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Exploring Filipino STEM Students' Struggles in Mathematics: Contributing Factors and Implications for Teaching

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Abstract

Despite its crucial role in shaping critical thinking and problem-solving skills, mathematics remains one of the most challenging subjects for students, particularly in the Science, Technology, Engineering, and Mathematics (STEM) strand. Various factors, including self-esteem, instructional delivery, learning environment, and time management, can influence the success of Filipino STEM students in mathematics. However, the specific impacts of these factors remain underexplored, particularly in the Philippine context. Given the increasing emphasis on STEM education, understanding STEM students' struggles in mathematics is essential for improving instructional strategies and student support programs. Thus, this study examines these struggles and their implications for teaching, providing insights specific to the Filipino STEM education context. Using an embedded mixed-methods design, data were collected from 82 Filipino STEM students in a public secondary school in Eastern Visayas through surveys and semi-structured interviews. This study found a statistically significant but weak positive correlation between self-esteem and mathematics performance, suggesting that students with higher self-esteem tend to perform slightly better. Nonetheless, no significant correlations were observed between students' mathematics performance and the other factors examined. Further, STEM students identified several reasons for their struggles in mathematics, including the subject matter complexity and learning pace in mathematics, apathy due to inadequate teaching and classroom management, lack of mastery of basic concepts and procedures, time constraints due to STEM subject overload, and difficulties in comprehension due to tardiness. This study provides insights that can enhance teaching methodologies and student support programs for future STEM professionals in the Philippines.

Keywords: Instructional Delivery, Learning Environment, Mathematics Performance, Self-esteem, STEM Students, Time Management.

Introduction

The quality of mathematics education has emerged as a significant concern worldwide, with many students needing help to engage with the subject due to its perceived difficulty and the wide range of concepts necessary to solve complex problems. This challenge is particularly critical given the global emphasis on scientific and technological innovation, where mathematics is a foundational pillar. In response, educational systems increasingly prioritize the Science, Technology, Engineering, and Mathematics (STEM) strand to promote national development and competitiveness.

In the Philippines, the STEM strand under the Senior High School (SHS) Academic Track is designed to equip students with the mathematical and scientific literacy required for higher education and future careers in STEM-related fields. However, concerns are rising over declining mathematics proficiency among Filipino students, which risks dampening their engagement and willingness to pursue further studies in the field despite the structural emphasis placed on the subject within the STEM curriculum (1-3). These concerns are amplified by the fact that, even within STEM disciplines, where students are presumed to exhibit higher aptitude, struggles in mathematics continue to endure. Previous studies suggest that multiple interrelated factors influence students' performance in mathematics, including psychological, pedagogical, environmental, and behavioral domains (4-7). Among these, self-esteem, instruc-

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tional delivery, learning environment, and time management are critical factors shaping a student's ability to engage with and succeed in mathematics. Interestingly, these factors have also been observed among Filipino STEM students, highlighting struggles that affect their ability to learn mathematics, a discipline essential for success in STEM.

Self-esteem, defined as an individual's assessment of their self-worth, significantly influences motivation, academic engagement, and persistence in challenging subjects like mathematics (8). It constitutes a comprehensive emotional evaluation of the self and can affect student performance, particularly in achievement-related contexts. Studies have shown that students with higher self-esteem are more confident in problem-solving and more resilient in facing academic challenges (9, 10). How instruction is delivered, particularly how teachers communicate concepts and engage with students, can affect educational outcomes. One study asserted that aligning teaching methods with students' learning preferences correlates with improved academic performance (11). Teachers prepared with effective curriculum planning, extensive knowledge, and strong student interaction encourage a more proactive classroom learning environment, enhancing students' motivation to learn and participate.

Furthermore, a supportive and stimulating learning environment is essential for promoting better academic achievement. Other studies have reported that when students view their environment as psychologically safe and intellectually engaging, they are more likely to engage with complex content and collaborate effectively with peers (12, 13). Factors such as classroom climate, teacher-student relationships, and access to academic resources significantly enhance the educational experience (14). Additionally, previous studies indicated that time management, a crucial self-regulatory skill, strongly predicts academic performance (15, 16). Students who allocate adequate time for studying, reviewing, and problem-solving are better able to master mathematical concepts, manage academic stress, and reduce procrastination. A serious commitment to time management can reduce the stress of last-minute studying and enable students to engage in additional constructive activities during their free time.

Despite growing global and local interest in understanding the contributing factors influencing student learning outcomes, particularly in mathematics, comprehensive studies that integrate psychosocial and instructional elements are still scarce within the unique context of STEM education among Filipino students. Previous studies have explored individual factors, such as the role of self-esteem in student motivation and academic performance, the influence of instructional delivery on learning outcomes, and the impact of time management on academic achievement (17-21). However, most of these studies have examined these factors in isolation and have primarily used quantitative methodologies, providing limited insights into how students experience and navigate their struggles in learning higher mathematics. Furthermore, previous studies have often overlooked the paradox where students perform well academically while also facing significant struggles related to learning mathematics.

In addition, what distinguishes this present study is its use of an embedded mixed methods design to examine the statistical correlations between these contributing factors and mathematics performance and the unique experiences of Filipino STEM students grappling with the subject. This study integrates quantitative and qualitative insights to investigate how self-esteem, instructional delivery, learning environment, and time management influence STEM students' performance and struggles in mathematics. This study addresses an insufficiency in methodological rigor in existing Philippine-based research and responds to the urgent need for context-specific insights that can inform policy decisions and instructional practices in STEM education. Additionally, it seeks to address the discrepancy between the perceived quality of mathematics instruction and the actual outcomes, highlighting the need to explore further the factors that influence performance among Filipino STEM students.

Considering the rationale presented, this study could assist SHS mathematics teachers and curriculum designers by providing actionable insights to guide curriculum design, instructional strategies, and student support programs in mathematics. It also intends to offer evidence-based recommendations to improve teaching strategies and encourage a more profound interest in mathematics among Filipino STEM students. Educational institutions, particularly those focused on the STEM strand, are expected to benefit from this study by better understanding how to optimize mathematics education for future Filipino STEM professionals. Generally, this study investigated the mathematics performance of Filipino STEM students at a public secondary school in the Eastern Visayas region of the Philippines and explored how self-esteem, instructional delivery, learning environment, and time management influenced their performance. In line with this, the study sought to address the following research objectives: (a) determine the levels of mathematics performance, self-esteem, instructional delivery, learning environment, and time management among Filipino STEM students; (b) examine the correlation between each of these contributing factors and students' mathematics performance; and (c) explore the underlying reasons for STEM students' struggles in learning mathematics.

Theoretical Grounding

This study is grounded in Albert Bandura's Social Cognitive Theory (SCT), highlighting the dynamic interaction between personal, behavioral, and environmental influences on human learning and behavior. SCT provides a framework for understanding how students' beliefs, actions, and contextual factors collectively shape their academic development (22).

Furthermore, SCT posits that learning occurs within a social context and is influenced by three interrelated factors: personal factors, behavioral patterns, and environmental influences. A key concept of the theory is self-efficacy, an individual's belief in their ability to perform a specific task or achieve a goal. Other studies emphasized that individuals with high self-efficacy are more likely to set challenging goals, persist through adversity, and recover from setbacks, traits closely linked to academic success (23, 24). Furthermore, SCT emphasizes the importance of observational learning, reinforcement, and outcome expectations in shaping behavior. The theory integrates personal and social influences to provide a clear and comprehensive lens for understanding student performance and motivation. Equally crucial in SCT is the principle of reciprocal determinism, which asserts that human behavior arises from the interaction of the three interrelated factors. These factors continuously interact and influence one another, creating a dynamic framework for learning and adaptation.

In this study, SCT serves as a guiding framework for examining how factors such as self-esteem, instructional delivery, learning environment, and time management shape the mathematics performance of Filipino STEM students. These factors were selected based on SCT's emphasis on reciprocal determinism, highlighting the continuous interaction among individuals' beliefs, behaviors, and learning environments. This study examines the interplay among these factors that may influence or hinder performance in mathematics among Filipino STEM students. This study hypothesized significant correlations between mathematics performance and the identified factors observed among Filipino STEM students. In the Philippine educational context, where students often face heavy academic demands and varied instructional conditions, SCT provides a relevant lens for examining the factors that contribute to or hinder student success in mathematics.

Guided by SCT, this study conceptualizes STEM students' mathematics performance as an outcome shaped by the interaction of personal, behavioral, and environmental factors. As presented in Figure 1, self-esteem reflects the personal dimension, time management represents behavioral patterns, and instructional delivery together with the learning environment constitute key environmental influences. Consistent with the theory's principle of reciprocal determinism, these factors are viewed as interacting with one another and collectively associated with students' mathematics performance.

The quantitative strand of the study examines the relationships among these variables through correlation analysis. Complementing this, the qualitative embedded component seeks to explore students' reasons for struggling in mathematics, offering contextual insights that help explain patterns observed in the quantitative results. This framework guided the selection of variables, the organization of the mixed-method design, and the overall analytic approach of the study.

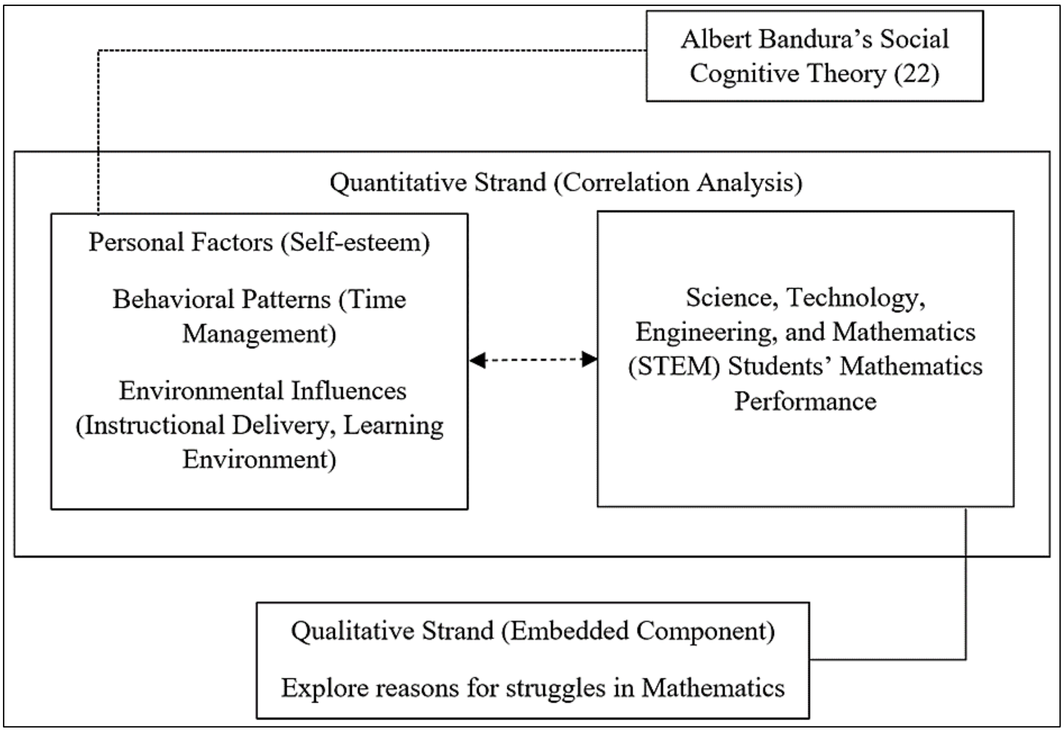

Figure 1: Conceptual Paradigm of the Study

Methodology

Research Design

This study utilized an embedded mixed methods design to examine the mathematics performance of STEM students and the influence of self-esteem, instructional delivery, learning environment, and time management on this performance. The embedded design prioritizes one approach while incorporating another into the study (25, 26). This study's qualitative aspect is embedded within the quantitative aspect to explore potential reasons for struggles in mathematics learning. Furthermore, this study's embedded design is suitable as it focuses on determining the extent to which the identified factors influence STEM students' mathematics performance and the underlying reasons for their struggles, which may affect their interest in the subject.

Further, this study employed surveys and correlational designs to analyze the data quantitatively. The survey assessed the mathematics performance of STEM learners and measured the extent of the identified factors. The correlational design was then used to investigate the link between mathematics performance and these factors. For the qualitative aspect, a single case study design was adopted to explore the underlying reasons for struggles in learning mathematics within the specific context of STEM students (27). The qualitative data were used to support the quantitative results, validating the hypothesis of this study.

Study Setting and Participants

The study was conducted at a public secondary school in the Eastern Visayas region of the Philippines, offering a specialized STEM strand for SHS students. This school was purposefully selected due to its strong emphasis on STEM education, making it an ideal context for examining mathematics performance among students pursuing math-related academic tracks. Additionally, the school provides a unique environment where STEM students face various challenges, particularly in higher mathematics. Likewise, the locale was chosen because it reflects typical educational conditions in urban secondary schools across the Philippines, making the results more relevant for similar institutions nationwide.

The study participants included 82 Filipino STEM students, 40 males and 42 females. As shown in Table 1, the sample comprised 59 grade 11 students and 23 grade 12 students aged 15 to 19 years. Participants were selected using a combination of purposive and convenience sampling. Purposive sampling ensured participants were drawn from the STEM strand, providing relevant insights into their mathematical performance. Additionally, convenience sampling was employed due to students' accessibility at the selected school, facilitating efficient data collection within the research timeline. While this sampling strategy enabled practical data collection, it presents a limitation in terms of generalizability. The findings may not fully represent all STEM students in the Philippines, as the sample came from a single institution and was not randomly selected. Therefore, caution is needed when extrapolating the results to larger populations. To improve representativeness in future studies, researchers should use probability-based sampling techniques, such as stratified or simple random sampling, across multiple schools or regions.

Table 1. Distribution of STEM Students According to Profile Variables

Profile	Category	f (n=82)	Percentage
Age	15 years old	1	1.22
	16 years old	26	31.71
	17 years old	42	51.22
	18 years old	12	14.63
	19 years old	1	1.22
Sex	Male	40	48.78
	Female	42	51.22
Grade Level	Grade 11	59	71.95
	Grade 12	23	28.05

For the qualitative component of the study, ten STEM students were interviewed individually using semi-structured interviews. The number of interviews was determined based on the point of data saturation, where no new themes or insights emerged. Participants were purposefully selected based on their perceived difficulty level in mathematics, identified from their responses in the quantitative phase. The selection also pointed to STEM students demonstrating struggles in mathematics, allowing the study to capture the underlying reasons influencing performance.

Instrumentations

This study included both quantitative and qualitative components. The quantitative survey was divided into two parts. The first part collected demographic profiles of the STEM students, including age, sex, and grade level. The second part assessed the students' mathematics performance, measured by their average grades in pre-calculus, statistics, probability, and general mathematics. These grades were obtained from the school registrar's office and evaluated using the Department of Education's (DepEd) grading system: 90-100 = Outstanding (O), 85-89 = Very Satisfactory (VS), 80-84 = Satisfactory (S), 75-79 = Fairly Satisfactory (FS), and below 75 = Did Not Meet Expectations (DNME).

In addition, the second part of the survey assessed how self-esteem, instructional delivery, learning environment, and time management influenced students' mathematics performance. Instruments for these variables were adapted from previously developed scales, with minor modifications to suit the context of mathematics learning (28-31). For instance, the items were rephrased to specifically target self-esteem, instructional delivery, learning environment, and time management, each in the context of mathematics. Self-esteem was measured with ten items, including statements such as "I feel that I have several good qualities that enable me to learn and understand mathematics." Instructional delivery was assessed with 16 items, featuring statements like "The content covered in the mathematics course materials is adequate for the time required to complete the coursework." The learning environment was evaluated using 19 items, including "During mathematics classes, I am always able to find a desirable seat in this classroom." Time management included 53 items, with statements such as "I use a formal system for organizing a weekly work plan to study mathematics." Responses for these items were measured using a five-point Likert-type scale: 1 = Never (N), 2 = Rarely (R), 3 = Sometimes (S), 4 = Often (O), and 5 = Always (A).

Table 2. Calculation of Cronbach's Alpha for Each Factor

Construct	Number of Items	Cronbach's Alpha [α]
Self-esteem	10	0.80
Instructional Delivery	16	0.77
Learning Environment	19	0.79
Time Management	53	0.82

To ensure the validity of the survey instrument, three experts in mathematics education reviewed the items for relevance and clarity. Their comments and suggestions regarding specific wording were incorporated to enhance the survey's contextualization. The instrument was then pilot-tested with a STEM class of 40 students from a secondary school outside the research setting. The reliability of the instrument was confirmed through the calculation of Cronbach's alpha for each factor, as presented in Table 2: self-esteem [α = 0.80], instructional delivery [α = 0.77], learning environment [α = 0.79], and time management [α = 0.82], all indicating good or acceptable internal consistency. This reliability confirmed that the instrument was suitable for data collection in the study.

For the qualitative aspect, interview guide questions were designed to align with the study's objectives, focusing on students' experiences and struggles in learning mathematics. Sample questions included, "What are the main struggles you face when studying mathematics?" and "How do these struggles impact your ability to understand and engage with the subject?" These questions aimed to elicit in-depth and reflective responses, providing insights into the reasons behind their struggles in learning mathematics.

Data Collection Procedures

Data collection began with securing approval from the agency head and sending communication letters outlining the study's objectives. After obtaining approval, the researchers contacted the school principal and three STEM teacher-advisers to explain the study's objectives. With the teacher-advisers' assistance, we administered the survey to the STEM students using Google Forms. The forms included detailed instructions and explanations about the survey's objectives and items to measure variables such as self-esteem, instructional delivery, learning environment, and time management. In addition, the researchers obtained the STEM students' performance records in pre-calculus, statistics, probability, and general mathematics from the school's registrar after securing the necessary approvals.

Individual semi-structured interviews were conducted with ten STEM students to gather deeper insights. These interviews permitted this study to explore further the issues STEM students faced while learning mathematics, providing rich narratives on the reasons for their struggles and the factors that may influence their interest in the subject. The interviews were conducted virtually via Google Meet, with each lasting no more than 25 minutes. After each interview, the recordings were transcribed, coded, and analyzed using thematic analysis to identify patterns and key themes related to the study's objectives. Data collection for the study occurred during the second semester of the 2023-2024 academic year, capturing the reasons for STEM students' struggles in learning mathematics.

Analytic Strategy

Table 3 presents an overview of the analytical procedures aligned with each research question. Quantitative data on mathematics performance and how self-esteem, instructional delivery, learning environment, and time management influenced performance were analyzed using frequency counts, percentages, medians, means, and standard deviations. Kendall's tau-b correlation coefficient was employed to examine the correlation between mathematics performance and the identified factors. This non-parametric test was chosen due to its appropriateness for ordinal data and its robustness in accommodating tied ranks within the dataset. Furthermore, Kendall's tau-b is particularly suitable for smaller sample sizes, such as in this study [n=82], as it imposes fewer assumptions regarding the distribution of variables. This test yields a more precise estimation of the strength and direction of relationships within a dataset that may not fully satisfy the assumptions of normality or linearity. All quantitative data processing and statistical analyses were performed using JAMOVI statistical software.

Table 3. Research Objectives and Corresponding Analyses

Research Objective	Type	Analysis Used
RO1: Determine the levels of mathematics performance, self-esteem, instructional delivery, learning environment, and time management among Filipino STEM students.	Quantitative	Descriptive statistics (frequency counts, percentages, means, medians, standard deviations)
RO2: Examine the correlation between each contributing factor (self-esteem, instructional delivery, learning environment, time management) and students' mathematics performance.	Quantitative	Kendall's tau-b correlation
RO3: Explore the underlying reasons for STEM students' struggles in learning mathematics.	Qualitative	Braun & Clarke's six-phase thematic analysis

For the qualitative component, this study employed Braun and Clarke's six-phase thematic analysis approach to identify patterns and themes within the interview transcripts (32). The process began with thorough familiarization, during which the researchers read and re-read the transcribed narratives of STEM students to gain an in-depth understanding of their experiences and struggles in learning mathematics. Following this, systematic open coding was used to identify recurring phrases, expressions, and concepts relevant to the research questions. The primary researcher started the coding process, which was then collaboratively reviewed with two co-researchers to ensure consistency in interpreting data segments. This review enhanced the reliability of the coding framework and reduced potential bias. After generating initial codes, the research team organized them into broader categories to identify preliminary themes. These themes were reviewed, refined, and cross-verified against the coded data and dataset to ensure coherence and alignment with the study objectives. Descriptions and nomenclature for each theme were carefully crafted to capture their essence and accurately reflect the participants' narratives on the reasons behind their struggles in learning mathematics, including factors that may influence their interest in the subject.

To establish the credibility and trustworthiness of the qualitative findings, several validation strategies were implemented to ensure consistency in theme identification and interpretation. Peer debriefing among researchers during the analysis and member checking, where selected STEM student-participants verified the accuracy and relevance of the identified themes related to their shared experiences, ensuring that the final thematic structure authentically represented the participants' voices.

Ethical Considerations

This study adhered to strict ethical guidelines to protect participants' rights and ensure data confidentiality. Before data collection, the researchers obtained informed consent and assent from participants and parental consent. Participation was entirely voluntary, with no pressure to join the study, and participants could withdraw at any time without consequences. Anonymity and confidentiality were rigorously maintained; participant identities were protected by assigning unique identifiers (e.g., P1, P2) instead of names, and all identifiable information was removed during data processing. Survey responses and interview transcripts were securely stored, with audio recordings saved on an external hard drive and permanently deleted after transcription to protect participants' privacy. Furthermore, researchers ensured that all data obtained from school records, including students' mathematics performance, were accessible only to the researchers and used solely for the study's purposes.

Results

STEM Students' Performance in Mathematics

Table 4 presents the frequency distribution of STEM students' mathematics performance. As illustrated in the table, most students [86.59%] achieved an "Outstanding" rating, with a mean grade of 92.17 [SD = 3.12], reflecting a strong performance in mathematics. Nine students [10.98%] received a "Very Satisfactory" rating, while only two students [2.44%] earned a "Satisfactory" rating. Notably, no students were classified under the 'Fairly Satisfactory' or 'Did Not Meet Expectations' categories.

Table 4. Distribution of STEM Students' Mathematics Performance

Score Range	Frequency	Percentage	Level
90-100	71	86.59	Outstanding
85-89	9	10.98	Very Satisfactory
80-84	2	2.44	Satisfactory
75-79	—	—	Fairly Satisfactory
< 75	—	—	Did Not Meet Expectations

Note: No. of cases = 82; Mean Score = 92.17 (O); Std. Dev.=3.12

Distribution of the factors influencing STEM students' mathematics performance

The results in Table 5 highlight the frequency distribution of factors influencing STEM students' mathematics performance across four key areas: self-esteem, instruction delivery, learning environment, and time management. Specifically, the learning environment [54.88%] and instructional delivery [47.56%] were the factors most often experienced, followed by self-esteem, with 30.49% of STEM students indicating it often affects their performance. Only 3.66% reported that self-esteem always influences them. The "Never" category was notably low across all factors, particularly in the learning environment, where no students indicated it as irrelevant. Time management showed more variation, with 40.24% of students reporting that it sometimes influences their performance and 13.41% stating it rarely does. Essentially, all these factors were reported to occur often, corresponding to 41.77% of the total responses across all categories.

Table 5. Distribution of the Factors Influencing STEM Students' Mathematics Performance

Frequency	Self-esteem f (%)	Instructional Delivery f (%)	Learning Environment f (%)	Time Management f (%)	Total f (%)
Always	3 (3.66)	14 (17.07)	14 (17.07)	4 (4.88)	35 (10.67)
Often	25 (30.49)	39 (47.56)	45 (54.88)	28 (34.15)	137 (41.77)
Sometimes	42 (51.22)	21 (25.61)	21 (25.61)	33 (40.24)	117 (35.67)
Rarely	8 (9.76)	6 (7.32)	2 (2.44)	11 (13.41)	27 (8.23)
Never	4 (4.88)	2 (2.44)	0 (0.00)	6 (7.32)	12 (3.66)

Note: No. of cases = 82; Mdn (Self-esteem) = 3 (S); Mdn (Instructional Delivery) = 4 (O); Mdn (Learning Environment) = 4 (O); Mdn (Time Management) = 3 (S)

Correlations between Mathematics Performance, Self-esteem, Instructional Delivery, Learning Environment, and Time Management Factors

As presented in Table 6, Kendall's Tau-b test revealed a statistically significant but weak positive correlation between self-esteem and students' mathematics performance [τ_b=0.185, p=0.039]. In contrast, no significant correlations were found between mathematics performance and the other variables examined, including instructional delivery [τ_b=0.012, p=0.893], learning environment [τ_b=0.152, p=0.093], and time management [τ_b=0.027, p=0.761], rejecting the hypothesis of significant correlations for these factors.

Table 6. Correlations between Mathematics Performance and Self-esteem, Instructional Delivery, Learning Environment, and Time Management Factors among STEM Students

		Mathematics Performance	Self-esteem	Instructional Delivery	Learning Environment	Time Management
Mathematics Performance	Kendall's Tau B	—				
	p-value	—				
Self-esteem	Kendall's Tau B	0.185*	—			
	p-value	0.039	—			
Instructional Delivery	Kendall's Tau B	0.012	0.255**	—		
	p-value	0.893	0.009	—		
Learning Environment	Kendall's Tau B	0.152	0.195*	0.277**	—	
	p-value	0.093	0.049	0.005	—	
Time Management	Kendall's Tau B	0.027	0.233*	0.288**	0.296**	—
	p-value	0.761	0.016	0.003	0.002	—

Note. *$p < 0.05$, **$p < 0.01$

Notably, significant intercorrelations emerged among the study variables. Self-esteem correlated positively with instructional delivery [τ_b=0.255, p=0.009], learning environment [τ_b=0.195, p=0.049], and time management [τ_b=0.233, p=0.016], suggesting that students who feel more confident also tend to appraise their classroom experiences more positively. Instructional delivery, learning environment, and time management were likewise significantly interrelated, indicating that these elements function as a cohesive set of contextual and behavioral factors.

Reasons for STEM Students' Struggles in Learning Mathematics

To gain deeper insights into the challenges associated with mathematics, STEM students were asked to explain their reasons, including how and why these struggles occurred. From the semi-structured interviews conducted and as presented in Table 7, five themes emerged such as (a) subject matter complexity and learning pace in mathematics; (b) apathy towards mathematics due to inadequate teaching and classroom management; (c) lack of mastery of the basic mathematical concepts and procedures; (d) time constraints in learning mathematics due to STEM subject overload; and (e) struggling to understand mathematics due to tardiness.

Subject Matter Complexity and Learning Pace in Mathematics

STEM students reported varying rates of assimilating mathematical concepts. While some grasped ideas quickly, others required more time to understand the material thoroughly. One STEM student explained, “Mathematics is very difficult for me because I am not a fast learner, and I struggle to keep up with subjects that involve numerical concepts” (P7). Another student emphasized that the difficulty of the subject is influenced by the instructional pace, stating, “What makes it difficult for me right now is the overall complexity and how fast the teachers teach it. We move from one lesson to another without fully understanding it” (P4). This sentiment underscores that teaching mathematics rapidly, without accounting for students’ individual learning needs, can hinder effective learning. Students also expressed concern that classroom instruction often focused on fundamental questions, whereas assessments demanded the application of more complex problem-solving skills, highlighting a disconnect between instruction and assessment.

Table 7. STEM Students' Struggles in Learning Mathematics

Themes	Codes	Descriptions
Subject matter complexity and learning pace in Mathematics	Subject Matter Complexity	The perceived difficulty of mathematics is due to its complexity and demand for critical thinking, problem-solving, and reflection.
	Learning Pace	The speed at which mathematics is taught affects student comprehension and mastery.
Apathy towards Mathematics due to inadequate teaching and classroom management	Lack of Interest	Students show reluctance toward mathematics due to poor instructional methods and engagement.
	Teaching Methods	Ineffective teaching styles and a lack of classroom management affect student learning.
Lack of mastery of basic mathematical concepts and procedures	Conceptual Gaps	Students struggle due to an inadequate understanding of fundamental concepts and procedures.
	Impact of Modular Learning	Students who underwent modular learning due to the COVID-19 pandemic lack foundational knowledge in math.
Time constraints in learning Mathematics due to STEM subject overload	Academic Overload	STEM students experience difficulty in mathematics due to the demanding nature of their subjects.
	Balancing Subjects	Difficulty in allocating time between mathematics and other STEM subjects.
Struggling to understand Mathematics due to tardiness	Missed Lessons	Tardiness results in students missing critical lessons, leading to gaps in understanding.
	Self-Study Challenges	Students struggle with independently catching up on missed lessons.

Apathy towards Mathematics Due to Inadequate Teaching and Classroom Management

Apathy and lack of engagement towards Mathematics were attributed to poor instructional methods and ineffective classroom management. Students expressed diminished interest when lessons were perceived as unengaging or monotonous. One STEM student admitted, "It stems from a lack of interest. I never wanted to be fascinated by theoretical mathematical problems or solving equations" (P1). Another added, "When teachers speak in a low, dull voice, my performance suffers as I lose interest and focus. Ineffective teaching methods also make it difficult for me to stay engaged" (P2). Similarly, a mathematics teacher's ability to explain concepts is crucial for students' understanding. A STEM student echoed this: "It often becomes harder for me to catch up when teachers do not explain mathematical concepts clearly, elaborate effectively, and provide sufficient examples" (P9). Many students lose interest in mathematics due to its inherent complexity and the numerous processes it demands. However, strengthened cooperation between students and teachers can help simplify the learning experience and make it more accessible. A conducive learning environment, free from distractions caused by peers, is also essential. As one STEM student shared, “At times, my seatmate talks to me and disrupts my ability to focus on mathematics class” (P8).

Lack of Mastery of Basic Mathematical Concepts and Procedures

Struggles were also linked to conceptual gaps in foundational mathematics knowledge, which hindered STEM students’ development and ability to excel in higher-level mathematics. This developmental setback reduces students' confidence, making it more challenging to grasp various topics in the subject. As one STEM student explained, "I need to understand the basic concepts and how they are applied and solved. In STEM mathematics, lessons can become confusing as you mix different topics, leading to complications and mistakes" (P3). Furthermore, the impact of modular learning during the COVID-19 pandemic was evident, with students describing how it left gaps in their foundational skills. One STEM student reflected, "Learning the concepts and procedures in basic calculus has been challenging due to my lack of foundational math knowledge, as my 7th to 9th grades were completed through modular learning. I did not learn much during those years" (P4).

Time Constraints in Learning Mathematics Due to STEM Subject Overload

The heavy academic demands of the STEM strand worsened students' struggles in Mathematics. STEM students described feeling overwhelmed by the breadth and intensity of their coursework, leaving limited time for focused study in Mathematics. One STEM student shared, "I often feel overwhelmed due to the many subjects I need to study. I need more time to focus because of this. A major requirement must be passed to progress to the next level, as failing Math can have serious consequences" (P10). Interviews with STEM students likewise revealed that they struggle to focus on learning mathematics while studying other subjects. Learning mathematics also puts pressure on them due to the potential consequences of failing the subject. Another student highlighted the challenge of balancing multiple subjects, stating, "Knowing that Mathematics is not the only subject in the STEM strand, you need to balance those subjects" (P5).

Struggling to Understand Mathematics Due to Tardiness

Timely attendance in mathematics classes is crucial for student success, as each lesson builds upon previously learned concepts. Regular tardiness disrupts the continuity of learning, leading to knowledge gaps that are difficult to bridge independently. Students who frequently arrive late miss key explanations, teacher-led problem-solving demonstrations, and peer discussions, which are essential for mastering complex mathematical ideas. Consequently, they often resort to self-study, which can be isolating and less effective without proper guidance. One STEM student reflected, "When I missed a class, the lesson was never taught again, leaving me in a cycle of confusion" (P6). Another student recounted, "I had to learn the content independently at home, leading to difficulties" (P7). A student echoed similar sentiments and emphasized the compounding effect of repeated tardiness: "Even if I try to catch up, I feel like I am always one step behind because I miss the start of important lessons where everything is first explained" (P2).

Discussion

Mathematics is vital in developing critical thinking and problem-solving skills, particularly among STEM students, for whom mathematical competence is foundational. The results of this study demonstrate that the overall mathematics performance among STEM students is remarkably high, with a substantial proportion attaining ratings in the outstanding category. However, it is essential to recognize that high assessment performance does not necessarily reflect a smooth learning experience. Despite achieving high scores, many STEM students in this study reported significant challenges in learning mathematics. This contradiction highlights a key insight: academic achievement and struggle are not mutually exclusive. Students may attain high grades through perseverance, strategic effort, or external support such as peer tutoring, supplemental instruction, or parental assistance. Additionally, some may employ coping strategies, such as prioritizing tasks, engaging in focused study sessions, or collaborating with classmates to overcome obstacles and meet assessment demands.

Similarly, it is essential to determine whether grade inflation or using assessment formats that emphasize procedural fluency over conceptual understanding may contribute to inflated scores, masking more profound learning difficulties among STEM students. High grades may not accurately represent students' conceptual challenges, anxiety, or lack of confidence in applying mathematical knowledge in real-world contexts. As a result, strong performance on assessments may coexist with ongoing internal struggles related to comprehension, pace, or engagement with mathematics. It further highlights the complexities of measuring authentic learning and stresses the need for a more comprehensive approach to evaluating academic outcomes. Acknowledging that high achievement may arise from external support or short-term coping strategies requires a deeper examination of students' daily experiences and the sustainability of their academic success.

Furthermore, the study's results stress that the learning environment is another factor affecting students' mathematics performance, with many students reporting that it often plays a crucial role. A supportive and engaging learning environment allows STEM students to focus more effectively on their mathematics studies, reinforcing the importance of creating spaces that promote positive engagement. This result aligns with previous studies emphasizing that students perform better when they enjoy their learning experiences (33-35). Students excel academically in a supportive learning environment, unlike less accommodating settings. Teachers must create a learning environment that keeps students focused, promotes goal-driven motivation, and minimizes distractions. However, one study specified that certain conditions, including distance learning and negative social factors, could decrease student motivation, engagement, and participation, potentially hindering performance (36). Similarly, another study reported that teachers can enhance mathematics achievement by promoting a positive and supportive learning environment, providing essential resources, and cultivating a positive attitude toward the subject (37).

As to the correlation between STEM students' self-esteem and their performance in mathematics, the results indicate that students with higher self-esteem tend to exhibit slightly better mathematics performance. Conversely, lower self-esteem is associated with comparatively lower performance. This pattern is consistent with previous studies which similarly reported a positive association between mathematics self-esteem and achievement (38-40). While this study demonstrates a relationship rather than a causal effect, the findings highlight the potential value of exploring interventions that support students' confidence in future research. Without initiatives to strengthen this confidence, students may experience academic setbacks, diminished motivation, and disengagement from mathematics, weakening their persistence and interest in STEM-related fields. Furthermore, the study found that self-esteem is significantly linked with instructional delivery and time management. Instructional delivery is also associated with both the learning environment and time management, suggesting that these variables tend to vary together within the classroom context. In addition, the learning environment and time management show a significant association, highlighting their interrelated nature without implying a directional or causal relationship between these variables.

Meanwhile, this study found no significant correlations between students' mathematics performance and the other factors examined, including instructional delivery, learning environment, and time management. While these factors may shape the STEM students' learning experience in mathematics, they do not directly influence performance outcomes within this study's context. This deviates from other studies which emphasized the importance of instructional quality and professional development in improving students' mathematics performance (41, 42). While instructional delivery, learning environment, and time management are often cited in the literature as influential to academic achievement, their lack of direct link with performance in this study suggests a more complex interplay of mediating factors and contextual influences that may have diluted their observable impact. One potential explanation for the non-significant findings is the variability in students' socioeconomic backgrounds, which was not controlled for in this study but may significantly influence access to learning resources and attitudes toward academic engagement. For instance, STEM students from high-income families may benefit from better support systems, enriched home learning environments, or access to supplemental resources outside of school, reducing the adverse impact of inadequate instructional delivery or limited school-based support. In contrast, students from less advantaged backgrounds may face challenges that cannot be effectively addressed solely through improved instructional quality or the classroom environment.

Additionally, prior learning experiences, especially during the COVID-19 pandemic, may have significantly impacted STEM students' readiness and adaptability to modern instructional practices.

Many students faced prolonged disruptions to foundational learning, leading to persistent gaps that continue despite current teaching strategies and time management practices. These gaps may limit the benefits of well-structured instruction or supportive classroom environments if students lack the knowledge to engage with the curriculum. Another possibility is that the impact of instructional delivery and learning environment may differ among students. Variations in learning styles, motivation, and resilience may influence students' responses to these factors, resulting in diverse effects that, when averaged across a sample, do not yield statistically significant results. For example, highly self-motivated students may perform well despite suboptimal instructional practices, whereas others may require individualized support to succeed.

The non-significant correlation with time management may indicate that mathematics necessitates consistent practice and a strong conceptual understanding rather than merely allocating time. STEM students' success in mathematics may be more contingent upon the quality of their study habits and the depth of their knowledge than on their scheduling skills. Furthermore, some STEM students may depend significantly on classroom instruction and demonstrate effective learning during school hours, reducing the relevance of independent time management to their academic outcomes. Nonetheless, one study found that reducing procrastination and improving time management were positively associated with better educational outcomes (43). They also noted that poor sleep patterns, often linked to poor time management, negatively influence students' performance by reducing focus and productivity. Further, one study affirmed this by showing that poor sleep quality can significantly impair academic achievement, stressing the need for effective time management habits, including prioritizing sufficient rest among students (44). While instructional delivery, learning environment, and time management are critical elements of the educational process, their influence on mathematics performance may be more indirect or contingent upon other mediating factors.

Although the majority of STEM students in this study demonstrated high-performance levels in mathematics, this does not preclude the presence of substantial learning struggles. High achievement can coexist with significant struggles and frustrations, especially in a cognitively demanding subject like mathematics, which requires sustained critical thinking, problem-solving skills, and conceptual understanding. Many STEM students may be navigating these struggles while still demonstrating good performance, not because mathematics is easy, but perhaps they have developed effective coping strategies, resilience, and support systems. Consequently, this study revealed that STEM students' struggles in learning mathematics arise from a complex interplay of personal, instructional, and contextual issues. These struggles, ranging from difficulties in grasping complex subject matter and keeping pace with lessons to limited instructional support, lack of foundational mastery, academic overload, and issues related to attendance, are often interconnected. The first theme, subject matter complexity and learning pace, emphasizes a longstanding instructional reality in mathematics education. Consistent with a previous study's assertion that insufficient review opportunities hinder conceptual understanding, STEM students expressed that a rapid transition between topics left little room for mastery (45). Similarly, students with weaker memory retention and concentration are unequally disadvantaged in fast-paced instructional settings, highlighting the need for differentiated pacing strategies to accommodate diverse learner needs within STEM programs (46). The emergence of apathy towards mathematics due to inadequate teaching and classroom management reinforces the role of effective pedagogical techniques in encouraging student interest and persistence. Factors such as lack of teaching aids, inappropriate teaching methods, teaching skills, and overcrowded classrooms have also been identified in previous studies as causes of students' failure in mathematics, further worsening apathy towards the subject (47-50). Participants' accounts in this present study align with previous findings which identified teacher engagement, instructional clarity, and supportive classroom environments as critical to sustaining student motivation and a lack of willingness to learn the subject (51, 52). The diminished academic self-efficacy associated with poor instructional practices and procedural emphasis in mathematics teaching is also an essential factor in students' disengagement observed in this study (53). Meanwhile, one study demonstrated that teacher-classroom practices, such as clarity, discussion, feedback, formative assessment, problem-solving strategies, and collaboration, positively influence student performance in mathematics (54). Helping students understand the conceptual aspects of a mathematics lesson can enhance their appreciation of the subject. With the students' apathy toward mathematics, one study also asserted that procedural focus not only fails to reduce apprehension but may also increase it, indirectly diminishing engagement through heightened frustration and reliance on rote memorization (55).

Similarly, the lack of mastery of basic mathematical concepts and procedures highlights significant gaps in foundational learning, which were intensified by the shift to modular and online learning during the COVID-19 pandemic. STEM students who experienced this transition faced considerable challenges, including unstable internet connectivity and limited interaction with teachers, which hindered their ability to engage meaningfully with mathematical instruction. This abrupt shift in educational delivery disrupted the continuity of learning. It adversely affected students' motivation, comprehension, and retention, particularly in mathematics, where a firm grasp of foundational concepts is critical for success in more advanced topics. This aligns with a previous study who indicated that students tend to be passive during online learning, displaying a one-way communication pattern (56). Other studies also observed that academic dishonesty poses a significant challenge in online learning, making it essential for educators to adopt effective strategies (57, 58). With nearly two school years of modular or online learning, the COVID-19 pandemic significantly contributed to students' lack of mastery of basic mathematical concepts. Such gaps have long-term repercussions, particularly in cumulative subjects like mathematics (59, 60). Providing proper guidance is essential for mathematics teachers to support students who struggle with the subject, particularly those who require reinforcement of fundamental concepts to build a strong foundation for advanced learning.

Furthermore, time constraints due to STEM subject overload also emerged as a salient factor for STEM students' struggles in learning mathematics. Although the STEM curriculum is designed to promote interdisciplinary competence, STEM students’ experiences indicate that the breadth of content compromises the depth of understanding (61). The cognitive overload resulting from simultaneous demands across multiple disciplines limits the opportunity for focused, meaningful engagement with mathematical concepts. This finding suggests that curriculum developers and school administrators need to revisit content load and sequencing to support mastery learning better. Meanwhile, the reported struggles of STEM students to understand mathematics due to tardiness highlight how frequent absenteeism deepens learning gaps in mathematics, a subject characterized by sequential skill building. Consistent with previous studies who stated that missed instructional time was identified as a critical barrier, with participants reporting few opportunities for remediation or review (62, 63). The inability to review missed lessons in the classroom places STEM students at a disadvantage, as learning complex material independently may not adequately address their questions or misconceptions. Persistent tardiness creates a compounding barrier to mathematical comprehension, hindering engagement and interest in the subject. Further, the finding highlights the importance of proactive attendance monitoring and the implementation of structured catch-up interventions to mitigate cumulative learning deficits.

Theoretical and Practical Implications

This study yields essential theoretical and practical insights for mathematics teachers, researchers, and policymakers seeking to improve the teaching and learning of mathematics for Filipino STEM students. Given the positive correlation between self-esteem and mathematics performance, the school may implement specific self-efficacy-building activities that support and build STEM students' self-esteem. This could include workshops, counseling sessions, and activities that encourage a growth mindset, as higher self-esteem may lead to better academic outcomes in mathematics. However, the observed weak positive correlation between self-esteem and mathematics performance implies that while confidence plays a role, it is not the sole determinant of success. Instructional practices, curriculum content, and foundational knowledge may exert a more significant influence. Thus, efforts to improve student outcomes should focus on enhancing self-esteem and target pedagogical quality, curriculum alignment, and academic support systems. Additionally, mathematics teachers may employ varied instructional strategies to address students' struggles with complex mathematical topics that break down difficult concepts into more manageable parts. Scaffolding methods or supplementary online resources could accommodate different learning paces and styles, making complex concepts more accessible.

Time constraints and workload balance also emerged as significant struggles for STEM students. Time management workshops and guidance on organizing study schedules can help students navigate their academic responsibilities more effectively. The finding further implies that a comprehensive review of the STEM curriculum can help determine if modifications to the subject load give students enough time to engage meaningfully with each discipline. Additionally, the issue of tardiness hinders students' ability to stay aligned with the lesson flow. Mathematics teachers are encouraged to monitor student attendance and reinforce classroom expectations regarding punctuality and active participation. School administrators can implement flexible scheduling and encourage teachers to start classes with a brief review of previous content. Incorporating recap sessions during mathematics lectures may help students catch up and improve their understanding of the topic. Moreover, since students expressed apathy toward mathematics due to inadequate teaching and classroom management, it may be beneficial for teachers to receive ongoing training specific to STEM education in effectively implementing active learning strategies, like collaborative problem-solving, to enhance student engagement. This could create a more engaging learning environment and reduce student apathy toward mathematics. Likewise, the prominence of concerns regarding instructional delivery points to the urgent need for pedagogical improvement. Mathematics teachers should adopt student-centered, interactive, and technology-integrated teaching strategies to increase engagement and comprehension.

From a theoretical standpoint, the study's results support SCT, particularly the role of self-efficacy in shaping academic achievement. The positive link between self-esteem and performance aligns with SCT's core proposition that belief in one's capabilities enhances motivation and persistence. However, the lack of significant correlations between mathematics performance and other environmental or behavioral factors, such as instructional delivery, classroom environment, and time management, diverges from SCT's broader framework, which posits the reciprocal interactions of personal, behavioral, and environmental determinants. This suggests that while SCT provides a valuable lens, additional context-specific factors may mediate the learning experiences of Filipino STEM students. Practically, the study underscores the importance of strengthening students' foundational mathematical skills before introducing advanced topics. Teachers should employ active learning strategies and problem-based approaches to mitigate disengagement and promote long-term retention. Schools should consider remedial instruction, tutoring programs, or flexible scheduling options for students struggling due to heavy academic workloads. Finally, addressing issues like tardiness and missed lessons may require school-wide policies that promote attendance and provide accessible catch-up mechanisms.

Limitations and Recommendations for Future Research

This study provides valuable insights into the struggles faced by Filipino STEM students in mathematics education; however, it is important to recognize several limitations. First, the study was conducted in one public secondary school in the Philippines, limiting the geographic and demographic diversity of the sample. As a result, the findings may not be fully generalizable to all Filipino STEM students, especially those in private institutions, urban areas, or other regions with different educational contexts and resources. Future studies may include a larger and more diverse sample of STEM students from multiple schools, regions, and educational contexts across the Philippines. Second, while the sample size is adequate for this study's objectives, it may not capture the full range of experiences and perspectives within the larger STEM student population. Additionally, self-selection bias may have influenced the responses, as participation was voluntary; those who chose to participate may have different characteristics or experiences than those who did not engage. Future studies should aim to increase the sample size and diversify the participant pool by including STEM students from a broader range of educational institutions, geographic regions, and socioeconomic backgrounds.

Third, the study used self-reported data from surveys and interviews, which were vulnerable to social desirability bias, recall errors, and personal interpretation. Respondents may have underreported or exaggerated specific challenges due to perceived expectations or misunderstandings of the survey questions. Given the limitations of self-reported data, future related studies should consider more robust mixed methods approaches that combine observational data, teacher assessments, academic records, or performance-based tasks with surveys and interviews. This methodological triangulation can enhance the validity of the results and provide a more objective and comprehensive understanding of students' challenges in mathematics. Likewise, researchers are encouraged to pursue longitudinal designs to investigate how students' challenges in mathematics develop over time and to explore how variables such as instructional practices, self-esteem, and study habits influence performance across various grade levels. Fourth, teacher preparation metrics and classroom observations were not included because the study focused solely on learner-related constructs. The absence of these data limits the study's ability to examine how teachers' instructional readiness, professional competencies, or actual classroom practices may have contributed to students' mathematics struggles. Incorporating such measures in future studies would allow for a deeper understanding of the instructional factors influencing student performance and would strengthen the alignment between student-reported perceptions and observed teaching behaviors.

Furthermore, the scope of this study was limited to examining how self-esteem, instructional delivery, learning environment, and time management relate to students' mathematics performance; therefore, variables such as socioeconomic status, parental involvement, prior academic achievement, and school resources were not included in the analytic framework. These unmeasured factors may also shape students' learning experiences and could influence the strength or direction of the relationships observed. Future studies may extend the present work by incorporating these contextual and background variables, as well as additional predictors such as problem-solving strategies and cognitive load. Researchers may also employ experimental or quasi-experimental designs to assess the effectiveness of adaptive instructional approaches, differentiated teaching, peer tutoring, or technology-enhanced learning environments for STEM students.

Conclusion

This study investigated the mathematics performance of Filipino STEM students and examined how self-esteem, instructional delivery, learning environment, and time management influenced their academic outcomes. It also explored the underlying reasons behind students' struggles in learning mathematics and analyzed the correlations between mathematics performance and the identified contributing factors. The results indicated that a substantial proportion of STEM students demonstrated outstanding performance in mathematics. Additionally, this study found a statistically significant yet weak positive correlation between self-esteem and mathematics performance, suggesting that students with higher self-esteem tend to perform slightly better in the subject. In contrast, no significant correlations existed between students' mathematics performance and the other factors examined, including instructional delivery, learning environment, and time management. Moreover, STEM students identified multiple factors contributing to their struggles in learning mathematics. These included the inherent complexity of the subject matter and the fast-paced instruction, a lack of engagement stemming from ineffective teaching and poor classroom management, insufficient mastery of fundamental mathematical concepts and procedures, limited time for learning due to the demanding STEM curriculum, and difficulties keeping up with lessons because of frequent tardiness. This study provides valuable insights into the struggles faced by Filipino STEM students in mathematics education. The results highlight the need for active learning strategies, such as collaborative problem-solving, to enhance student engagement, promote conceptual understanding, implement effective teaching practices, and establish strong student support systems. Additionally, the results contribute to the growing body of literature on student-centered education, emphasizing the importance of addressing students' academic and emotional needs. It also provides a foundation for mathematics teachers, school administrators, and policymakers to develop more responsive, inclusive, and effective mathematics programs for Filipino STEM students.

Abbreviations

SCT: Social Cognitive Theory, SHS: Senior High School, STEM: Science, Technology, Engineering, and Mathematics.

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Author Contributions

Joshua Mina Pillero: conceptualization, investigation, contributed to methodology, project administration, data gathering, analysis, interpretation, implications, prepared the initial manuscript draft, Jomar Cobacha Cabuquin: visualization, data curation, formal analysis, interpretation, implications, methodology development, resource acquisition, software utilization, supervision, validation, literature review update, refined the manuscript through critical revisions, Phoebe Kirstelle Dysoco: data gathering, writing the initial manuscript draft, discussing the results, interpreting findings, shaping the initial conclusions, recommendations, Xianelle Antoneth Alas: data gathering, writing the initial manuscript draft, discussing the results, interpreting findings, shaping the initial conclusions, recommendations, Rosalie Marilag Nazal: literature review, formal analysis, critical interpretation of results, validation, and technical resources, Mary Ann Abegonia Manabat: literature review, critical interpretation of results, validation, and technical resources.

Conflict of Interest

The authors confirm that this manuscript is original, has not been previously published, and is not under consideration by any other journal. Furthermore, this work has not been released as a preprint. The authors declare no actual or potential conflicts of interest related to this study.

Declaration of Artificial Intelligence (AI) Assistance

In preparing the manuscript, the researchers utilized AI-assisted tools (e.g., Grammarly and QuillBot) solely for grammar refinement and writing clarity. Additionally, tools such as Perplexity and Consensus were used only to locate relevant scholarly sources. These AI tools did not generate or analyze any part of the study’s data, nor did they influence the interpretation of findings.

Ethics Approval

The study was conducted according to ethical standards and institutional guidelines. The authors confirm that informed consent was obtained from all participants, who were assured confidentiality and anonymity. Participation in the research was entirely voluntary. Additionally, secondary data on students' grades were formally obtained from the school.

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