Non-cognitive Factors of Mathematics Achievement Among Higher Education Students in Bahrain

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The European Conference on Education 2026
Official Conference Proceedings

Abstract

This study examined the non-cognitive factors influencing mathematics achievement among higher education students in Bahrain through a descriptive-correlational design, employing correlation analysis and structural equation modeling (SEM) to test the predictive roles of mathematics anxiety, attitude towards mathematics, motivation, and learning strategies. Results indicated that students generally exhibited moderate levels of mathematics anxiety, attitude, and motivation, alongside moderately effective use of learning strategies. Correlation analysis revealed that mathematics anxiety was negatively correlated to attitude, motivation and achievement, and positively linked to learning strategies. In contrast, attitude, motivation, and learning strategies were positively associated with one another and with achievement. The best-fit SEM confirmed mathematics anxiety, attitude, and learning strategies as significant predictors of achievement. These findings underscore the importance of strengthening positive attitudes, enhancing learning strategies, and reducing anxiety to improve mathematics performance.

Keywords: non-cognitive factors**,** mathematics achievement, best-fit SEM, correlation analysis, higher education students

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Introduction

Mathematics is essential for solving real-world problems and supports advancement in fields like science, engineering, economics, and technology (Sharma, 2021). It develops critical skills such as problem-solving, critical thinking, and communication, helping students make informed decisions (Khan & Salman, 2020; Sharma, 2021; Wanamaker, 2024). Despite its importance, achieving proficiency in mathematics remains a global challenge, with recent reports emphasizing the need for educational reforms to improve math achievement and support both individual and societal progress (Seagull, 2024).

In the 2023 Trends in International Mathematics and Science Study (TIMSS), several countries consistently outperformed others in both fourth and eighth grade mathematics, with many exceeding the international average, while some regions performed below it. Within the Gulf Cooperation Council, Bahrain ranked mid-range for both grades but remained below the international average, underscoring the need for continued educational improvements (von Davier et al., 2024).

Bahrain's performance in the TIMSS from 2003 to 2023 shows overall improvement in mathematics achievement up to 2019 at both fourth- and eighth-grade levels, followed by declines through 2023, with some earlier fluctuations (von Davier et al., 2024). Regionally, Bahrain ranked among the top Gulf Cooperation Council (GCC) countries, although all GCC nations remained below the international average. Despite progress and ongoing government reforms in curriculum, teacher training, and policy, Bahrain's mathematics achievement still falls short of global standards, highlighting the need for continued improvement.

Mathematics anxiety remains a significant issue in education, negatively affecting students' learning experiences, well-being, and long-term engagement with mathematics, with evidence showing a notable increase in anxiety levels across OECD countries between 2012 and 2022 (Earp, 2024; OECD, 2024). Students' attitudes and confidence toward mathematics are equally important, as low confidence can limit lifelong learning and reduce interest in math-related careers (OECD, 2024). Motivation further influences achievement, as confident students tend to be more intrinsically motivated and use effective learning strategies, while less confident students rely more on extrinsic factors, though many still recognize the value of mathematics (OECD, 2024). In the context of Bahrain educational landscape, mathematics anxiety, attitude towards mathematics, and learning strategies remain an underexplored area of study. No research has been conducted to explore students' motivation in connection to learning mathematics.

Despite extensive research on mathematics anxiety, attitudes, motivation, and learning strategies, studies often examine these factors in isolation, leaving a gap in understanding their combined and interactive effects on academic achievement. This gap is more evident in the Gulf Cooperation Council (GCC) region, particularly in Bahrain, where limited and outdated research has explored these non-cognitive factors among higher education students. Moreover, the lack of advanced statistical techniques in existing studies further restricts the depth and reliability of findings, highlighting the need for more comprehensive and methodologically robust research.

This study is anchored on theories explaining key non-cognitive factors influencing mathematics achievement. Mathematics anxiety is framed by the deficit theory and the debilitating anxiety model, which explain how poor performance and cognitive interference contribute to anxiety (Brooks, n.d.). Attitudes toward mathematics are grounded in Ajzen's Theory of Planned Behavior, emphasizing affective, cognitive, and behavioral dimensions that influence students' engagement with mathematics (Ajzen, 1991; Fennema & Sherman, 1978; Mohr-Schroeder et al., 2017; Sengül & Dereli, 2013). Motivation is supported by expectancy-value theory, self-determination theory, and self-efficacy theory, highlighting the roles of expectations, intrinsic and extrinsic factors, and beliefs in one's abilities (Bandura, 1985; Eccles et al., 1993; Ryan & Deci, 2000). Learning strategies are supported by metacognitive, social learning, and experiential learning theories, which emphasize cognitive regulation, observation, and experience-based learning (Bandura, 1985; Kolb, 1984). The overall framework of the study is further substantiated by Ajzen's Theory of Planned Behavior (TPB), which provides a foundation for understanding how students' attitudes, motivation, anxiety, and learning strategies influence mathematics achievement.

The study addressed the following questions: What is the extent of mathematics achievement of higher education students in Bahrain in terms of final course grades; what is the level of non-cognitive factors in terms of (a) mathematics anxiety, (b) attitude towards mathematics, (c) motivation, and (d) learning strategies; is there a significant relationship between and among mathematics achievement and these non-cognitive factors; and what is the best-fit structural equation model for mathematics achievement as influenced by mathematics anxiety, attitude towards mathematics, motivation, and learning strategies?

Literature Review

Mathematics Achievement

Academic achievement is a widely researched topic in education, psychology, and social sciences, as it serves as a key indicator of student success and future opportunities. According to Moss & Moss-Racusin (2021), it refers to an individual's scholastic accomplishment, distinct from innate intelligence. Mathematics achievement is a construct used to represent the level or nature of demonstrated learning in relation to a specified domain of mathematics. It is typically evaluated using standardized tests or structured assessment methods (Shear, 2020). Numerous studies have been conducted to examine the factors influencing mathematics achievement. Villa and Sebastian (2021) demonstrated that achievement motivation plays a crucial role in predicting students' performance in mathematics. Complementing this, Abin et al. (2020) highlighted cognitive, motivational, and emotional components as significant determinants of mathematics achievement, showing that a model integrating these factors accounted for considerable differences in students' math performance. Additionally, previous academic performance in mathematics, as well as critical and creative thinking skills, have been identified as predictors of math achievement (Fernández-Cézar et al., 2021). Moreover, Mendaje (2018) found that students' level of learning engagement and sustained participation in mathematics learning were significantly and positively associated with mathematics achievement, suggesting that learning-related factors contribute to improved mathematical performance.

Mathematics Anxiety

Mathematics anxiety is the feeling of tension, fear, and apprehension experienced when engaging in mathematical tasks, which can impair performance and lead to avoidance of mathematics-related activities (Ashcraft, 2002; Hembree, 1990; Richardson & Suinn, 1972). It may occur as a temporary state during mathematical tasks or as a persistent trait that influences long-term attitudes and behaviors toward mathematics (Buckley et al., 2016). As a multidimensional construct involving emotional, cognitive, physical, and behavioral responses, mathematics anxiety negatively affects students' attitudes, learning, and achievement in mathematics (Caviola et al., 2019; Sangaram & Maat, 2020; Telaumbanua et al., 2023).

Attitude Towards Mathematics

Attitude toward mathematics is a multidimensional construct that encompasses students' cognitive, emotional, and behavioral dispositions toward the subject (Wen & Dubé, 2022). It includes key components such as self-confidence, perceived value, and enjoyment, which influence students' engagement and achievement in mathematics (Tapia & Marsh, 2002). Students with greater confidence, stronger perceptions of the value of mathematics, and higher enjoyment are more likely to participate actively in learning, persist in mathematical tasks, and achieve better academic outcomes (OECD, 2024).

Motivation

Motivation refers to the psychological processes that initiate, direct, and sustain goal-oriented behavior, influencing students' effort, persistence, and academic performance (Lens & Vansteenkiste, 2020; Schunk & DiBenedetto, 2020). It may be intrinsic or extrinsic and is particularly important in mathematics, where perseverance and self-discipline are essential for success (Kumar, 2020). Research by Davidovitch and Dorot (2023) further showed that motivation is positively associated with age and academic performance, with undergraduate students demonstrating higher motivation than high school students.

Learning Strategies

Learning strategies are cognitive processes and behaviors employed by learners to enhance their academic achievement. They can be classified into basic strategies used by younger children and advanced strategies developed by older students, involving metacognition (Yip, 2019). However, students' strategy use varies depending on factors such as assessment activities, and those with low academic performance often struggle with organization and strategy knowledge (García-Pérez et al., 2020). Importantly, the ability to transfer deep learning strategies between courses is associated with higher grades, while continued use of surface strategies may lead to lower achievement. These findings emphasize the need for educators to support students in developing and transferring effective learning strategies, particularly in problem-based learning environments (Saqr et al., 2023).

Relationship Between Mathematics Anxiety and Mathematics Achievement

The reviewed studies consistently show that mathematics anxiety is negatively associated with mathematics achievement, whereas positive attitudes toward mathematics are generally linked to better academic performance. Meta-analyses and empirical studies (e.g., Baral et al., 2025; Caviola et al., 2022; Zhang et al., 2019) found that higher mathematics anxiety leads to lower achievement, although motivation, working memory, age, and other cognitive and psychological factors also influence performance. Similarly, studies by Dowker and Sheridan (2022), Hwang and Son (2021), and Kiwanuka et al. (2020) reported that positive attitudes toward mathematics support higher achievement, while Libradilla et al. (2023) found no significant relationship, suggesting that the effect of attitudes may vary across contexts.

Overall, the evidence highlights the importance of reducing mathematics anxiety and fostering positive attitudes to enhance students' mathematics achievement.

Relationship Between Motivation and Mathematics Achievement

Several studies have identified motivation as an important factor influencing mathematics achievement. Students with higher intrinsic and extrinsic motivation, self-efficacy, goal orientation, and educational aspirations demonstrated greater engagement and better academic performance (Akayuure & Akayuure, 2024; Asanre, 2024; Jehadus et al., 2022; Ovella, 2023; Shum & Fryer, 2023). Similarly, Bakar et al. (2022) and Oluyomi et al. (2024) confirmed the positive influence of motivation on achievement, highlighting its important role in enhancing students' success in mathematics.

Relationship Between Learning Strategies and Mathematics Achievement

Research on mathematics education consistently emphasizes the importance of learning strategies in enhancing students' academic performance. Effective learning strategies, including cognitive, self-regulated, metacognitive, and effort management strategies, were consistently associated with higher mathematics achievement and improved academic performance (Almoslamani, 2022; Ha et al., 2023; Liebendörfer et al., 2022; Okudan & Yeşilyurt, 2023; Wild & Neef, 2023). These findings highlight the importance of fostering effective learning strategies to enhance students' success in mathematics.

Relationship Between Mathematics Anxiety and Attitude Towards Mathematics

Research consistently highlights the close relationship between mathematics anxiety and attitudes toward mathematics. Caputol and Chan (2024) found that attitudes toward mathematics significantly influence mathematics anxiety, emphasizing the role of students' emotional and perceptual experiences in shaping anxiety. Similarly, Alias et al. (2023) and Tuncer and Yilmaz (2020) reported a significant negative relationship between mathematics anxiety and attitudes, suggesting that reducing anxiety may foster more positive attitudes and improve academic achievement.

Relationship Between Mathematics Anxiety and Motivation

The relationship between mathematics anxiety and motivation has been widely examined in mathematics education research. Schukajlow et al. (2023) found that higher motivation helps reduce the negative effects of mathematics anxiety on learning and performance. Similarly, Süren and Kandemir (2020) and Supriadi et al. (2024) reported significant relationships between mathematics anxiety and motivation, indicating that stronger motivation may help mitigate anxiety and support better mathematical learning.

Relationship Between Mathematics Anxiety and Learning Strategies

Several studies have examined the relationship between mathematics anxiety and learning strategies, with mixed findings. Caputol and Chan (2024) and Marticion (2021) found significant positive relationships between mathematics anxiety and learning strategies, particularly motivated learning, self-regulation, and effort regulation. In contrast, Gursel et al. (2023) reported no significant relationship between mathematics anxiety and students' self-regulated learning strategies, suggesting that this relationship may vary across educational contexts.

Relationship Between Attitude Towards Mathematics and Motivation

Ampadu and Anokye-Poku (2022) investigated the influence of personal, motivational, and learning environment factors on students' attitudes toward mathematics among junior secondary school students. The study found that students generally had positive attitudes toward mathematics, which were positively associated with academic achievement and supported by motivation, self-efficacy, and a positive learning environment.

Relationship Between Attitude Towards Mathematics and Learning Strategies

The association between attitudes toward mathematics and learning strategies has received considerable attention in recent research. Siller and Ahmad (2024) found that collaborative learning strategies improved both mathematics achievement and students' attitudes toward mathematics. Similarly, Caputol and Chan (2024) and Pizon and Ytoc (2021) reported significant positive relationships between learning strategies and attitudes, suggesting that effective learning approaches contribute to more positive perceptions of mathematics.

Relationship Between Motivation and Learning Strategies

Molnár and Kocsis (2023) studied academic achievement in higher education by examining cognitive and non-cognitive factors. The study found that learning motivation and learning strategies positively predicted academic achievement and were positively correlated with each other, while learning attitudes were also positively associated with learning motivation.

Methodology

Research Design

This study utilized quantitative, non-experimental research design, specifically descriptive-correlational methodology to investigate the factors that would influence the mathematics achievement of higher education students in Bahrain. Strunk and Mwavita (2024) note that quantitative research involves the use of structured tools, such as surveys and experiments, to collect data that can be quantified. Bryman (2016) explained that quantitative design is characterized by its emphasis on measurement, statistical analysis, and the use of large samples to ensure the generalizability of findings. The descriptive-correlation design is a quantitative research approach that is used to explore relationships or associations between two or more variables without establishing causality (Salkind, 2017). This approach does not infer causation but rather identifies the degree and direction of relationships. This is essential for generating insights that could guide further research or practical applications (Creswell & Creswell, 2018).

The descriptive components of this study aimed to provide a comprehensive analysis of the respondents' levels or extent in five key areas: mathematics anxiety, motivation, attitude towards mathematics, learning strategies, and mathematics achievement. Specifically, it examined mathematics achievement in terms of mathematics course final grades, mathematics anxiety in terms of learning math anxiety and math evaluation anxiety, and attitudes towards mathematics in terms of self-confidence, value, and enjoyment.

Furthermore, the descriptive component evaluated motivation through dimensions such as intrinsic and extrinsic goal orientation, task value, control of learning beliefs, and self-efficacy for learning and performance. Additionally, it investigated the extent to which learning strategies were employed, encompassing rehearsal, elaboration, organization, critical thinking, metacognitive self-regulation, time and study environment, effort regulation, peer learning, and help seeking. The correlational aspect of the study aimed to explore how mathematics anxiety, mathematical attitudes, motivation, and learning strategies are interconnected.

Bahrain Polytechnic was selected as the primary locale for this study within Bahrain's higher education sector, which consists of 16 institutions, including 2 public (12.5%) and 14 private (87.5%) universities, with the Polytechnic representing 6.25% of the total. The study utilized data from students enrolled at Bahrain Polytechnic who reside across various governorates, ensuring diverse representation, with primary data collected through standardized and previously validated survey instruments measuring mathematics anxiety, motivation, attitude towards mathematics, and learning strategies. In addition, secondary data were obtained from institutional records, including final mathematics course grades and assessment results, to support the analysis of students' mathematics achievement.

Participants

The respondents were 227 students enrolled in the Statistics and Data Analysis course at the School of Foundation, Bahrain Polytechnic, during the second semester of AY 2024–2025. Selected from a population of 594 students, they represented learners progressing to Business, Logistics, Web Media, and Visual Design programs, with the course historically recording the lowest passing rate among mathematics courses. The adequacy of the sample size was validated using Soper's (2021) a priori SEM sample size calculator based on an anticipated effect size of 0.30, statistical power of 0.80, five latent variables, twenty-two observed variables, and a 0.05 significance level, which recommended a minimum sample size of 150. The final sample of 227 respondents exceeded this requirement and the recommended minimum for SEM, supporting the reliability and stability of the model estimates.

Research Instrument

Mathematics anxiety was measured using the Abbreviated Math Anxiety Scale (AMAS), a 9-item Likert-scale instrument consisting of Learning Math Anxiety (5 items) and Math Evaluation Anxiety (4 items), rated from 1 (low anxiety) to 5 (high anxiety) (Hopko et al., 2003). Students' attitudes toward mathematics were assessed using the ATMI-Short, a 20-item instrument measuring self-confidence, value, and enjoyment on a five-point Likert scale (Lim & Chapman, 2013; Tapia & Marsh, 2002). The motivation and learning strategies of students were measured using the Motivated Strategies for Learning Questionnaire (MSLQ), an 81-item instrument covering motivation and learning strategy domains on a seven-point Likert scale (Pintrich et al., 1993). The motivation indicator of ATMI-Short and the test anxiety indicator of MSLQ were excluded since these constructs were measured using separate instruments.

Data Collection and Procedure

The data collection process was conducted using Google Forms, where all survey instruments, including the AMAS, ATMI, and MSLQ, were consolidated into a single form to ensure simplicity and minimize respondent confusion, while preserving the original item formats and scaling of each validated instrument; clear instructions were provided at the beginning to guide participants. Invitations were sent via institutional email, including a brief description of the study, a unique survey link, and attached informed consent and participant information forms, with a reminder issued midway through the data collection period to improve response rates. Upon completion, all responses were securely downloaded, stored in a password-protected file, and handled with strict confidentiality to prevent unauthorized access.

Analysis of Data

Mean and summation are used to determine the extent of mathematics proficiency, the level of mathematics anxiety, the level of motivation, and the extent of employing different learning strategies.

Pearson correlation was used to determine the relationships between and among Mathematics achievement and the non-cognitive factors.

Structural Equation Modeling using SPSS AMOS was utilized to identify the best-fit structural equation model of mathematics achievement. Specifically, the analysis evaluated the bivariate relationships among the variables, the direct influence of mathematics anxiety on mathematics achievement, and the mediating role of mathematics anxiety in the relationships between attitude towards mathematics and mathematics achievement. To determine if the model is over-identified, the number of distinct sample moments is calculated using the formula

$$\frac{p(p+1)}{2} \tag{1}$$

and compared it with the number of free parameters. After confirming that the model is over-identified, the data were screened to ensure that key SEM assumptions were satisfied prior to estimation. Multivariate normality, a fundamental requirement for maximum likelihood estimation (MLE), was assessed using Mardia's coefficient of multivariate kurtosis in AMOS, and any violation was addressed through bootstrapping to obtain bias-corrected parameter estimates and robust standard errors, thereby improving the reliability of inference under non-normal conditions (Nevitt & Hancock, 2001). In this study, bootstrapping involved 5,000 replications with replacement while maintaining the original sample size ($n = 227$), as this number is recommended for stable estimation of confidence intervals and reduced sampling variability (Bollen & Stine, 1990; Efron & Tibshirani, 1993; Nevitt & Hancock, 2001; Preacher & Hayes, 2008). Multicollinearity was assessed using variance inflation factor (VIF), tolerance values, and correlation coefficients among predictors, with values above 0.85 to 0.90 indicating potential issues (Kline, 2016), while outliers were examined using standardized scores with cut-off values of ± 3 (Tabachnick & Fidell, 2019). The adequacy of the sample size was confirmed using Soper's (2021) a priori SEM calculator and supported by the minimum recommendation of 200 cases (Boomsma, 1982).

Ethical Considerations

The study adhered to ethical standards for research involving human participants by obtaining approval from the Research Ethics Committee of Bahrain Polytechnic and the University Research Ethics Committee of Don Mariano Marcos Memorial State University (DMMMSU), along with the necessary institutional permissions. Participation was voluntary, with informed consent obtained from all respondents. Confidentiality and anonymity were ensured by excluding personally identifiable information, anonymizing all data, restricting access to the researcher, and securely storing digital files in accordance with institutional ethical guidelines.

Results and Discussion

Mathematics Achievement of Higher Education Students

Table 1 presents the means and passing rate of the respondents enrolled in AP5101 (Statistics and Data Analysis) during Semester 2, AY 2024-2025. Overall, the course achieved a final passing rate of 95.15% (216 out of 227), which is slightly higher than the institutional passing rate of 94.29%.

Table 1
Means and Passing Rate of Respondents Enrolled in AP5101 (Statistics and Data Analysis) Course During Semester 2, AY 2024–2025

Assessment	Mean	Pass	%	Fail	%
Midterm	74.30	181	79.74	46	20.26
Project	90.19	222	97.80	5	2.20
Final	80.13	204	89.87	23	7.93
Final Grade		216	95.15	11	2.64
Institutional Passing Rate			**94.29%**		

Level of Non-cognitive Factors of Higher Education Students in Bahrain

Level of Mathematics Anxiety

The overall level of mathematics anxiety is displayed in Table 2. The results show that Learning Math Anxiety was classified as Mild Anxiety with a mean of 2.57, while Math Evaluation Anxiety was rated higher at the Moderate Anxiety level with a mean of 3.12. When combined, the overall mean of 2.82 corresponds to Moderate Anxiety, indicating that students generally experience a manageable but consistent level of worry in mathematics.

Table 2
Overall Level of Mathematics Anxiety

Indicator	Mean	Descriptive Level
1. Learning Math Anxiety	2.57	Mild Anxiety
2. Math Evaluation Anxiety	3.12	Moderate Anxiety
Overall	**2.82**	Moderate Anxiety

Note. Legend: 1.00 – 1.80 (Low Anxiety), 1.81 – 2.60 (Mild Anxiety), 2.61 – 3.40 (Moderate Anxiety), 3.41 – 4.20 (High Anxiety), 4.21 – 5.00 (Very High Anxiety)

Level of Attitude Towards Mathematics

Table 3 summarizes the overall level of attitude towards mathematics across the three indicators. The results show that Enjoyment (M = 3.22) and Self-Confidence (M = 3.12) were both rated as Moderate Attitude, while Value obtained the highest mean (M = 3.50) and was classified as a Positive Attitude. When combined, the overall mean score of 3.28 corresponds to a Moderate Attitude.

Table 3
Overall Level of Attitude Towards Mathematics

Indicator	Mean	Descriptive Level
1. Enjoyment	3.22	Moderate Attitude
2. Self-Confidence	3.12	Moderate Attitude
3. Value	3.50	Positive Attitude
Overall	**3.28**	Moderate Attitude

Note. Legend: 1.00 – 1.80 (Very Negative Attitude), 1.81 – 2.60 (Negative Attitude), 2.61 – 3.40 (Moderate Attitude), 3.41 – 4.20 (Positive Attitude), 4.21 – 5.00 (Very Positive Attitude)

Level of Motivation

Table 4 presents the overall level of motivation of higher education students in Bahrain across five indicators. The results show that Intrinsic Goal Orientation (M = 3.85), Task Value (M = 4.16), and Control of Learning Beliefs (M = 4.18) all fall within the category of Moderate Motivation. On the other hand, Extrinsic Goal Orientation (M = 4.88) and Self-Efficacy for Learning and Performance (M = 4.50) stand out as Slightly High Motivation.

Table 4
Overall Level of Motivation

Indicator	Mean	Descriptive Level
1. Intrinsic Goal Orientation	3.85	Moderate Motivation
2. Extrinsic Goal Orientation	4.88	Slightly High Motivation
3. Task Value	4.16	Moderate Motivation
4. Control of Learning Beliefs	4.18	Moderate Motivation
5. Self-Efficacy for Learning and Performance	4.50	Slightly High Motivation
Overall	**4.34**	Moderate Motivation

Note. Legend: 1.00 – 1.85 (Very Low Motivation), 1.86 – 2.71 (Low Motivation), 2.72 – 3.57 (Slightly Low Motivation), 3.58 – 4.43 (Moderate Motivation), 4.44 – 5.29 (Slightly High Motivation), 5.30 – 6.15 (High Motivation), 6.16 – 7.00 (Very High Motivation)

Level of Learning Strategies

Table 5 summarizes the overall level of learning strategies across nine indicators. The results show that all components which constitute Rehearsal (M = 4.30), Elaboration (M = 4.26), Organization (M = 4.31), Critical Thinking (M = 4.10), Metacognitive Self-Regulation (M = 4.24), Time and Study Environment (M = 4.34), Effort Regulation (M = 4.42), Peer Learning (M = 4.38), and Help Seeking (M = 4.32) were consistently rated as Moderately Effective Use of Learning Strategies. Among these, Effort Regulation obtained the highest mean, while

Critical Thinking registered the lowest, though all remained within the same descriptive category.

Table 5
Overall Level of Learning Strategies

Indicator	Mean	Descriptive Level
1. Rehearsal	4.30	Moderately Effective Use of Learning Strategies
2. Elaboration	4.26	Moderately Effective Use of Learning Strategies
3. Organization	4.31	Moderately Effective Use of Learning Strategies
4. Critical Thinking	4.10	Moderately Effective Use of Learning Strategies
5. Metacognitive Self-Regulation	4.24	Moderately Effective Use of Learning Strategies
6. Time and Study Environment	4.34	Moderately Effective Use of Learning Strategies
7. Effort Regulation	4.42	Moderately Effective Use of Learning Strategies
8. Peer Learning	4.38	Moderately Effective Use of Learning Strategies
9. Help Seeking	4.32	Moderately Effective Use of Learning Strategies
Overall	**4.29**	Moderately Effective Use of Learning Strategies

Note. Legend: 1.00 – 1.85 (Highly Ineffective Use of Learning Strategies), 1.86 - 2.71 (Ineffective Use of Learning Strategies), 2.72 – 3.57 (Slightly Ineffective Use of Learning Strategies), 3.58 – 4.43 (Moderately Effective Use of Learning Strategies), 4.44 – 5.29 (Effective Use of Learning Strategies), 5.30 – 6.15 (Highly Effective Use of Learning Strategies), 6.16 – 7.00 (Very Highly Effective Use of Learning Strategies)

Relationship Between and Among Mathematics Achievement and Non-cognitive Factors

Table 6 presents the correlation analysis among mathematics achievement and selected non-cognitive factors, showing several statistically significant relationships at the 0.05 level with varying strengths. Mathematics achievement has a weak positive and statistically significant correlation with motivation ($r = 0.374$) and learning strategies ($r = 0.306$), and a moderate positive and statistically significant correlation with attitude towards mathematics ($r = 0.498$).

In contrast, mathematics anxiety is weakly negative and statistically significantly correlated with mathematics achievement ($r = –0.288$). Similarly, mathematics anxiety shows weak negative and statistically significant relationships with attitude ($r = –0.209$) and motivation ($r = –0.253$), while it has a very weak positive yet statistically significant correlation with learning strategies ($r = 0.149$). Moreover, attitude towards mathematics had a moderate positive and significant relationship with motivation ($r = .433$), while its relationship with learning strategies was weak but positive and significant ($r = .357$). Meanwhile, motivation had a moderate positive and significant relationship with learning strategies ($r = .422$).

Table 6
Significance of the Relationship Between and Among Mathematics Achievement and Non-cognitive Factors

Indicators	Mathematics Achievement	Mathematics Anxiety	Attitude Towards Mathematics	Motivation	Learning Strategies
Mathematics Achievement	1				
Mathematics Anxiety	-0.288*	1			
Attitude Towards Mathematics	0.498*	-0.209*	1		
Motivation	0.374*	-0.253*	0.433*	1	
Learning Strategies	0.306*	0.149*	0.357*	0.422*	1

Note. *correlation is significant at 0.05

Best-Fit Structural Equation Model for Mathematics Achievement as Influenced by Non-cognitive Factors

The initial model, developed using SPSS Amos, hypothesizes the relationships among five latent constructs influencing mathematics achievement: Attitude Towards Mathematics, Motivation, Learning Strategies, Mathematics Anxiety, and Mathematics Achievement. The model consists of 22 observed indicators and 54 free parameters, with direct paths to Mathematics Achievement and bi-directional correlations among the non-cognitive predictors. With 253 distinct sample moments exceeding the 54 parameters to be estimated, the model is over-identified, allowing the assessment of model fit and the evaluation of the hypothesized relationships.

After confirming that the model was over-identified, the data were screened to ensure that the assumptions for SEM were met. Mardia's coefficient of multivariate kurtosis (128.086; critical ratio = 29.693) indicated a violation of multivariate normality (Byrne, 2016; Kline, 2016), necessitating the use of bootstrapping with 5,000 resamples in AMOS to obtain bias-corrected estimates and robust standard errors.

The bootstrap results demonstrated stable model estimation across 5,000 resamples, with consistent maximum likelihood discrepancy values and low Kullback–Leibler overoptimism. These findings indicate good model stability, low sampling variability, and robust parameter estimation.

To assess multicollinearity, variance inflation factor (VIF) values were all below 10, tolerance values exceeded 0.10, and correlations among the observed variables were below 0.85. These results indicate that multicollinearity was not a concern, allowing reliable estimation of the model parameters (Hair et al., 2020).

The standardized scores of all observed variables were within the acceptable range of ± 3, indicating the absence of problematic outliers. Consequently, all observations were retained for the SEM analysis.

The sample size of 227 was adequate based on Soper's (2021) a priori SEM sample size calculator, which recommended a minimum of 150 participants under the specified model conditions. The sample also exceeded the recommended minimum of 200 cases for reliable SEM analysis (Boomsma, 1982), supporting stable and valid parameter estimates.

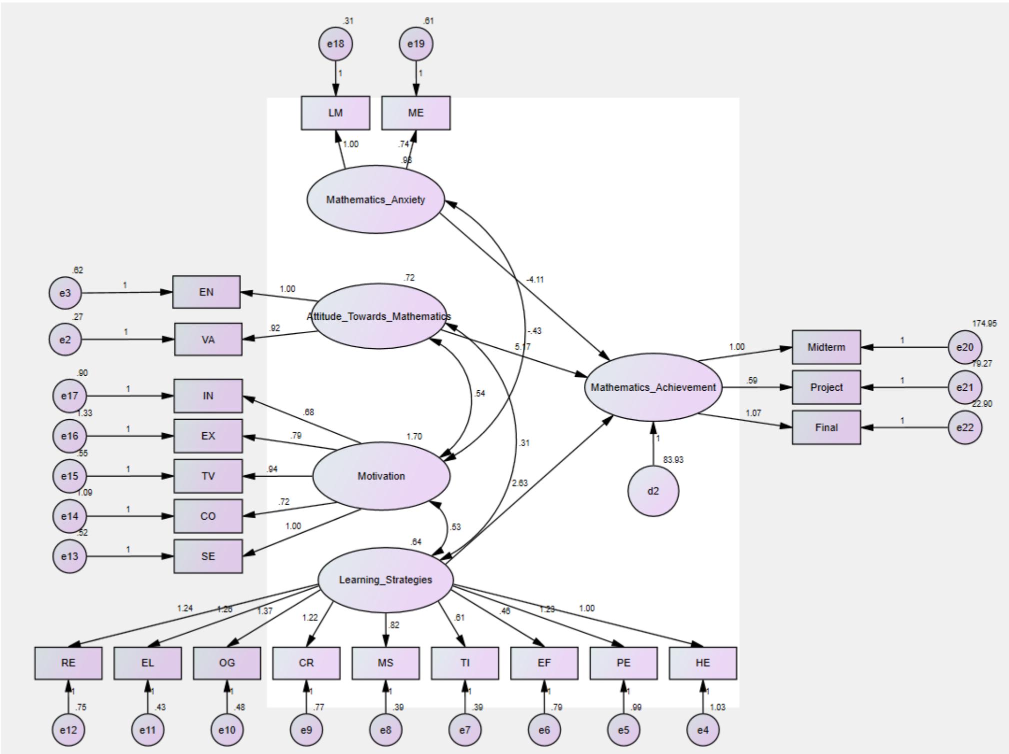
After confirming model identification and assumption testing, all 54 free parameters were estimated simultaneously using the Maximum Likelihood (ML) method with bootstrap corrections to obtain robust parameter estimates under non-normality (Nevitt & Hancock, 2001). All observed indicators loaded significantly on their respective latent constructs except Self-Confidence, which showed a weak and non-significant loading and was therefore removed to improve the measurement model. The remaining indicators demonstrated significant factor loadings, positive variances, and no evidence of Heywood cases, supporting the adequacy of the measurement model.

The structural model showed that Attitude Towards Mathematics, Learning Strategies, and Mathematics Anxiety were significant predictors of Mathematics Achievement, whereas Motivation was not. Consistent with the recommendations of Teo et al. (2013), the non-significant paths were removed to obtain a more parsimonious model. The revised model as shown in Figure 1 consisted of five latent constructs, 21 observed variables, and 51 free parameters, remaining over-identified and suitable for model fit evaluation.

Following the estimation of the hypothesized model, the revised model was evaluated for its adequacy in representing the observed data. All indicators loaded significantly on their respective latent constructs, while the structural model showed that Mathematics Anxiety negatively predicted Mathematics Achievement, whereas Attitude Towards Mathematics and Learning Strategies exerted significant positive effects. These findings indicate that the revised model adequately represents the hypothesized relationships among the constructs.

The initial model demonstrated only a marginally acceptable fit to the data ($\chi^2 = 551.455$, $\chi^2/df = 2.771$, CFI = .853, TLI = .829, RMSEA = .089, SRMR = .0790). After model revision, the fit indices improved ($\chi^2 = 470.681$, $\chi^2/df = 2.615$, CFI = .875, TLI = .854, RMSEA = .085, SRMR = .0661), indicating a more satisfactory representation of the data, although some indices remained below the recommended thresholds.

Figure 1
Revised Mathematics Achievement Model



Following the recommendations of Byrne (2016) and Kline (2016), model modification was guided by both statistical evidence and theoretical justification. Non-significant covariances between Mathematics Anxiety and Attitude Towards Mathematics (Estimate = –.027, p = .701) and between Mathematics Anxiety and Learning Strategies (Estimate = .072, p = .244) were removed to improve model parsimony. In addition, theoretically justifiable error covariances were added within the Learning Strategies construct (e6–e7, e4–e5, e6–e11, e6–e9, and e6–e8), consistent with recommended SEM practices (Byrne, 2016; Kline, 2016).

Sequentially adding theoretically justifiable error covariances within the Learning Strategies construct resulted in substantial improvements in model fit. The largest improvement was obtained by adding the covariance between e6 ↔ e7 (M.I. = 77.706), which improved the fit indices to χ^2 = 380.788, χ^2/df = 2.104, CFI = .914, TLI = .900, RMSEA = .070, and SRMR = .0623. Adding e4 ↔ e5 (M.I. = 27.945) further improved the model (χ^2 = 351.608, χ^2/df = 1.953, CFI = .926, TLI = .914, RMSEA = .065, SRMR = .0611), while the addition of e6 ↔ e8 (M.I. = 16.161) produced the final acceptable fit (χ^2 = 337.283, χ^2/df = 1.884, CFI = .932, TLI = .920, RMSEA = .063, SRMR = .0599).

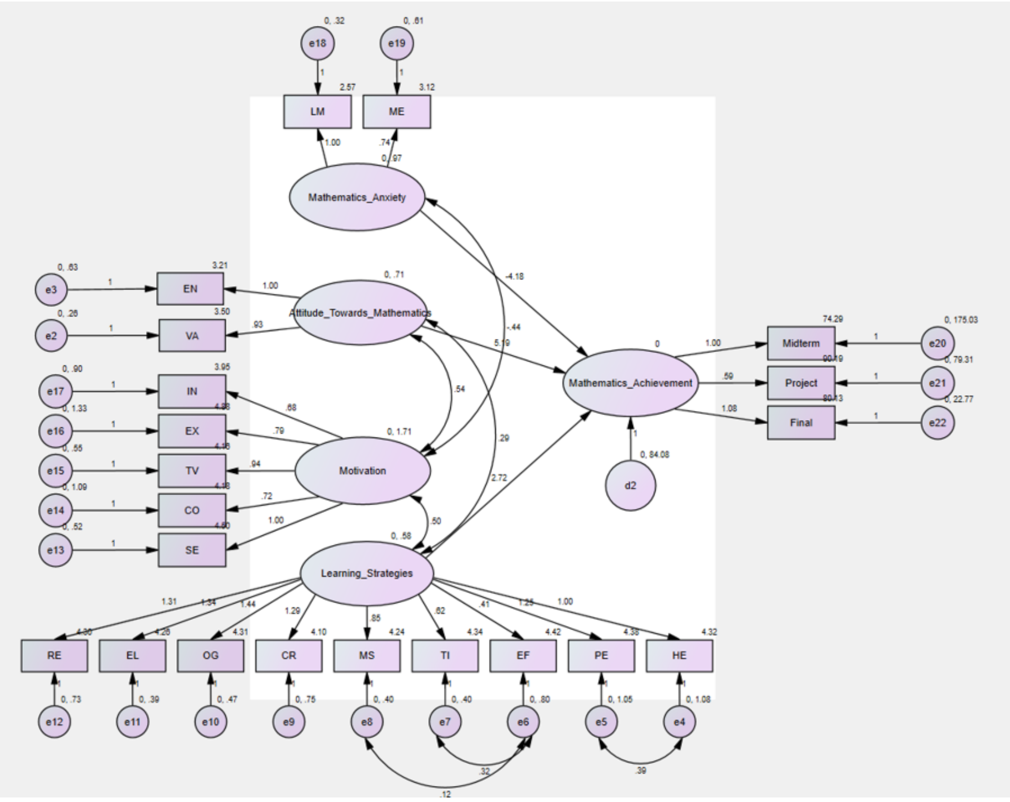
Although additional covariances between e6 ↔ e9 (M.I. = 12.859) and e6 ↔ e11 (M.I. = 10.427) were suggested, they produced only minimal improvements in model fit and were therefore not retained to preserve model parsimony. This decision is consistent with the recommendations of Byrne (2016) and Kline (2016), who emphasized that model modifications should be theoretically justified and should avoid unnecessary model complexity.

The final model as shown in Figure 2 demonstrated a substantially better fit than the revised model. The chi-square decreased from 470.681 (χ^2/df = 2.615) to 337.283 (χ^2/df = 1.884), while SRMR improved from .0661 to .0599 and RMSEA decreased from .085 to .063.

Likewise, the incremental fit indices increased from CFI = .875 and TLI = .854 to CFI = .932 and TLI = .920, exceeding the recommended .90 threshold and indicating an acceptable model fit.

The final model consists of five latent constructs and 21 observed variables, with correlated error terms among selected Learning Strategies indicators (e.g., MS–EF, TI–EF, and PE–HE) to account for shared measurement variance.

Figure 2
Final Mathematics Achievement Model



Limitations of the Study

This study is limited by its focus on a single institution, Bahrain Polytechnic, which may restrict the generalizability of the findings to other higher education contexts in Bahrain or beyond. Additionally, the reliance on self-reported questionnaire data may introduce response bias, particularly in measuring non-cognitive constructs such as anxiety, motivation, and learning strategies. Although validated instruments were used, their applicability within the specific cultural and institutional context may still pose constraints.

Conclusion

Based on the findings of the study, it is concluded that students demonstrated strong mathematics achievement, meeting and even exceeding institutional expectations. However, they exhibited only average levels of mathematics anxiety, attitude towards mathematics, motivation, and learning strategy use, indicating that their potential for higher achievement remains underutilized. The significant relationships among these non-cognitive factors suggest that improvements in one area, such as attitude or motivation, can positively influence the others and collectively enhance mathematics performance. Overall, the findings confirm that mathematics achievement is shaped by a combination of mathematics anxiety, attitude towards mathematics, and learning strategies, highlighting the important role of these non-cognitive factors in students' academic success.

In light of the findings, the institution should sustain the effective instructional practices that contributed to student achievement while strengthening support for students' non-cognitive development through evidence-based programs targeting mathematics anxiety, attitudes, motivation, and learning strategies. Integrating effective learning strategies into the curriculum and developing context-specific assessment instruments can further enhance teaching, learning, and institutional decision-making. Future research should involve larger and more diverse samples, examine additional factors influencing mathematics achievement, and ensure instrument validity through pilot testing and confirmatory factor analysis to produce more robust and generalizable findings.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the author used ChatGPT (OpenAI) solely to assist with language editing, grammar correction, sentence restructuring, and improving the clarity and readability of the text. The AI-assisted tool was not used to generate research ideas, collect or analyze data, interpret results, or formulate the study's conclusions. All aspects of the research, including the study design, methodology, data collection, statistical analyses, interpretation of findings, and final conclusions, were independently conducted and critically reviewed by the author, who assumes full responsibility for the accuracy, originality, and integrity of the work.

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