

MATHEMATICS ACHIEVEMENT AMONG MANAGEMENT STUDENTS: ROLE OF INDIVIDUAL AND ENVIRONMENTAL FACTORS

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Abstract: Mathematical knowledge is important for management students because it supports effective decision-making, financial analysis, and strategic planning. Without mathematical knowledge, students may struggle with budgeting, data interpretation, and solving business problems. Therefore, the study addresses the influence of classroom management, teacher's quality, mathematics interest, and metacognitive strategies on the mathematics achievements of management students with the moderating effect of mathematical self-efficacy. Cross-sectional quantitative data were collected from 350 university management students applying the purposive sampling technique. Hypothesis results showed that classroom management, teacher's quality, mathematics interest, and metacognitive strategies significantly increase the mathematics achievements of management students. The moderating effect of mathematical self-efficacy also positively strengthens the relationship of all exogenous and endogenous variables. These findings recommended that improving classroom management, teacher quality, and raising interest in mathematics could significantly enhance students' mathematical achievement in management studies. Incorporating metacognitive learning strategies further boosts performance by promoting self-regulated learning. Furthermore, a significant moderating effect also shows that factors such as student motivation or learning environment can enhance or weaken the impact of classroom management, teacher quality, mathematics interest, and metacognitive strategies on achievement. This suggests that interventions targeting these moderating factors can further increase students' mathematical success, highlighting the need for a supportive and motivating learning context alongside effective teaching practices. Therefore, educational institutions should prioritize these factors in curriculum design and teaching practices to improve outcomes.

Introduction

Mathematics achievement (MA) holds significant importance in management education, as it forms the backbone of various core disciplines such as finance, accounting, business analytics, and economics [10]. These subjects require strong quantitative skills and logical reasoning to interpret data, forecast trends, and optimize resources effectively [68]. In today's competitive and data-driven business environment, managers are expected to make strategic decisions grounded in numerical analysis and evidence-based projections, which are heavily reliant on mathematical competence [71]. In this regard, the ability to apply mathematical knowledge directly affects making quality decisions of managers that could boost companies competitive advantage [30]. Despite its significance, business students,

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leading to underperformance and reduced confidence Saha, et al. [60], often perceive mathematics as a challenging and less engaging subject. This makes it essential to explore and address the factors that influence mathematics achievement, specifically within the context of management education. Without targeted efforts to improve mathematical achievement, management graduates may lack the analytical precision required to thrive in complex and evolving global markets [81]. Hence, this research responds to a critical gap by emphasizing the urgent need to strengthen mathematics education for future business leaders.

Prior literature highlighted that various factors improve the MA, but among those, effective classroom practices are an important factor in enhancing students' mathematics achievement, predominantly in management education where mathematical literacy is essential [3]. Therefore, classroom management (CM) in mathematics significantly impacts students' ability to concentrate, engage, and perform well academically [9]. When classrooms are organized and students understand expectations clearly, it enhances their cognitive engagement and reduces anxiety related to mathematical tasks [76]. Such environments are especially important for management students who often face pressure to master quantitative skills essential for fields like finance, accounting, and analytics [50]. Additionally, mathematics interest (MI) also acts as a strong motivational factor that drives students to engage persistently with mathematical tasks, raising a positive attitude toward learning [49]. Renninger and Hidi [57] also suggested that students with MI can invest in the cognitive resources that increase their understanding of mathematics to increase their achievements. Tabe [72] empirically confirmed that raising MI is associated with higher achievement across academic disciplines, including business and management studies. When MI is integrated into the curriculum through real-life examples and problem-based learning, the students increase their focus on mathematics, which leads to an improvement in their grades in Mathematics [42], which leads to an improvement in their MA. Therefore, the study focused on the influence of MI and CM on MA.

In addition, teacher quality (TQ) has a profound effect on students' MA. High TQ, which consisted of not only experts in subjects but also important to raise their mathematical skills to deliver their lecture more effectively [72]. The clarity with which a teacher explains mathematical theories, their ability to connect abstract content to real-world scenarios, and their responsiveness to student difficulties all contribute significantly to learning outcomes [75]. Ozcan [54] also highlighted that TQ is one of the most significant school-related factors that influence student performance. In the context of management education, where mathematical concepts need to be applied in diverse domains like budgeting, forecasting, and statistical analysis, the role of a skilled teacher is even more crucial [36]. Similarly, metacognitive strategies (MS), which include planning, monitoring, and evaluating one's learning process, are vital for mastering mathematics [73]. Students who use metacognitive strategies are more likely to regulate their learning, identify mistakes, and apply appropriate problem-solving techniques [31]. These skills are particularly critical for management students who are required to think critically, analyze numerical data, and make evidence-based decisions. For instance, Vula, et al. [78] study demonstrated that students trained in MS outperformed peers in mathematical problem-solving tasks. Therefore, focusing on both TQ and MS serves as a dual approach to enhancing mathematics achievement and overall academic performance among management students. Therefore, the study investigated the role of TQ and MS on MA.

With the significance of CM, MI, MS, and TQ for the MA, various gaps exist in the

prior literature. For instance, prior studies have mainly concentrated on overall academic achievement with a limited focus on mathematics achievements [1, 3]. Therefore, this study contributed literature in the context of MA. Furthermore, prior studies have also had inconsistent findings on CM, MI, MS, TQ, and [9, 79], which reinforces that further research could be explored with moderating effective because it is argued that moderating variables is more effective when the relationship are inconsistent [12]. Literature cited that mathematical self-efficacy (MSE) could be used as a moderating variable [28]. MSE enhances students' belief in their capabilities to solve mathematical problems, leading to increased persistence and better performance [81]. When students feel confident in their math abilities, they are more likely to engage in complex tasks and apply effective problem-solving strategies [58]. High MSE reduces math anxiety and promotes a positive attitude toward learning, which contributes to academic success [23]. Studies also show that students with strong math MSE tend to set higher goals and exhibit greater resilience in the face of challenges [26]. Therefore, this study contributed MSE as a moderating variable to fill the previous inconsistent findings.

Furthermore, prior studies have been conducted in other fields at the school level, college level, while having limited attention on the university level, especially on management education students [32]. Mathematical education is essential in the management field as it equips students with quantitative skills needed for decision-making, budgeting, forecasting, and data analysis [51]. It raises logical reasoning and problem-solving abilities, which are critical in strategic planning and operational efficiency [20]. Lastly, extant studies in methodology perspective has majorly focused on regression based analysis or structural equation based analysis with a limited attention on complex moderating effect models through testing in Partial Least Square (PLS)-Structural Equation Modeling (SEM), particularly in the field of management education [9]. This study contributed literature in the management education field context. Therefore, to address the previous gaps, the study mainly focused on testing the impact of CM, MI, MS, and TQ on the MA of mathematics students in management education studies with the moderating effect of MSE.

Practical significance lies in this study on direct implications for improving MA among university-level management education students. Through identifying CM, MI, MS, and TQ as key determinants of MA, educational institutions can design targeted interventions to strengthen these areas. For instance, improving CM practices can raise a more conducive learning environment, while enhancing MI and MS can motivate students and equip them with essential self-regulation skills. Strengthening TQ through continuous professional development ensures that students receive quality instruction aligned with management education needs. Furthermore, introducing MSE as a moderating variable provides deeper insight into individual differences among learners and emphasizes the need to boost students' confidence in mathematics. This is particularly critical in management education, where analytical and quantitative competencies are vital for real-world decision-making, financial forecasting, and strategic analysis. Hence, educational policymakers and university administrators could use study findings to reform curriculum design, teacher training, and student support services to promote excellence in mathematics achievement and overall academic performance in the management domain.

Literature Review

Classroom Management and Students' Mathematics Achievement

The classroom management (CM) composition of various techniques that teachers use to maintain order and create an effective learning environment [13]. This includes the establishment of classroom rules, regulation of student behavior, time management, and promoting a positive relationship between the student and teacher. Effective CM contributes significantly to the educational success of the students, especially in mathematics, by reducing behavioral disorders and maximizing the time for busy learning. When the students feel safe and the classroom is structured then they are more likely to focus on learning tasks, participate in problems, and focus on complex mathematical processes [41]. Research provides strong support for links between classroom management and educational performance. Mavilidi, et al. [48] demonstrated that active CM leads to a decline in behavior outside the task, which improves academic benefits in subjects including mathematics. Cox and Mullen [17] further stated that the teacher directly impresses the students' work engagement and performance by using clear directive goals, auxiliary responses, and a monitoring system. HD and Darmawan [37] also conducted a study and found that CM is one of the most influential factors that affect students' learning to improve their MA. In addition, Liu, et al. [44] found that when teachers maintained well-managed classes, students not only taught better, but also demonstrated trust in subjects such as mathematics, which in turn increases their achievements in mathematics, and accordingly hypothesis is,

H1: Classroom management effect significantly to students' mathematics achievements.

Mathematics Interest and Students' Mathematics Achievement

Mathematics interest (MI) is defined as a student's positive emotional commitment and personal value, which is the place for students in learning mathematics [34]. This includes happiness from solving mathematical problems, and curiosity to discover new concepts of mathematics in real life. MI plays an important and inspiring role in the students' educational success [34]. Students who take an interest in mathematics then they could get benefit in gaining better results in mathematics [24]. Since mathematics often involves intellectual thinking and problems and hence it is important to maintain an interest in constant learning. Japelj Pavešić, et al. [40] empirically also found that MI increases internal motivation which is important for learning mathematics. Chand, et al. [15] further showed that continuous MI from early grades leads to high performance in upper secondary education. Steidtmann, et al. [67] emphasized that minimizing interest often leads to little involvement which decreases their MA. In addition, Chew also emphasized that interest not only affects the amount of effort but also improves the quality of cognitive strategies used during learning, which increases their MA. These previous studies highlight the significance of MI for MA, and hence study has the hypothesis,

H2: Mathematical interest effects significantly to students' mathematical achievements.

Teacher Quality and Students' Mathematics Achievement

Teacher quality (TQ) includes the teacher's professional knowledge, educational skills, expertise in instruction, class management, and ability to have meaningful relationships with students [64]. High-quality teachers not only have knowledge of deep content but also understand how they can distribute this knowledge to different students effectively [21]. In mathematics teaching, TQ is important due to their intangible nature of the subject and cognitive requirements [6]. Skilled teachers can diagnose misconceptions, use visual representations, adjust the instructions based on students' needs, and promote growth thinking that increases their MA [74]. Li, et al. [43] empirically showed that instructors with strong mathematical knowledge to teach significantly increase students' ideological understanding and problem-solving. Howard and Milner [39] repeated these findings in the urban school's surroundings, emphasizing that teacher skills contribute more to the students' performance than the size or resources of the school. Maamin, et al. [46] further found that teachers are associated with high mathematics performance increases the students' engagement towards mathematics. In addition, Allensworth, et al. [4] also highlighted the positive effect of the instruction practices of teachers on the achievement of mathematics results. These findings indicate that teachers can invest in training and commercial development. These previous studies supported the significance of TQ for the student's MA. Hence, a study has the following hypothesis below,

H3: Teachers' quality effects significantly to students' mathematical achievements.

Metacognitive Strategies and Students' Mathematics Achievement

Metacognitive strategies (MS) includes the ability to plan, monitor, and evaluate their thinking and learning processes [47]. These strategies help students set goals, track their understanding, choose the right problem-solving methods, and reflect on results [5]. In the context of mathematics, MS are especially important because they enable students to regulate the procedures to solve their problems and optimize the approach when facing challenging tasks [61]. Students using MS are more likely to identify errors, persist, which increases their grades in mathematics [77]. Many studies emphasize the effectiveness of MS to improve mathematics. Morales, et al. [52] emphasized that successful mathematical problem solutions consistently use metacognitive procedures such as self-regulation and reflection. de Vreeze-Westgeest and Vogelaar [22] showed that primary students trained in MS showed much better in mathematics. Özçakmak, et al. [53] found that metacognitive awareness increases the consequences of learning in subjects, especially in mathematics, due to its structured logical requirements. Skowrońska [66] showed that MS, including collaboration, education, and improved mathematical thinking and learning which improves MA. These studies have shown the importance of MS for the MA, and hence hypothesis is,

H4: Metacognitive strategies effect significantly to students' mathematical achievements.

Moderating role of Mathematical self-efficacy

Prior studies have also had inconsistent findings on CM, MI, MS, TQ, and MA Asare, et al. [9], Wafubwa and Csikos [79], which reinforces that further research could be

explored with moderating effective because it is argued that moderating variables is more effective when the relationship are inconsistent [12]. Literature cited that mathematical self-efficacy (MSE) might be a moderating variable. MSE enhances students' belief in their capabilities to solve mathematical problems, leading to increased persistence and better performance [81]. When students feel confident in mathematical abilities then they solve complex tasks and apply effective problem-solving strategies [58]. High MSE reduces math anxiety and promotes a positive attitude toward learning, which contributes to academic success [23]. These studies emphasized that mathematical MSE could be used as a moderating variable in the present. It has been found that the mathematical skills increase the CM, which leads to improved students' academic achievements (Steidtmann, et al. [67]. They also argued that further research could be conducted with the moderating effect

Furthermore, it has been highlighted that MI improves students' desire to contact mathematical functions and its effect is, more importantly, increased when mathematical self-efficacy improves [59]. MSE translates this motivation into action, and firmness increases the MI of students to boost their academic achievements [62]. Other studies also highlighted that students who are interested in mathematics, but lack of MSE may not be good because they doubt their abilities and avoid challenging problems [2]. Conversely, when students have both interest and high efficiency, they are more likely to detect complex ideas, complete successes, and show more achievements [3]. Equally, TQ improves the students' academic achievements, but it increases with the MSE [80]. Students with strong MSE are more likely to respond positively to high-quality teaching through providing with materials deeply and trying hard tasks [19]. Qashou [56] emphasized the interactive role of personal faith and external influences in the learning process. Sufyan Ghaleb and Alshiha [69] further emphasized that MSE enhances the use of deep learning strategies, which leads to improved mathematical grades. Celik [14] argued that MS use is contingent on a student's motivational state, particularly their MSE. Moreover, Ba, et al. [11] found that MS increases positively to MA when there is the involvement of MSE of students. These studies justify the moderating role of mathematical SE in enhancing the impact of CM, MI, MS, and TQ on SA, and the study has hypothesis,

H5: Classroom management and mathematical achievements relationship is significantly moderated by mathematical self-efficacy.

H6: Mathematical interest and mathematical achievements relationship is significantly moderated by mathematical self-efficacy.

H7: Teacher's quality and mathematical achievements relationship is significantly moderated by mathematical self-efficacy.

H8: Metacognitive strategies and mathematical achievements relationship is significantly moderated by mathematical self-efficacy.

Research Design and Survey Instrument

The study mainly focused on testing the impact of CM, MI, MS, and TQ on the MA of mathematics students in management education studies with the moderating effect of MSE. To test the study objective, researchers employed the quantitative research approach. Quantitative research provides objective, measurable data that can be statistically analyzed. It enables researchers to identify patterns, test hypotheses, and make generalizable conclusions across larger populations [29]. Therefore, research employed the quantitative approach. As data collected using a

self-administered survey instrument. Therefore, cross-sectional research design is considered more effective compared to longitudinal research design. Cross-sectional research design is quicker and more cost-effective than longitudinal design, as it collects data at a single point in time. It is ideal for assessing prevalence and identifying associations without the need for long-term follow-up [18]. Therefore, this design is appropriate for present study.

Cross cross-sectional survey instrument adopted from previous studies. CM comprises from 5 items of [9]. MI comprised from 5 items [9], TQ comprised from 5 items [9]. Furthermore, MA comprises from 5 items [9]. MS comprise three dimensions, namely planning, monitoring, and evaluating strategies. 6 items taken planning, monitoring comprise 6 items, and lastly, evaluating comprise from 5 items. These items were adopted from the study of [55]. Lastly, mathematics mathematical self-efficacy was composed of 5 items [45]. Each item ranked on five point Likert Scale and variables are predicted in Figure.1 below,

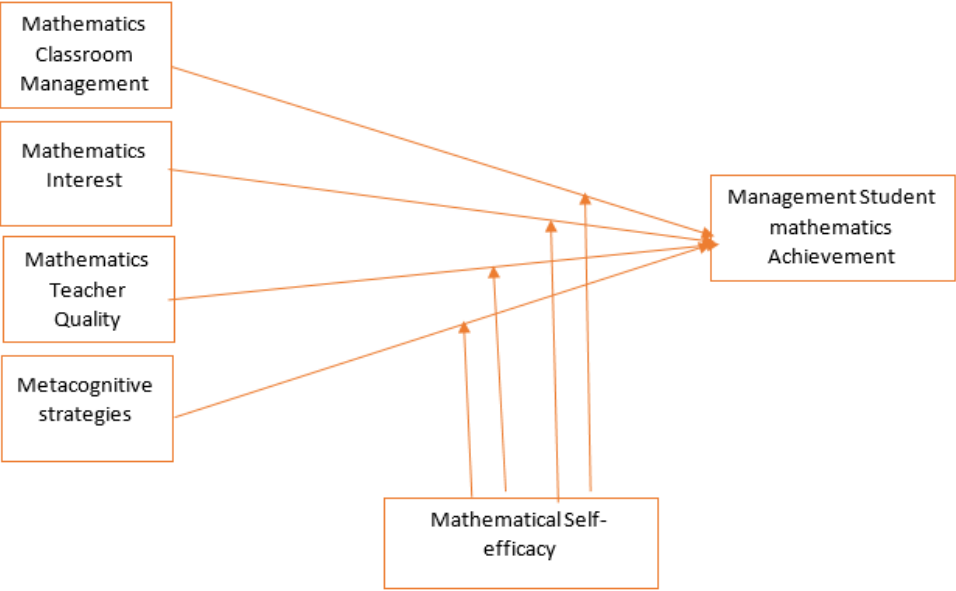


Figure 1: Conceptual Framework

Population and Sampling Technique

The current study population is graduation students of management studies of universities. Mathematics is important for management students as it enhances their analytical, problem-solving, and decision-making skills essential for business and finance. This is reason, researchers selected management students. Sampling involves choosing a smaller group of individuals from a larger population to accurately reflect the characteristics of the entire group in a research study. Using the purposive sampling technique sample selected because data collected only from those students who were students of mathematics and have knowledge of mathematics. Total 450 students were selected from different universities as a sample size of the study. 360 questionnaires were returned back and among those 350 were valid for analysis that is 76.7 percent response rate. The collected data was coded in the excel sheet.

Analysis and Results

Study analysis conducted in two software is namely SPSS and Smart PLS 4. Smart PLS used for the hypothesis testing using Partial Least Square (PLS)-Structural Equation modeling (SEM). While SPSS used for the data screening and demographic analysis.

Demographic Characteristics

This section in Table.1 represents 350 management sciences students profile which almost shown the balanced gender representation with a male comprising 51.4% and females 48.6% of the sample. The majority of respondents fall within the age range of 21–23 years (45.7%), followed by 18–20 years (37.1%), suggesting a predominantly young adult population. In terms of academic level, most students are in their 3rd year (31.4%), indicating that a significant portion has substantial exposure to university-level coursework. Regarding mathematics performance, 31.4% of students scored between 71%–80%, with 30% in the 60%–70% range, reflecting moderate to high achievement levels in mathematics. Additionally, a substantial majority (62.9%) reported having a background in business mathematics, while 25.7% had studied general mathematics, and only 11.4% reported no mathematics background.

Table 1: Demographic Characteristics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	180	51.4%
	Female	170	48.6%
Age Group	18–20 years	130	37.1%
	21–23 years	160	45.7%
	Above 23 years	60	17.1%
Students semester	1 to 2 semester	70	20.0%
	3 to 4 semester	90	25.7%
	5 to 6 semester	110	31.4%
	7 to 8 semester	80	22.9%
Mathematics Grade	Below 60%	65	18.6%
	60% – 70%	105	30.0%
	71% – 80%	110	31.4%
	Above 80%	70	20.0%
Previous Math Stream	Business Mathematics	220	62.9%
	General Mathematics	90	25.7%
	No Math Background	40	11.4%

Measurement Model Results

The hypotheses were tested using the Partial Least Squares (PLS)-Structural Equation Modeling (SEM) in two models, namely measurement and structural. The measurement model is first evaluated to ensure the validity and reliability of the constructs used in the questionnaire. One essential aspect of this evaluation is convergent validity, which refers to the extent to which items within a construct are correlated and collectively represent the same underlying concept [33]. To assess convergent validity, several criteria are used, including factor loadings, Cronbach’s alpha, composite reliability (CR), and average variance extracted (AVE). Factor loadings reflect the degree of association between each item and its corresponding latent variable, with values of 0.70 or higher indicating a strong relationship [16]. Cronbach’s alpha is used to evaluate internal consistency, and values exceeding 0.70

are generally considered acceptable [16]. Composite reliability, which offers a more precise reliability estimate by considering different item loadings, should also surpass 0.70 to confirm construct reliability [33]. Lastly, the AVE measures the average variance captured by the construct about the variance due to measurement error, with a minimum threshold of 0.50 recommended to ensure that the construct captures more variance than error [33]. Based on these criteria, the results provided in Table 2 determined that all constructs satisfy the convergent validity criteria.

Table 2: Reliability and Validity

Construct	Cronbach's Alpha	Composite Reliability	AVE
Classroom Management (CM)	0.882	0.903	0.652
Mathematics Interest (MI)	0.873	0.894	0.672
Teacher Quality (TQ)	0.864	0.882	0.632
Planning strategies (PS)	0.783	0.834	0.643
Monitoring strategies (MOS)	0.893	0.810	0.647
Evaluating strategies (ES)	0.853	0.873	0.663
Mathematical self-efficacy (MSE)	0.893	0.914	0.724
Math Achievement (MA)	0.912	0.933	0.753

Note: Metacognitive strategies used a second-order construct with three dimensions PS, MOS, and ES

Table 3 shown the discriminant validity results. It is shown that each construct should be different from another construct that could be measured from Fornell and Larcker which shown that diagonal values should be greater from below values [27]. Predicted results highlighting that each value is greater from below value.

Table 3: Fornell-Larcker Criterion

Construct	CM	MI	TQ	PS	MOS	ES	MSE	MA
CM	0.813							
MI	0.522	0.823						
TQ	0.483	0.452	0.793					
PS	0.552	0.583	0.502	0.812				
MOS	0.342	0.673	0.562	0.342	0.783			
ES	0.342	0.563	0.321	0.352	0.673	0.893		
MSE	0.501	0.531	0.473	0.543	0.423	0.342	0.853	
MA	0.602	0.632	0.594	0.572	0.343	0.342	0.612	0.870

Model Fit Indices

Overall model fitness results (Table 4) in this model confirmed that all are on a satisfactory level with the observed data.

Table 4: Model fitness

Fit Index	Recommended Value	Model Value
Chi-square/df	< 3.0	2.12
CFI	> 0.90	0.95
TLI	> 0.90	0.94
RMSEA	< 0.08	0.06
SRMR	< 0.08	0.05

The Chi-square to degrees of freedom ratio stands at 2.12, falling below the recommended limit of 3.0, which supports the adequacy of the model fit (Hair Jr et al., 2021). Furthermore, the values for the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are 0.95 and 0.94, respectively—both surpassing the suggested threshold of 0.90—demonstrating strong evidence of comparative and incremental model validity (Hu & Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA) is measured at 0.06, indicating a good approximation of the model to the

data, as values below 0.08 are generally considered acceptable (Browne et al., 2002). In addition, the Standardized Root Mean Square Residual (SRMR) is 0.05, which is within the recommended cutoff of 0.08, suggesting a small discrepancy between observed and predicted correlations (Sahoo, 2019). The summarized outcomes presented in Table 4 confirm that the model satisfies the essential criteria for structural model fit.

Empirical Results

The next step is to test the hypothesis when the model fitness and the measurement model meet their criteria. The results indicated that classroom management (CM) has a strong positive effect on MA ($\beta = 0.301, p < 0.001$), which suggests that well-structured and disciplined classroom environments contribute meaningfully to students' academic performance. Mathematics interest (MI) also has a significant and positive impact on MA ($\beta = 0.282, p < 0.001$), which highlights that when students are more engaged and interested in math, then their achievement improves. Teacher Quality (TQ) also affects positively and significantly to MA ($\beta = 0.323, p < 0.001$), emphasizing the importance of knowledgeable, effective, and motivating instructors.

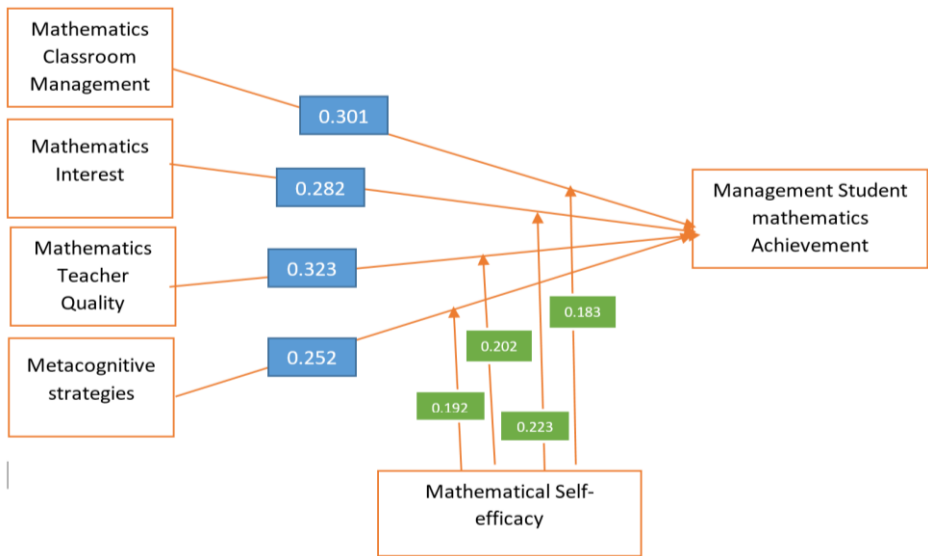


Figure 2: Coefficient Values

Additionally, metacognitive strategies (MS) also significantly influence MA ($\beta = 0.252, p < 0.001$), which indicates that students who are actively planning, monitoring, and evaluating their learning tend to perform better in math-related tasks. On the other hand, mathematical self-efficacy (MSE) also significantly the relationship of independent and dependent variables. The moderation effects of MSE are significant for CM ($\beta = 0.183, p < 0.001$), MI ($\beta = 0.223, p < 0.001$), TQ ($\beta = 0.202, p < 0.001$), and MS ($\beta = 0.192, p < 0.001$). These findings in the context of management education, where quantitative analysis is a core skill, emphasize the significance of raising not only strong instructional practices and learning strategies but also students' belief in their mathematical competence to achieve better academic outcomes. Hypothesis result depicted in Table 5 and Figure.2.

Table 5: Hypothesis Results

Path	Beta Coefficient	t-value	Supported
CM → MA	0.301	4.122	Yes
MI → MA	0.282	3.89	Yes
TQ → MA	0.323	4.30	Yes
MS → MA	0.252	3.50	Yes
CM × MSE → MA	0.183	2.65	Yes
MI × MSE → MA	0.223	2.98	Yes
TQ × MSE → MA	0.202	2.80	Yes
MS × MSE → MA	0.192	2.55	Yes

Discussion

The study findings indicate that class management (CM) significantly increases the management education students' mathematics achievements (MA). These results show that well-organized and structured CM provides accessible concentration, focused learning, and reduces disruptions, so that students can effectively focus on mathematical materials. In this connection, CM creates a positive learning environment where students are motivated to participate actively in psychologically safe, vigilant, and mathematical discussions. Setyaningsih and Suchyadi [63] also confirmed that CM is a powerful determinant for academic success. Similarly, Silvola, et al. [65] stated that student engagement promotes and improves academic results in classes with strong routines and expectations. Therefore, in the context of management education, where students need to understand complex mathematical and analytical concepts, the application of CM practices can provide sufficient educational benefits. For this purpose, teachers should receive targeted training in the use of behavioral management techniques, collaborative teaching structures, and a systematic environment. In addition, taking advantage of the classroom reaction system and collaborative platforms such as digital tools can increase class control and student participation, and eventually improve MA, which could also increase their overall academic performance. Therefore, it is enforced that educational institutions should focus on their proper CM to increase their students' MA.

Further results indicated that MI also played a significant role in increasing the management students' MA. Traditionally, students who find the complicated and meaningful of mathematics are more likely to make constant efforts, be cognitively engaged, and embrace challenges with enthusiasm. In this connection, MI acts as a motivational factor that has control and depth of learning, especially in people with theoretical logic and numerical ability. Arthur, et al. [8] found the same results, where they highlighted that MI development emphasizes continuous educational improvements, which lead to long-term performance. Similarly, Hashim, et al. [35] found the same results, where they also highlighted that students' interest in mathematics could increase their MA. Therefore, these findings are more relevant for management students, whose curriculum often includes accounting, financial modeling, and commercial analysis. In addition, integration of business applications in Excel can stimulate curiosity and strengthen the experiential value of mathematical skills. Furthermore, education programs should also promote interdisciplinary projects where students use mathematical equipment in marketing, logistics, or strategic decision-making so that MI can elaborate and increase MA, which will also lead to improving the students' academic performance. TQ in mathematics significantly improves the MA of the management students. These findings highlighted that qualified teachers in mathematics could possess a

strong content expertise, effective pedagogical strategies, and the ability to adapt instruction to diverse learner needs. In the literature, it has also been highlighted that TQ influences not only the clarity of instruction but also the enthusiasm and support that inspire student engagement and perseverance. The findings are in line with the study of Tabe [72], who also emphasized that TQ is the most significant school-related factor affecting student performance. Therefore, these findings are more important for management students tackling quantitative courses; skilled instructors who can break down complex formulas, guide problem-solving, and relate theory to practice are indispensable. Consequently, business schools should prioritize employment and trained instructors with a combination of educational qualifications and real experience. Continuous business development programs focusing on instructional design, digital education, and student-centric teaching must be installed in institutions to increase TQ. Based on this argument, it is highlighted that educational institutions should focus on TQ in mathematics to increase students' achievements.

The study results further highlighted that the application of MS also played a significant role in increasing the MA of management students. Historically, MS, such as goal setting, monitoring comprehension, and evaluating learning outcomes, enable students to regulate their thinking and adopt strategic approaches to complex mathematical problems. In this regard, MS fosters learner autonomy, self-awareness, and adaptive expertise, which are essential in managing quantitative tasks effectively. Syaiful, et al. [70] supported the results they highlighting that MS played a significant role in increasing the MA of management students. Güner and Erbay [31] also found that MS is especially vital in domains requiring problem-solving and abstract reasoning, such as mathematics. The study results are more significant for the management students who often face case studies involving data interpretation and financial decision-making, and in their study use of MS can significantly boost performance. Therefore, teachers should be built into promote metacognitive development in teaching, reflective tasks, self-assessment equipment and their teaching. Instruction techniques such as thinking protocols, miscellany, and learning portfolio can also help students internally MS. In addition, institutions can offer workshops and seminars that equip students with learning for teachers, which increases their ability in mathematics and beyond independent education. Therefore, it is enforced that in higher educational institutions, there should be a proper MS to improve the students' educational performance

Further, the moderating effect results show that MSE also significantly moderates the relationship among CM, MI, TQ, MS, and MA of management education students. These findings highlight that management students with their higher MSE believe in their capability to succeed in mathematical tasks enhances their motivation, resilience, and engagement that is leading to an improvement in their MA. In this connection, MSE acts as a psychological amplifier, which strengthens the effect of external factors such as effective teaching and classroom environment on student results. Hiller, et al. [38] also found that MSE has predicted mathematics performance compared to the former academic items. The moderating effect of MSE has also been shown in various previous studies [7, 25]. They were also highlighted that the moderating effect of mathematical self-efficacy could also be used in other studies to increase the strength of this moderating variable. This study also found the same results. Therefore, it is strengthening the effect of this moderating variable in this study also and study results are more effective for the management education students where success on courses such as quantitative methods and business analysis is important, it is more likely that students with high MSE take the

initiative, stay through difficulties and implement problems with problems-resolution effectively. It is emphasized that educational institutions should also implement educational practice that creates mathematical trust, such as coping experience, creative response, and supportive colleague action. Therefore, academic institutions should implement targeted interventions such as mathematical self-efficacy workshops, confidence-building exercises, and formative assessments to raise MSE levels. Instructors should model problem-solving processes, highlight student progress, and create opportunities for peer collaboration to reinforce self-belief.

Implications

Various theoretical and practical contributions have been highlighted in the present study. Theoretically, this study, as per the best researchers' knowledge, empirically validates a comprehensive model involving CM, MI, TQ, and MS along with the moderating role of MSE on MA in the context of management education. Theoretically, this research extends educational and motivational learning frameworks into a domain where quantitative proficiency is essential yet often undervalued. At first, the research contributed a significant educational theory by confirming that CM plays a significant role in enhancing MA among management students. While classroom management has been discussed extensively in general education literature, this study repositions CM as a vital component in business schools, particularly for improving achievement in mathematical subjects such as business statistics, quantitative methods, and financial analysis. Second, research also contributed by reinforcing motivational learning theories through the significant effect of MI on MA. These results demonstrated that when management students find MI then they are more likely to succeed academically. This contributes to the theoretical discourse on intrinsic motivation, especially in non-STEM disciplines like business, where students' disinterest in math often hampers performance. Third, this study contributed to the academic principle of validating the TQ role in the design of the students' performance. It extends the scope of constructive and teachers' efficiency principles in management education, which indicates that competent, well-prepared teachers can significantly affect students' mathematical results, even in areas that traditionally focus on deep quantitative involvement. Fourth, the study strengthened the theoretical basis for the MS and showed its direct impact on MA in management education. It suggests that self-regulated learning plans, monitoring, and evaluation of their cognitive processes, and academic structure aimed at performance in business courses should be a central theoretical construction. Lastly, most importantly, the study contributed theoretically by integrating and confirming the moderating role of MSE. MSE improves the effect of CM, MI, TQ, and MS on MA, and provides strong theoretical evidence to maintain self-confidence and confidence in the center of educational models in vocational education. It adds significant depth to educational motivation, cognitive development, and learning efficiency within the multi-dimensional modeling roles professional study.

Practically, the study first contributed by highlighting the need for effective CM in business schools. Faculty should receive training in maintaining structured, disciplined, and responsive learning environments that raise attention and reduce cognitive load, thereby improving performance in complex subjects like mathematics and business modeling. Secondly, the study contributed practical

strategies for increasing MI among management students. This can be achieved by linking mathematical content with real-world applications in entrepreneurship, investment planning, marketing analytics, and logistics. Such contextual learning can help students appreciate the relevance of mathematics and encourage deeper engagement. Thirdly, the study contributed by emphasizing the importance of TQ in mathematical achievement. Business schools must adopt rigorous faculty development frameworks that not only emphasize subject-matter expertise but also strengthen teaching pedagogy, communication, and assessment skills. High-quality instruction ensures that abstract quantitative content becomes accessible and applicable to students in management programs. Fourthly, this research contributed by advocating for the integration of MS into academic development programs. Workshops and interventions that teach students how to regulate their learning, reflect on their problem-solving approaches, and adjust their strategies can lead to significant improvements in academic performance, especially in mathematics-focused management subjects. Lastly, the study made a pivotal contribution by demonstrating the practical importance of MSE as a moderator. Since MSE strengthens the effect of CM, MI, TQ, and MS on MA. Therefore, institutions should focus on confidence-building initiatives. These strategies can involve tailored feedback, structured goal-setting initiatives, peer-assisted learning, and recognizing small achievements—all aimed at strengthening students' confidence in their mathematical abilities. Enhancing MSE is not merely a psychological gain it directly boosts academic outcomes and prepares management students for data-driven decision-making in professional settings.

Conclusion and Future Directions

Mathematical knowledge is important for management students because it supports in effective decision-making, financial analysis, and strategic planning. Without mathematical knowledge, students may struggle with budgeting, data interpretation, and solving business problems. Therefore, study addresses the influence of CM, TQ, MQ, and MS on the MA of management students. Cross-sectional quantitative data were collected from 350 university management students applying purposive sampling technique. Hypothesis results shown that CM, TQ, MQ, and MS significantly increases the MA of management students. Moderating effect also positively strengthens the relationship of all exogenous and endogenous variables. These findings recommended that improving CM, TQ, and MI in mathematics could significantly enhance students' MA in management studies. Incorporating MS further boosts performance by promoting self-regulated learning. Furthermore, significant moderating effect also shown that factors such as student motivation or learning environment can enhance or weaken the impact of classroom management, teacher quality, mathematics interest, and metacognitive strategies on achievement. This suggests that interventions targeting these moderating factors can further amplify students' mathematical success, which is highlighting the need for a supportive and motivating learning context alongside effective teaching practices. Therefore, educational institutions should prioritize these factors in curriculum design and teaching practices to improve outcomes. The study has various limitations. The purposive sampling technique may reduce the generalizability of the findings to all management students. Therefore, future research could be explored using a random sampling technique to increase the generalizability of findings. Additionally, the study focused solely on university

management students, so the results may not apply to other disciplines or educational levels. Therefore, future research could be conducted with other students, such as those in computer science or physics, to increase the variability of the study results. The study used one moderating variable. Therefore, investigating additional moderating variables, such as technological tools or peer support, could provide deeper insights.

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