

UNDERSTANDING THE IMPACT OF MATHEMATICS LEARNING MINDSET ON ACADEMIC OUTCOMES AMONG BUSINESS GRADUATES

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Abstract: Academic performance remains a critical indicator of educational success, particularly among business graduates who require strong analytical and quantitative competencies. This study examines the influence of value of mathematics, motivation towards mathematics, and enjoyment of mathematics on academic performance through the mediating role of student learning mathematics. Grounded in Expectancy-Value Theory, the study employs a quantitative research design and collects data using a structured questionnaire adapted from validated scales. Data is analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The findings reveal that value of mathematics, motivation towards mathematics, and enjoyment of mathematics significantly enhance students learning mathematics. Furthermore, students learning mathematics positively influences academic performance. The results also indicate that value of mathematics has a direct positive effect on academic performance, whereas the direct effects of motivation and enjoyment are not significant. Mediation analysis demonstrates that student learning mathematics mediates the relationships between value of mathematics and academic performance and between enjoyment of mathematics and academic performance. The study highlights the importance of fostering positive mathematics attitudes to strengthen learning outcomes and academic success among business graduates.

Introduction

Academic performance remains one of the most important indicators of educational success because it reflects students' ability to acquire knowledge, develop competencies, and achieve desired learning outcomes [3]. A major goal of educational institutions is to continue to develop an understanding of the influences on academic success, especially for students in business programs. Despite the massive efforts that have taken place in curriculum development, instructional practices and learning technologies [3, 43], a large number of students still struggle to attain satisfactory academic achievement. Such difficulties are clearly seen in subjects that require quantitative reasoning and problem-solving skills, and students show different levels of achievement in this area. This has made it important to identify factors that impact academic outcomes and concern educators, policymakers, and researchers.

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There is a strong relationship between mathematics and logical thinking, analytical reasoning and decision making skills which are very much relevant to business education [38]. Mathematical concepts often need to be applied in business fields like finance, accounting, economics, statistics and data analysis; therefore, business graduates often require these related skills. Thus, a student's perception and attitude towards mathematics could significantly affect his or her learning experiences and academic achievement [7]. Mathematics is, however, a challenging subject to many students and they feel anxious, less confident and less motivated to participate in learning activities. These negative perceptions may impede learning effectiveness and consequently have a negative impact on academic results. Positive attitudes on the other hand can motivate students to make greater effort in learning, improve problem solving skills and obtain better learning results.

The relationship between mathematics-related factors and achievement has been investigated broadly in the past [8, 14, 38]. Research indicates that students with a positive perception of the value of math are more active in learning activities and have better learning outcomes. Likewise, some studies have found that students' motivation to learn mathematics is also a factor affecting their learning behaviour [12], which affects students' willingness to persist in obstacles along with academic learning. Enjoyment of mathematics has been given significant focus as it is known that a child's enjoyment of learning mathematics is positively associated with increased activity in educational activities and commitment to learning. Moreover, students' learning experience and confidence in mathematics have been correlated to students' learning outcomes and success. Therefore, previous studies indicate an important role mathematics-related attitudes and perceptions can have in educational performance.

Although there is an increasing amount of literature available on attitudes toward mathematics and academic achievement [9, 20], there are a few areas that are still missing. First, previous research often deals with specific aspects of mathematics attitudes separately, for example, motivation, enjoyment, confidence, and perceived value. The treatment of mathematics mindset does not allow for insight into the effect that different aspects of mathematics mindset have in combination with academic results. Students' attitude towards mathematics is multidimensional and thus, studying these aspects in one integrated framework helps to understand its impact on students' performance. Secondly, previous research has tended to focus on mathematics-related attitudes' direct influence on academic outcomes rather than on the learning processes that mediate these impacts. A key mechanism is how students learning mathematics are translated into better academic outcomes, namely through positive attitudes towards mathematics. Students with positive attitudes are interested in learning and to develop healthy learning habits, confidence and develop a positive relationship with mathematical concepts. These learning experiences may subsequently contribute to improved academic performance. But currently research related to the mediating variable, student learning mathematics, are relatively limited and thus creates an important theoretical and empirical gap. Thirdly, while mathematics attitudes have been examined in different educational settings [14, 20, 27], there is not much research that specifically examines the attitudes of business graduates towards mathematics. A growing emphasis is placed in business education on quantitative skills, and mathematics is especially applicable to students' academic and career goals.

This study aims to gain insights into the impact of various aspects of mathematics mindset on academic achievement among business graduates, which can guide educators to improve teaching effectiveness and shape the academic achievement

of business graduates. This study investigates the role of various dimensions of mathematics mindset in influencing academic achievement among business graduates, providing insights for educators to enhance teaching effectiveness and equip business graduates with academic capabilities. To overcome these discrepancies, the present study proposes and validates an integrated model, which considers the effects of value of mathematics, motivation towards mathematics, enjoyment of mathematics on academic performance by considering the intervening role of student learning mathematics. This study contributes to the current research literature on mathematical mindsets by combining various facets of mathematical mindsets in a single model. Moreover, the study contributes to literature by elucidating how mathematics-related attitudes relate to academic performance. The results should make significant contributions to mathematics education and academic performance literature. It further provides implications for educators and institutions aiming to foster positive mathematics mindsets and enhance academic achievement.

Literature Review

Theoretical Foundation

This study was based on Expectancy-Value Theory (EVT) that posited that students' academic behavior and outcomes depends on their expectancy of success and the value they place on learning activities [6]. Educational tasks will be more likely to be undertaken by learners if they think that tasks are important, useful, enjoyable, and easy to undertake [26]. In the learning process of mathematics, students who see the benefits of mathematics are more motivated to invest effort in learning activities. Likewise, the joy of mathematics promotes intrinsic motivation and motivates learners to engage in learning activities [41]. These positive attitudes promote engagement, confidence and perseverance and contribute to better learning experiences. This means that the student learning mathematics is a pivotal process linking mathematics-related beliefs and motivations to outcomes of student learning in mathematics. Based on EVT, the following study suggests that value of mathematics, mathematics motivation as well as enjoyment of mathematics are positively related to student learning mathematics which in turn leads to an improvement in academic performance for business graduates as shown in Figure 1.

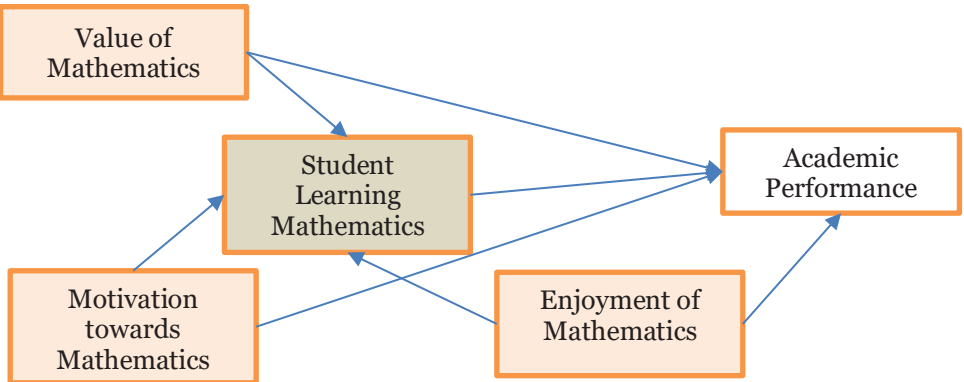


Figure 1: Conceptual Framework of the Study

Hypotheses Development

Academic Performance

Academic performance is the degree of achievement students make toward meeting educational goals and learning requirements [33, 35]. It is widely believed to be a measure of students' knowledge acquisition and skill development and a reflection of their educational achievements. Academic performance is the ability of students to fulfil tasks, fulfil the requirements of the course and demonstrate competence in academic tasks [32]. Academic performance has been shown to be a multidimensional construct in previous studies that has been affected by cognitive, behavioral, motivational factors, and environmental factors. Good academic achievement helps to nurture better employment prospects, working skills and learning for life. In higher education, especially in business-related fields, students' analytical and quantitative skills are increasingly key quality attributes of their academic performance [13]. Therefore, it is essential to gain insights into the factors that facilitate better academic outcomes, which continues to be a key research and practice question in education.

Value of Mathematics

Value of mathematics is students' perception of the usefulness, importance and relevance of mathematics in their academic, personal and professional lives [31]. It captures the degree of learners' perception that mathematical knowledge is useful for learning objectives and career outcomes. When students feel like math is important, they are more interested to invest time into the concepts and problem-solving strategies of math [20]. Students' attitudes toward mathematics also affect their willingness to do more difficult, and to persevere with, tasks when they find them challenging. Mathematics is critical in business education for fields like data analysis, economics, accounting and finance. Hence the relevance of mathematics in day-to-day activities help the students in learning activities and have more confidence in using mathematical knowledge and skills in various academic and work situations.

Motivation towards Mathematics

Motivation towards mathematics refers to the inner desire to learn, comprehend and apply mathematical concepts [31]. It is a reflection of students' beliefs around their ability to be successful in mathematics and willing to work on mathematical learning activities [25]. Learners who are motivated tend to show greater persistence, involvement and effort when dealing with problems that are complex and difficult. Educational research indicates that motivation is one of the key factors influencing learning behavior and consequently learning performance. Students who have high mathematical motivation tend to be active, eager to learn more and to concentrate on academic aims [29]. In addition, motivation can boost students' self-confidence in learning mathematics, creating a positive environment for them to engage in learning and skill acquisition. This has led to the view of motivation as one of the factors that effect learning achievement and effectiveness, particularly in mathematics.

Enjoyment of Mathematics

Enjoyment of mathematics is the positive emotional experiences and satisfaction that students have in learning and engaging mathematics [31]. It is an indicator of how interesting, stimulating and rewarding mathematics is to learners. Students

who are interested in mathematics tend to show a higher curiosity, enthusiasm and willingness to engage in mathematical activities. Positive experiences in mathematics can help to decrease learning anxiety and promote higher involvement in content area material [42]. There are studies suggesting that enjoyment can increase students' intrinsic motivation, thus engaging them in learning activities in order to gain personal satisfaction. Students who feel happy learning mathematics will be more inclined to have positive attitudes towards mathematics, persevere when encountering challenges and actively pursue opportunities to deepen their understanding of mathematics. Thus, enjoyment is an important psychological factor of successful learning outcomes.

Student Learning Mathematics

Student learning mathematics is a process by which students learn mathematical knowledge, acquire problem solving skills, and gain confidence in applying mathematical concepts [20, 42]. It includes students' perceptions of understanding, competence, and effectiveness about the learning of mathematics related material [34]. Mathematics learning is a successful learning where the students engage in cognitive activities, persist, think critically and overcome learning challenges. Students who have good mathematical learning expertise are likely to be more confident in solving mathematical problems and adapting to new quantitative tasks. Effective learning experiences also help students to transfer mathematical knowledge to academic and real-life contexts [20]. In the field of business education, mathematical learning is a very crucial foundation in analytical concepts and making choices in business. Thus, student learning mathematics is an important educational outcome which is expected to be correlated with students' academic achievement and development of required competencies in their future career.

Several psychological and attitudinal factors affect the learning of mathematics by students that drive students to accept and hold back on mathematical concepts or to persist in learning activities [24]. Expectancy-Value Theory states that the effort people put into learning is more likely to occur when they value the subject matter, are motivated to learn and enjoy the process of learning [6]. The value of mathematics is used to help students see mathematics' value in school success and career readiness and encourages students to engage in greater learning of mathematics concepts. Similarly, motivation for mathematics positively boosts pupils' confidence in their capability to achieve, encourages them to persevere with tasks when they find them difficult and encourages them to actively participate in learning activities. Moreover, positive emotional events that enhance learning through the enjoyment of mathematics are created [24]. Those who like math are more active in class, learn new concepts and have better problem-solving abilities. These positive perceptions and attitudes support effective mathematics learning by facilitating engagement, confidence, and persistence [14]. Hence, it is expected that students who think that mathematics is useful, motivated to learn, and enjoy doing math activities, are capable to learn mathematics well. With this rationale, the following hypotheses are suggested:

Hypothesis 1: Value of mathematics has a positive effect on students learning mathematics.

Hypothesis 2: Motivation towards mathematics has a positive effect on students learning mathematics.

Hypothesis 3: Enjoyment of mathematics has a positive effect on students

learning mathematics.

In addition to cognitive factors, students' attitudes and perceptions towards learning also contribute to academic performance [9, 20]. Students will spend more time on a subject when they believe that it is important and useful, have a desire to be successful and interested in learning various techniques. The value of mathematics makes the student conscious of its importance for academic success and their career development and as a result puts more effort into academic coursework and learning activities [31]. Likewise, students' motivation towards mathematics enhances their persistence, commitment and willingness to face challenges in learning [31], which affects their learning performance. The enjoyment of mathematics is also very significant and helps to generate positive feelings which contribute to engagement and aversion to learning being diminished. Therefore, students who like mathematics are more alert, involved in the activities of learning, and more inclined to spend time on the skill acquisition in mathematics. The results of previous studies have all established a positive association between positive attitudes related to mathematics and academic success [18, 36], which is attributed to learning behaviors and sustained academic engagement. The learners who appreciate mathematics are motivated to learn the concepts of mathematics and are expected to perform at higher level of mathematics. The above reasoning leads to the following hypotheses:

Hypothesis 4: Value of mathematics has a positive effect on academic performance.

Hypothesis 5: Motivation towards mathematics has a positive effect on academic performance.

Hypothesis 6: Enjoyment of mathematics has a positive effect on academic performance.

The extent to which students gain mathematical understanding, confidence and problem-solving abilities in the context of their learning in mathematics is defined as student learning mathematics. The benefits of effective mathematic learning strengthen student critical thinking [39], logical reasoning and analytical skills that are required in other learning areas and are important to their success. Students who have good mathematical learning skills can grasp and understand complex concepts, learn academic material and realize the expected learning outcomes [30]. Based on prior research, it is known that mathematics learning can improve academic performance [11, 40], because when a student learns mathematics, it makes his/her cognitive ability stronger and learning more effective. Mathematical competency is especially pertinent in business education since students are often faced with subjects in which quantitative skills combine with analytical decision making and problem-solving skills. Hence, students with better mathematics learning capacity have better success in the pursuit of studies. Under this reasoning, we hypothesize that:

Hypothesis 7: Student learning mathematics has a positive effect on academic performance.

Student learning mathematics is one important relationship between mathematics-related attitudes and student learning outcomes [11]. Students believe that mathematics is beneficial, have a strong interest in learning, and relish math activities; they will be more motivated to participate in the learning process and build their mathematical skills. The value of mathematics motivates the students to understand the value of mathematics learning for their academic achievement and

for their career development and fosters learning effort and achievement persistence [31]. Similarly, mathematics' motivation enables the students to become confident and willing to face challenges in learning mathematics, which results in mathematical understanding [31]. In turn, positive emotional experiences of enjoyment promote active participation in and prolonged engagement with mathematics learning activities. Students' positive attitudes lead to better learning of mathematical knowledge [7], skills in problem solving and self-confidence to apply mathematical knowledge. This helps to foster better academic achievement as it builds analytical thinking, logical reasoning and learning effectiveness [38], leading to better mathematics learning. Thus, student learning mathematics is expected to be a mediating variable between these variables to explain the role of these variables in achieving student performance in mathematics learning. Therefore, the following hypotheses are proposed:

Hypothesis 8: Student learning mathematics mediates the relationship between value of mathematics and academic performance.

Hypothesis 9: Student learning mathematics mediates the relationship between motivation towards mathematics and academic performance.

Hypothesis 10: Student learning mathematics mediates the relationship between enjoyment of mathematics and academic performance.

Methodology

Research Design

This study considered quantitative research design to focus on the relation between value of mathematics, mathematics motivation, mathematics enjoyment, learning mathematics and academic performance. This is because cross-sectional survey approach allows for obtaining standardized data from a large sample in a short period of time. The quantitative approach is supportive for testing the proposed hypotheses and testing the direct and indirect relationships between the study variables. Moreover, the survey approach allows for assessing the perception, attitudes, and learning experiences of the respondents towards mathematics, as well as the effect on their academic performance.

Population and Data Collection

This study considered business graduates who are attending higher education as the target population. Business students are chosen because mathematics is very important in developing analytical, statistical and problem-solving skills that are needed in business related subjects like accountancy, finance, economics and management. The data are gathered using a structured questionnaire with online and offline distribution. The survey is anonymous and voluntary, and the purpose of the study is explained to the respondents prior to their participation in the survey. Confidentiality and anonymity of the answers is respected during all stages of the research process because this can encourage honest and unbiased responses from the participants. Seven hundred (700) questionnaires were distributed, however, two hundred and eighty-eight (288) valid questionnaires were returned and used for data analysis.

Measures

The questionnaire is comprised of five constructs that are measured with previously validated scales adapted from the literature. Each item is measured on a five-point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree.

Value of Mathematics

Seven items adapted from Pokharel [31] are used to measure the value of Mathematics. The scale measures students' self-perceptions of the usefulness, importance and relevance of mathematics in their academic and professional lives. Sample items are examples of what students might say: "I think studying mathematics is useful; A strong mathematics background could help me in my professional life". High scores represent greater perceptions of the value and importance of mathematics. The complete scale items are reported below:

Value of Mathematics [31]

1. "I think studying mathematics is useful.
2. Mathematics is important in everyday life.
3. Mathematics is a very worthwhile and necessary subject.
4. A strong mathematics background could help me in professional life.
5. Mathematics is one of the most important subjects for students
6. Mathematics is also very useful for other activities.
7. I can think of many ways in which I use mathematics outside the classroom."

Motivation towards Mathematics

The instrument of measuring motivation towards mathematics has comprised of five items, which are adapted from Pokharel [31]. The scale assesses students' confidence, willingness and determination to learn mathematics and perform well on mathematics-related activities. Some examples of these are: "I know I can succeed with math" and "I am sure that I can learn math." The higher the score, the more motivated students are towards mathematics learning. The complete scale items are reported below:

Motivation towards Mathematics [31]

1. "I can get good grades in mathematics.
2. I know I can succeed with math.
3. I am sure that I can learn math.
4. I think I could do better in math so far.
5. Learning math gives me knowledge and skills relevant to my future career."

Enjoyment of Mathematics

The six items are adapted from Opstad [27], used to assess enjoyment of Mathematics. The construct is focused on students' positive affective experiences and satisfaction of learning mathematics. These sample items are: "Mathematics is a very interesting subject, and I like to solve new problems in mathematics." Scores higher than zero indicate greater enjoyment and interest in mathematics. The complete scale items are reported below:

Enjoyment of Mathematics [28]

1. "Mathematics is a very interesting subject.
2. I am happier in a mathematics class than in any other class.
3. I would prefer to do an assignment in mathematics than to write an essay.
4. I like to solve new problems in mathematics.
5. I gain great satisfaction from solving mathematics problems.
6. I am willing to take more than the required amount of mathematics."

Student Learning Mathematics

The eleven items adopted from Fogarty, et al. [14] which are used to measure student learning in mathematics. The scale measures the students' confidence, learning ability, problem-solving skills, and the ability to learn mathematics effectively. These may include statements such as "I have a mathematical mind", "I always feel confident learning mathematics" and "I find mathematics easy". These scores range from high to low, with higher scores indicating more mathematics learning ability and confidence. The complete scale items are reported below:

Student Learning Mathematics [14]

1. "I have less trouble learning mathematics than other subjects.
2. When I have difficulties with mathematics, I know I can handle them in comfortable way.
3. I have a mathematical mind.
4. It takes me less time to understand mathematics than the average person.
5. I always feel confident learning mathematics.
6. I enjoy trying to solve new mathematics problems.
7. I find mathematics easy.
8. I find many mathematics problems interesting and challenging.
9. I don't understand how some people seem to enjoy spending so much time on mathematics problems.
10. I have always been very excited about mathematics.
11. I find mathematics important and easy."

Academic Performance

Academic performance is assessed based on four items that are adopted from Hanaysha, et al. [17]. The construct assesses students' perceptions of their success in meeting academic expectations and completing academic responsibilities. Some examples of these items are: "I meet the official performance requirements expected out of a student" and "I complete assigned tasks adequately." Scores reflect higher perceived academic performance with higher scores. The complete scale items are reported below:

Academic Performance [17]

1. "I meet the official performance requirements expected out of a student.
2. I adequately complete assigned duties.
3. I fulfill responsibilities specified in the course outline.
4. I perform tasks that are expected of me."

Data Analysis

Table 1 shows the descriptive statistics of all the measurement items employed in the study such as the mean, median, minimum, maximum, standard deviation, kurtosis, and skewness. The mean scores vary between 2.785 and 3.427, suggesting that the respondents have moderate to favorable attitudes, learning experiences and academic outcomes related to mathematics. The range of standard deviations is from 1.102 to 1.362, which indicates a reasonable level of variation among the responses. Moreover, skewness ranges from -0.380 to 0.300 and kurtosis values are from -1.271 to -0.578. The skewness and kurtosis values for both data sets are within the acceptable range of ± 2 , indicating that both sets of data are approximately

normally distributed. In general, the descriptive statistics revealed that the data set is appropriate for further analysis using multivariate techniques and structural equations.

Table 1: Data Statistics

	Missing	Mean	Median	Min	Max	SD	Kurtosis	Skewness
VM1	0	2.936	3	1	5	1.318	-1.108	-0.149
VM2	0	3.326	3	1	5	1.303	-1.06	-0.235
VM3	0	3.051	3	1	5	1.263	-1.011	-0.247
VM4	0	3.236	3	1	5	1.225	-0.923	-0.209
VM5	0	2.785	3	1	5	1.125	-0.578	0.3
VM6	0	2.802	3	1	5	1.102	-0.658	0.211
VM7	0	3.181	3	1	5	1.267	-1.02	-0.251
MM1	0	3.167	3	1	5	1.288	-0.961	-0.285
MM2	0	3.045	3	1	5	1.302	-1.011	-0.084
MM3	0	3.045	3	1	5	1.242	-0.884	-0.119
MM4	0	3.038	3	1	5	1.273	-0.966	-0.173
MM5	0	2.965	3	1	5	1.248	-0.915	-0.308
EM1	0	3.399	3	1	5	1.251	-0.934	-0.288
EM2	0	3.389	4	1	5	1.3	-1.059	-0.293
EM3	0	3.41	4	1	5	1.282	-1.022	-0.305
EM4	0	3.281	3	1	5	1.28	-0.98	-0.189
EM5	0	3.069	3	1	5	1.185	-0.803	-0.173
EM6	0	3.146	3	1	5	1.19	-0.813	-0.247
SLM1	0	3.146	3	1	5	1.258	-0.897	-0.235
SLM2	0	3.08	3	1	5	1.195	-1.038	-0.179
SLM3	0	3.125	3	1	5	1.269	-0.93	-0.247
SLM4	0	3.417	3	1	5	1.176	-0.718	-0.327
SLM5	0	2.909	3	1	5	1.235	-0.838	-0.283
SLM6	0	3.389	3	1	5	1.281	-0.979	-0.289
SLM7	0	3.302	3	1	5	1.24	-0.818	-0.249
SLM8	0	3.427	4	1	5	1.237	-0.885	-0.38
SLM9	0	3.021	3	1	5	1.187	-1.049	-0.053
SLM10	0	3.01	3	1	5	1.276	-0.999	-0.02
SLM11	0	2.935	3	1	5	1.204	-0.881	-0.019
AP1	0	2.952	3	1	5	1.242	-1.013	0.021
AP2	0	3.149	3	1	5	1.362	-1.271	-0.082
AP3	0	3.01	3	1	5	1.276	-0.999	-0.02
AP4	0	3.035	3	1	5	1.204	-0.881	-0.019

The data collected are analyzed using PLS-SEM. PLS-SEM is appropriate because it enables simultaneous assessment of measurement and structural models while accommodating complex relationships among multiple constructs [15, 16, 19]. The analysis follows a two-step approach [19]. First, measurement model and second, structural model. The results of the convergent validity assessment are reported in Table 2. All retained items have factor loadings greater than 0.70 which range from 0.797 to 0.925, suggesting that the items are a good representation of the constructs they measure. Cronbach's alpha is from 0.915 to 0.937, indicating good internal consistency reliability. Likewise, the composite reliability (CR) scores are above the minimum recommended score of 0.70 (range 0.937 – 0.948) confirming the reliability of the measurement scales. The average values of variance extracted (AVE) are in the range of 0.695 to 0.798, and higher than the threshold value of 0.50, which means the validity of convergent value is satisfactory.

The results obtained showed that the measurement instruments have an adequate reliability and validity and are suitable to measure the latent constructs that were included in this study. Measurement model is shown in Figure 2.

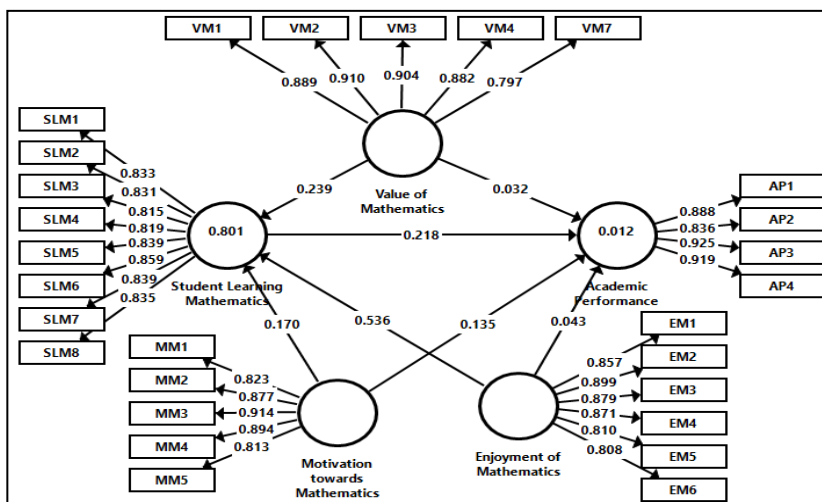


Figure 2: Measurement Model

Table 2: Convergent Validity

Variable	Items	Loading	α	CR	AVE
Academic Performance	AP1	0.888	0.916	0.94	0.798
	AP2	0.836			
	AP3	0.925			
	AP4	0.919			
Enjoyment of Mathematics	EM1	0.857	0.926	0.942	0.73
	EM2	0.899			
	EM3	0.879			
	EM4	0.871			
	EM5	0.81			
	EM6	0.808			
Motivation towards Mathematics	MM1	0.823	0.915	0.937	0.748
	MM2	0.877			
	MM3	0.914			
	MM4	0.894			
	MM5	0.813			
Student Learning Mathematics	SLM1	0.833	0.937	0.948	0.695
	SLM2	0.831			
	SLM3	0.815			
	SLM4	0.819			
	SLM5	0.839			
	SLM6	0.859			
	SLM7	0.839			
	SLM8	0.835			
Value of Mathematics	VM1	0.889	0.924	0.943	0.769
	VM2	0.91			
	VM3	0.904			
	VM4	0.882			
	VM7	0.797			

The discriminant validity result obtained by the Fornell-Larcker criterion [21] which is presented in Table 3. The diagonal values represent the square root of AVE, while the values below the diagonal show correlations between constructs. Results indicate that each construct is more strongly associated with its own indicators than with other constructs, supporting discriminant validity. Thus, the results of the test showed discriminant validity, meaning that the variables studied were empirically different and measured different conceptual phenomena.

Table 3: AVE Square Root

	Academic Performance	Enjoyment of Mathematics	Motivation towards Mathematics	Student Learning Mathematics	Value of Mathematics
Academic Performance	0.893				
Enjoyment of Mathematics	0.59	0.855			
Motivation towards Mathematics	0.62	0.831	0.865		
Student Learning Mathematics	0.045	0.774	0.808	0.834	
Value of Mathematics	0.72	0.824	0.807	0.818	0.877

The results of the direct relationships between the study variables are presented in Table 4. The results show that enjoyment of mathematics positively affects students learning mathematics ($\beta = 0.536$, $p < 0.001$) meaning that students who enjoy mathematics have a strong capability to learn mathematics. Motivation towards mathematics also positively influences student learning mathematics ($\beta = 0.170$, $p = 0.004$), and value of mathematics also significantly enhances student learning mathematics ($\beta = 0.239$, $p < 0.001$). Moreover, students learning mathematics has a positive effect on academic performance ($\beta = 0.218$, $p = 0.049$) which makes students learning mathematics important for student success in school learning. Academic performance is also positively influenced by value of mathematics ($\beta = 0.032$, $p < 0.001$). The direct effect of enjoyment of mathematics ($\beta = 0.043$, $p = 0.386$) and motivation towards mathematics ($\beta = 0.135$, $p = 0.143$) on academic performance are not statistically significant.

Table 4: Direct Effect Results

Relationship	β	Mean	SD	T Statistics	P Values
Enjoyment of Mathematics -> Academic Performance	0.043	0.039	0.148	0.292	0.386
Enjoyment of Mathematics -> Student Learning Mathematics	0.536	0.551	0.061	8.82	0
Motivation towards Mathematics -> Academic Performance	0.135	0.129	0.125	1.077	0.143
Motivation towards Mathematics -> Student Learning Mathematics	0.17	0.174	0.061	2.773	0.004
Student Learning Mathematics -> Academic Performance	0.218	0.231	0.129	1.682	0.049
Value of Mathematics -> Academic Performance	0.032	0.045	0.01	3.2	0
Value of Mathematics -> Student Learning Mathematics	0.239	0.221	0.062	3.866	0

The results indicate that mathematics-related attitudes have mostly indirect effects on academic performance through improving learning processes. Structural model is reported in Figure 3.

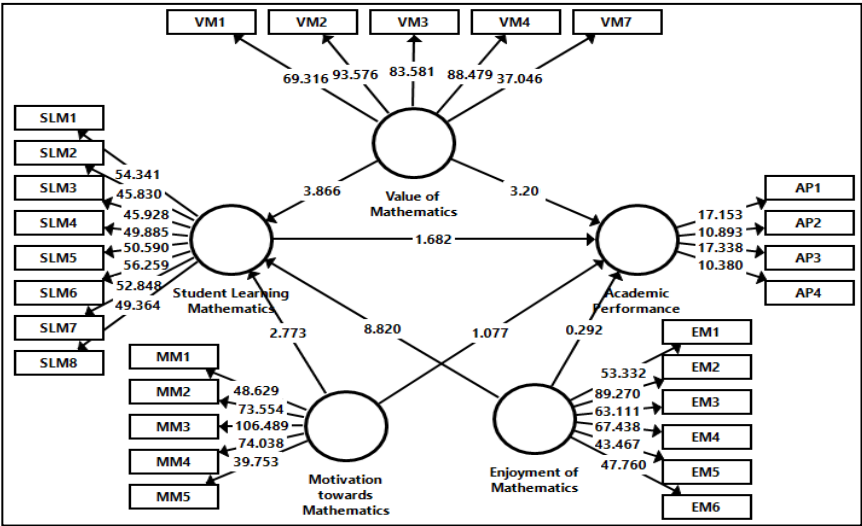


Figure 3: Structural Model

The results of the mediation analysis are shown in Table 5 which presents the results of indirect effect of mathematics-related attitudes to academic performance through student learning mathematics. The findings show that student learning mathematics plays a significant mediating role in the relationship between value of mathematics and academic performance with a value of $\beta = 0.052$ and $p < 0.001$. From this finding, it can be concluded that if students feel that mathematics is important in their lives, they are more likely to build their mathematics learning ability, which in turn will improve their achievement. Likewise, the relationship between enjoyment of mathematics and academic performance was mediated by student learning mathematics ($\beta = 0.117$, $p = 0.046$), meaning that an increase in enjoyment led to better academic performance by promoting mathematics learning experiences. However, the indirect effect of motivation towards mathematics on academic performance through student learning mathematics is not significant ($\beta = 0.037$, $p = 0.101$). In general, the mediation results indicate that the role of a mediating variable in explaining the relationship between attitude toward mathematics and mathematics achievement is crucial and as significant as student learning mathematics.

Table 5: Indirect Effect Results

Relationship	β	Mean	SD	T Statistics	P Values
Motivation towards Mathematics -> Student Learning Mathematics -> Academic Performance	0.037	0.041	0.029	1.291	0.101
Value of Mathematics -> Student Learning Mathematics -> Academic Performance	0.052	0.053	0.016	3.24	0
Enjoyment of Mathematics -> Student Learning Mathematics -> Academic Performance	0.117	0.125	0.068	1.717	0.046

Discussion

The purpose of the study is to investigate the influence of value of mathematics, mathematics motivation and enjoyment of mathematics on academic performance with student learning mathematics as the mediator in business students. The results offer valuable insights into the impact of mathematics-related attitudes and learning experiences on academic outcomes. Findings of the study reveal that value of mathematics has a favorable effect on students' learning of mathematics. The findings show that students who observe mathematics as useful and relevant are more likely to be interested in mathematical topics and build up their learning skills. Students' awareness of the value of mathematics and work achievement are positively associated with engagement in learning activities [5] and perseverance in developing quantitative skills. This result aligns with previous studies that indicated that perceived value helps to increase learning engagement and motivate students to put more effort into learning activities [1, 2, 37].

Furthermore, results highlighted the positive impact between motivation towards mathematics and students' learning mathematics. This confidence drive for success that directs better learning, as shown in this finding presented by Opstad [27]. Motivation helps students to keep on trying when they encounter difficult mathematical problems and enhances students' readiness to exert efforts in activities of learning [31]. The findings are consistent with the basic tenets of Expectancy-Value Theory [6], which suggests that motivated learners will be more inclined to engage in behaviors that will facilitate their learning and performance. This means that motivation becomes an important factor influencing the learning of business graduates in mathematics.

Additionally, results indicate that enjoyment of mathematics has a highly positive impact on students learning mathematics. This finding suggests that students who are interested in and enjoy learning mathematics possess a more positive attitude toward being involved in learning activity, problem solving, and in doing mathematical tasks. Enjoyment fosters positive emotional experiences that inspire students to spend more time and energy to learn [42]. This result aligns with earlier research which shows that enjoyment is a key component in promoting engagement, stamina and effective learning behaviors [10, 22, 31]. Positive attitude is more likely to be adopted by the students who like mathematics and this attitude will help them to develop their love for mathematics.

The results further illustrate that there is a significant impact of student learning mathematics in academic performance. The outcome is in line with studies that have shown that students with more mathematical learning, confidence, and problem-solving abilities have improved academic outcomes. Similarly, previous studies highlighted the positive correlation between student learning and academic performance [4, 11, 20]. Learning mathematics helps students to think analytically, reason logically and develop their thinking abilities, which in turn supports their academic success. These skills are especially relevant for business students as many business-related subjects depend on quantitative analysis and making decisions based on evidence. Student learning mathematics is therefore an important pathway to facilitate the achievement of positive educational outcomes.

In contrast to the theory, the positive relationship between mathematics enjoyment and academic achievement is not significant. Because mathematics enjoyment does not necessarily mean it will result in better academic outcomes. Academic achievement requires not only positive emotions, but also knowledge and learning skills, which are achieved in the process of learning. The finding implies that

enjoyment is an important factor that helps academic success mostly in stimulating students to participate effectively in mathematics learning activities. Therefore, enjoyment has an indirect effect on academic performance by improving the learning processes rather than by direct means. The idea of a direct relationship between motivation for mathematics and academic achievement is not supported either. Motivation is a factor that encourages students to engage in learning activities and to overcome difficulties, but if motivation is not accompanied by meaningful learning and skill development, it cannot be used to improve academic achievement. Students can have high levels of motivation but not demonstrate high levels of achievement if their motivation is not reflected in their learning behaviors. On the other hand, value of mathematics has high positive direct effect on academic performance. The results indicate that students who value mathematics and believe that it can be useful for them are more likely to have positive academic results which is also supported by [31].

The mediation analysis yields further insights into the mechanisms between mathematics attitudes and mathematics achievement. The enjoyment of mathematics has a very significant indirect effect on academic outcomes through student learning mathematics. This finding suggests that pleasure promotes knowledge by making students' learning more meaningful, as well as their mathematics skills. Similarly, the connection between value of mathematics and academic performance is also mediated by student learning mathematics, indicating that perceived value can stimulate better learning behaviors, which then translate to better academic performance. However, the mediating role of student learning mathematics between student motivation towards mathematics and academic performance is not significant. Motivation has a positive effect on mathematics learning, but the indirect effect is not statistically significant and hardly decisive in improving academic performance. The findings of the study as a whole highlight the significance of students' learning of mathematics as one of the major mechanisms by which mathematics-related attitudes are associated with academic achievement of business graduates.

Conclusion

This study aims to investigate the mediating role of student learning mathematics between value of mathematics, motivation towards mathematics and academic performance of business graduates. The results show that the value of mathematics, motivation towards mathematics and enjoyment of mathematics have significant effects on student learning mathematics. In addition, a positive learning attitude has a positive impact on the students' academic achievement, which is relevant to the role of mathematics in achieving academic success. The results also indicate that value of mathematics significantly contributes directly to academic performance while the direct effects of enjoyment and motivation on academic performance are not significant. The mediation analysis results support previous findings that student learning mathematics act as a mediator between value and enjoyment of mathematics and academic achievement. Therefore, the findings of the study suggest that positive perceptions, motivation and enjoyment of mathematics enhance learning experiences which in turn lead to improved academic performance among business graduates.

Implications

Theoretically, the results are extensions of the Expectancy-Value Theory as it shows how value of mathematics, motivation towards mathematics and enjoyment of mathematics contributes to academic performance through student learning mathematics. The study contributes to literature by bringing together several aspects of a mathematics mindset in one framework and student learning mathematics as an explanatory mechanism. It also provides a contribution to the existing knowledge on academic performance by emphasizing the indirect routes of influence of attitudes toward mathematics on academic outcomes. Realistically, the results indicate that teachers and universities should consider building positive learning experiences through mathematics to boost the perceived value, fun and motivation of students. Real life applications of mathematics can be added to the curriculum to enhance the relevance of mathematics among business students. Teachers may also use interactive teaching that makes mathematics more interesting and enjoyable to students. These programs could strengthen student learning which can lead to higher academic performance.

Limitations and Future Directions

There are a few limitations of this study that should be the future research directions. First, the cross-sectional design makes it difficult to develop causal relationships between variables. Second, the study is self-reported, and thus results may be affected by response bias and common method variance. Third, the model emphasizes only certain factors related to mathematics and does not include other factors that likely impact students' achievement, such as learning environment, teacher quality, and technology use. Longitudinal study designs could be used in future studies to better investigate causal relationships within time. Other psychological and educational variables that are related to academic achievement may also be studied. Additionally, cross-disciplinary and cross-grade analyses of the impact of mathematics mindset on learning outcomes and academic achievement might offer more detailed analyses of the impact of mathematics mindset on learning outcomes and academic achievement.

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References

- [1] H.-E. Al Issa, M. M. S. Omar, A. Çelebi, *Higher education student engagement with online learning: the role of perceived value and academic entitlement*, Higher Education, Skills and Work-based Learning **14** (2023), 545-561.
- [2] H.-E. Al Issa, S. Saad, R. Dittavichai, *The impact of perceived value on engagement: the role of teacher behavior*, International Journal of Educational Management **36** (2022), 1176-1192.
- [3] M. A. Alsuwaiet, *Generative AI in higher education: the roles of knowledge, willingness, concerns, gamification and digital literacy in shaping perceived*

- learning effectiveness and academic performance*, Kybernetes (2026), 1-31.
- [4] M. Bellaj, A. B. Dahmane, S. Boudra, M. L. Sefian, *Educational Data Mining: Employing Machine Learning Techniques and Hyperparameter Optimization to Improve Students' Academic Performance*, International Journal of Online & Biomedical Engineering **20** (2024).
- [5] A. J. Bishop, *Can Values Awareness Help Teachers and Parents Transition Preschool Learners into Mathematics Learning?*, in: T. Meaney, O. Helenius, M.L. Johansson, T. Lange, A. Wernberg (Eds.) *Mathematics Education in the Early Years: Results from the POEM2 Conference, 2014*, Springer International Publishing, Cham, 2016, 43-56.
- [6] C. K. Y. Chan, W. Zhou, *An expectancy value theory (EVT) based instrument for measuring student perceptions of generative AI*, Smart Learning Environments **10** (2023), 64.
- [7] P. K. K. Chu, *Attitudes toward statistics among business students: Do majors, mathematical background, sex, and field of secondary education matter?*, Teaching Statistics **47** (2025), 63-74.
- [8] G. Cohen, *Algorithmic Trading and Financial Forecasting Using Advanced Artificial Intelligence Methodologies*, Mathematics **10** (2022), 3302.
- [9] M. Courtney, M. Karakus, Z. Ersozlu, K. Nurumov, *The influence of ICT use and related attitudes on students' math and science performance: multilevel analyses of the last decade's PISA surveys*, Large-scale Assessments in Education **10** (2022), 8.
- [10] J.-M. Dewaele, C. Li, *Teacher enthusiasm and students' social-behavioral learning engagement: The mediating role of student enjoyment and boredom in Chinese EFL classes*, Language Teaching Research **25** (2021), 922-945.
- [11] H. Duncan, T. Dick, *Collaborative workshops and student academic performance in introductory college mathematics courses: A study of a Treisman model math excel program*, School Science and Mathematics **100** (2000), 365-373.
- [12] A. Ekmekci, D. M. Serrano, *The Impact of Teacher Quality on Student Motivation, Achievement, and Persistence in Science and Mathematics*, Education Sciences **12** (2022), 649.
- [13] G. R. El Said, *How Did the COVID-19 Pandemic Affect Higher Education Learning Experience? An Empirical Investigation of Learners' Academic Performance at a University in a Developing Country*, Advances in Human-Computer Interaction **2021** (2021), 6649524.
- [14] G. Fogarty, P. Cretchley, C. Harman, N. Ellerton, N. Konki, *Validation of a questionnaire to measure mathematics confidence, computer confidence, and attitudes towards the use of technology for learning mathematics*, Mathematics Education Research Journal **13** (2001), 154-160.
- [15] J. Hair, C. L. Hollingsworth, A. B. Randolph, A. Y. L. Chong, *An updated and expanded assessment of PLS-SEM in information systems research*, Industrial management & data systems **117** (2017), 442-458.
- [16] J. F. Hair, M. Sarstedt, T. M. Pieper, C. M. Ringle, *The Use of Partial Least Squares Structural Equation Modeling in Strategic Management Research: A Review of Past Practices and Recommendations for Future Applications*, Long Range Planning **45** (2012), 320-340.
- [17] J. R. Hanaysha, F. B. Shriedeh, M. In'airat, *Impact of classroom environment, teacher competency, information and communication technology resources, and university facilities on student engagement and academic performance*,

- International Journal of Information Management Data Insights **3** (2023), 100188.
- [18] B. Hemmings, P. Grootenboer, R. Kay, *Predicting Mathematics Achievement: The Influence Of Prior Achievement And Attitudes*, International Journal of Science and Mathematics Education **9** (2011), 691-705.
 - [19] J. Henseler, C. M. Ringle, R. R. Sinkovics, *The use of partial least squares path modeling in international marketing*, In New challenges to international marketing (2009).
 - [20] A. Hidayatullah, C. Csíkos, *The Role of Students' Beliefs, Parents' Educational Level, and The Mediating Role of Attitude and Motivation in Students' Mathematics Achievement*, The Asia-Pacific Education Researcher **33** (2024), 253-262.
 - [21] F. Hilkenmeier, C. Bohndick, T. Bohndick, J. Hilkenmeier, *Assessing distinctiveness in multidimensional instruments without access to raw data—a manifest Fornell-Larcker criterion*, Frontiers in psychology **11** (2020), 223.
 - [22] P. L. Invernizzi, M. Crotti, A. Bosio, L. Cavaggioni, G. Alberti, R. Scurati, *Multi-Teaching Styles Approach and Active Reflection: Effectiveness in Improving Fitness Level, Motor Competence, Enjoyment, Amount of Physical Activity, and Effects on the Perception of Physical Education Lessons in Primary School Children*, Sustainability **11** (2019), 405.
 - [23] I. Marchis, *Factors that influence secondary school students' attitude to mathematics*, Procedia - Social and Behavioral Sciences **29** (2011), 786-793.
 - [24] M. d. L. Mata, V. Monteiro, F. Peixoto, *Attitudes towards mathematics: Effects of individual, motivational, and social support factors*, Child development research **2012** (2012), 876028.
 - [25] P. Nuankaew, W. S. Nuankaew, *Student Performance Prediction Model for Predicting Academic Achievement of High School Students*, European Journal of Educational Research **11** (2022), 949-963.
 - [26] L. Opstad, & Årethun, T, *Choice of courses in mathematics at upper-secondary school and attitudes towards mathematics among business students: The case of Norway*, International Journal of Learning, Teaching and Educational Research **18** (2019), 228-244.
 - [27] L. Opstad, T. Årethun, *Choice of courses in mathematics at upper-secondary school and attitudes towards mathematics among business students: The case of Norway*, International Journal of Learning, Teaching and Educational Research **18** (2019), 228-244.
 - [28] D. Otoo, W. A. Iddrisu, J. A. Kessie, E. Larbi, *Structural Model of Students' Interest and Self-Motivation to Learning Mathematics*, Education Research International **2018** (2018), 9417109.
 - [29] S. Pieters, A. Desoete, H. Roeyers, R. Vanderswalmen, H. Van Waelvelde, *Behind mathematical learning disabilities: What about visual perception and motor skills?*, Learning and Individual Differences **22** (2012), 498-504.
 - [30] T. P. Pokharel, *The math mindset: How master business students' attitudes impact their academic success*, Journal of Business and Management **9** (2025), 105-119.
 - [31] S. Razzaq, *Exploring the Integration of the Metaverse in Business Model Design Education: Enhancing ESL Learners' Language Acquisition and Proficiency in Higher Educational Institutions*, Journal of Metaverse Business Designs **1** (2020), 37-46.

- [32] S. Razzaq, P. M. McCarthy, A. El-Soussi, *AI-driven pathways to improve writing performance of ESL learners to drive innovation and sustainability in higher education*, Discover Sustainability (2026).
- [33] C. Reyes, *High school students' views on the use of metaverse in mathematics learning*, Metaverse **1** (2020), 9.
- [34] P. Sribunrueng, K. Chaisangduean, Working Environment and Motivations Effecting the Efficiency in Employees' Work Performance: A Case of a Textile and Clothing Industrial Factory in Thailand, Proceedings of International Academic Conferences, International Institute of Social and Economic Sciences, 2018.
- [35] H. W. Stevenson, R. S. Newman, *Long-term prediction of achievement and attitudes in mathematics and reading*, Child development **57** (1986), 646-659.
- [36] W. Sun, J.-C. Hong, Y. Dong, Y. Huang, Q. Fu, *Self-directed Learning Predicts Online Learning Engagement in Higher Education Mediated by Perceived Value of Knowing Learning Goals*, The Asia-Pacific Education Researcher **32** (2023), 307-316.
- [37] M. Wang, M. E. E. Mohd Matore, R. Rosli, *A systematic literature review on analytical thinking development in mathematics education: trends across time and countries*, Frontiers in Psychology **16** (2025), 1523836.
- [38] Q. Wang, A. H. Abdullah, *Enhancing students' critical thinking through mathematics in higher education: A systemic review*, Sage Open **14** (2024), 21582440241275651.
- [39] Y.-L. Wang, J.-C. Liang, C.-Y. Lin, C.-C. Tsai, *Identifying Taiwanese junior-high school students' mathematics learning profiles and their roles in mathematics learning self-efficacy and academic performance*, Learning and Individual Differences **54** (2017), 92-101.
- [40] A. Wigfield, J. S. Eccles, *Expectancy-Value Theory of Achievement Motivation*, Contemporary Educational Psychology **25** (2000), 68-81.
- [41] T. M. Winberg, J. M. Hellgren, T. Palm, *Stimulating positive emotional experiences in mathematics learning: influence of situational and personal factors*, European Journal of Psychology of Education **29** (2014), 673-691.
- [42] J. Zhu, *Text mining and topic modelling in English teaching: Extracting key themes and concepts for effective curriculum development*, Journal of Computational Methods in Sciences and Engineering **25** (2025), 1210-1222.