while a small percentage of students excel in mathematics with an "Outstanding" rating, a larger portion struggles within the "Fair" range, indicating areas for improvement. The distribution suggests that students may benefit from additional support in mastering mathematical concepts, especially those who fall within the lower performance categories. According to Ba et al. [62], students believe that their abilities can improve with effort and persistence by giving importance to fostering a growth mindset. Through providing targeted interventions such as peer tutoring, problem-solving workshops, and gamified learning experiences, educators can help students enhance their mathematical skills and overall academic achievement [63]. However, the presence of students in the lower-performing range (below 75) suggests that some students may struggle with mathematics, potentially due to self-esteem issues or mathematics anxiety [11]. These challenges can hinder their confidence, engagement, and ability to grasp mathematical concepts, leading to a cycle of poor achievement and increased anxiety. Implementing supportive interventions,

such as confidence-building activities, personalized instruction, and anxiety-reducing strategies, can help these students overcome their struggles and improve their mathematics achievement [64]. These results indicate that while a significant portion of students perform at an average or above-average level, there is still room for improvement.

Additionally, the interaction effect between self-esteem and mathematics anxiety is insignificant. It shows a negligible negative correlation. It indicates that increases in self-esteem are associated with only a very slight decrease in math [65]. However, given the negligible negative correlation of the variables, the relationship is not meaningful, which suggests that self-esteem may not be a major contributing factor in predicting mathematics anxiety among the respondents. One possible explanation is that students with lower self-esteem may exert more effort in mathematics due to self-doubt or external pressure, leading to better achievement. Students with lower self-esteem may compensate for their self-doubt by putting in extra effort in mathematics, possibly due to external pressure from teachers, peers, or family.

Moreover, Dweck's growth mindset theory supports this finding, suggesting that students who focus on persistence and effort rather than confidence alone are more likely to succeed academically [66]. Students who prioritize persistence and effort over confidence alone are more likely to develop resilience and problem-solving skills, which are crucial for academic success. These findings suggest that if students believe that their intelligence is fixed, this makes them avoid challenging tasks or give up easily on mathematics, which leads them to lower effort and achievement regardless of their level of self-esteem. The negligible negative correlation implies that other factors, such as study habits, motivation, and external support systems, may have a stronger influence on achievement.

Consequently, this study examined the relationship between self-esteem and mathematics achievement, moderated by mathematics anxiety. The findings of the study showed that the relationship between self-esteem and mathematics achievement is moderated by mathematics anxiety. Specifically, higher levels of anxiety may weaken the potential benefits of self-esteem on achievement. This aligns with research indicating that excessive anxiety can interfere with cognitive processes and problem-solving abilities, particularly in high-stakes academic settings [40]. These findings contribute to understanding the complex interplay between emotional and cognitive factors in academic achievement. The results support theories emphasizing the dual impact of self-perception and anxiety on performance outcomes, such as Pekrun's [67] control-value theory of achievement emotions. This study reinforces the idea that academic self-concept alone is insufficient to predict achievement unless psychological moderators, like anxiety, are accounted for.

6. Conclusions

The study found that mathematics anxiety plays a significant role in influencing the connection between self-esteem and mathematics achievement among Grade 8 students. Although self-esteem had a slight negative correlation with mathematics achievement, mathematics anxiety showed a moderate positive link, indicating that a certain amount of anxiety might boost performance. Still, high levels of anxiety remain a hindrance to success. These results highlight the complex relationship among confidence, anxiety regulation, and academic outcomes. Although our findings differ from much of the existing literature, which often reports positive links between self-esteem and academic performance, the study recommends interventions supporting students' emotional well-being, resilience, and coping skills, on the basis of broader evidence. Further research is needed to explore the contextual factors behind these findings, particularly during early adolescence, and to consider

additional influences such as teacher support, parental involvement, and the classroom environment.

7. Limitations

Although the present study offers important evidence that mathematics anxiety moderates the link between self-esteem and mathematics achievement, several restrictions temper the conclusions that can be drawn. First, the descriptive–correlational design captures only a single time-point; consequently, it cannot establish chronological sequence or causality, and bidirectional influences, such as low achievement increasing anxiety, remain plausible. Second, all three focal constructs were measured exclusively with self-report instruments. Well-validated as these scales are, they remain open to social desirability effects and inaccuracies in self-analysis that may inflate or suppress actual levels of self-esteem or mathematics anxiety. Third, the sample was drawn from one educational jurisdiction within a specific cultural environment. Sociocultural norms surrounding mathematics, competition, and help-seeking differ markedly across regions. They may condition the anxiety–achievement relationship, so the findings should be generalized only to populations with similar characteristics. Fourth, the model omitted other variables that prior work has shown to shape mathematics achievement, such as prior achievement, intrinsic motivation, stereotype threat, parental involvement, and emotional support by the teacher, raising the possibility of omitted variable bias and more complex moderated mediation pathways. Fifth, we did not include the growth mindset theory proposed by Carol Dweck. The theory may be significant in the study, as it emphasizes the role of mindset, specifically, the belief that anything can be learned or improved with sufficient perseverance. Finally, a single standardized examination served as the sole index of achievement; alternative facets of mathematical competence (e.g., problem-solving, mathematical reasoning) or other academic domains might exhibit different patterns. Together, these limitations highlight the need for multi-method, multi-informant, and longitudinal research to clarify the causal mechanisms and boundary conditions of the observed effects.

8. Implications

Despite these limitations, the findings have clear implications for scholarship and educational practice. For researchers, future work should adopt longitudinal or experience-based sampling designs to trace dynamic shifts in mathematics anxiety and self-esteem across the school year, incorporate additional psychosocial and contextual moderators (e.g., classroom climate, teachers' warmth, parental mathematics attitudes), and combine quantitative modeling with qualitative interviews to capture the students' lived experiences. Randomized controlled trials that test the efficacy and cost-effectiveness of specific interventions, such as expressive writing, cognitive reappraisal, and mindfulness exercises, would be particularly valuable for isolating causal pathways.

For practitioners, early screening that embeds brief mathematics anxiety and self-esteem inventories into routine assessments could identify at-risk learners before achievement gaps widen. In recent meta-analyses, classroom-based anxiety management techniques like mindfulness breaks, coping self-talk, and incremental performance goals have been shown to attenuate the anxiety–achievement correlation substantially. At the same time, mastery-oriented feedback and peer mentoring can bolster academic self-esteem. Engaging families through workshops that demystify mathematics and model supportive practices may further reduce home-originating anxiety cues. At

the policy level, curricula that balance procedural fluency with conceptual understanding and limit excessive time pressure in high-stakes testing could help prevent the cultivation of debilitating mathematics anxiety across the student population.

By addressing both the affective (anxiety) and self-perceptual (self-esteem) dimensions of learning, educators and researchers can create environments in which students' mathematical potential is realized rather than constrained by fear, thereby improving achievement not only in mathematics but across the broader academic spectrum.

Beyond the aforementioned implications, it is essential to develop more nuanced variables from this research. Identifying additional variables and factors that influence learners' mathematics achievement is crucial to shedding light on the inconsistencies in their performance. Once these factors are known, experts in the field can incorporate them into educational practice.

Author contributions

Emerson D. Peteros: Supervision; Lorraine B. Tandoc: Data curation, project administration, writing – original draft; Mezhraem H. Palapar: Formal analysis, resources, software, writing – review and editing; Rotchel C. Adlaw: Investigation, validation; Cristine M. Fuentes: Conceptualization, methodology, visualization.

Use of Generative AI tools declaration

The authors would like to disclose that an AI tool was utilized in the development of this paper. The primary AI tool used was Grammarly, which was used to assist in improving writing, providing suggestions, and enhancing the overall quality of the written paper.

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Conflict of interest

The authors declare that there is no potential conflict of interest in the manuscript.

Ethics declaration

In order to ensure that the respondent's well-being was meticulously safeguarded, ethical considerations were regarded. The respondents were informed about the purpose of the research study, their roles in making the study achievable, and the confidentiality of their personal information, assuring them that it was voluntary.

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