

# A Structural Model of Attitudes Toward Mathematics as Estimated by Teaching Strategies, Learning Styles, and Motivation of Senior High School Students

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## ABSTRACT

This study examined the relationships among teaching strategies, learning styles, motivation and attitudes of students toward mathematics. Using a quantitative research design, Structural Equation Modeling (SEM) was employed to determine the levels of these variables and develop a structural model explaining their interrelationships. It was conducted among 380 grade 11 students from selected private senior high school institutions in Region XI, Philippines. Descriptive statistics revealed that teaching strategies were practiced at a high level, with teacher-centered strategies more prevalent than student-centered approaches. Learning styles were also rated as high, with visual style being the most preferred, followed by kinesthetic and auditory styles. Students' motivation in learning mathematics was rated as moderate, with intrinsic value, self-regulation, and utility value rated high, while self-efficacy was moderate and test anxiety remained a concern. Students' attitudes toward mathematics were also moderate, implying that although they generally value mathematics and exert effort in learning it, limited confidence and test anxiety may hinder stronger positive attitudes. Correlation analysis showed that teaching strategies and motivation had positive correlation with students' attitudes toward mathematics, while learning styles showed a negative relationship, suggesting that different learning styles may influence students' attitudes toward mathematics differently, depending on how they engage and perceive mathematical information. Moreover, the best-fit model demonstrated that motivation plays a dominant role in forming students' attitude toward mathematics, followed by learning styles. On the other hand, teaching strategies can indirectly influence student's attitudes by fostering motivation and learning styles.

**Keywords:** Teaching strategies, learning styles, motivation, attitudes, best-fit structural model, Philippines.

## INTRODUCTION

Attitude toward mathematics simply refers to how much a student likes or dislikes mathematics. It significantly influences students' engagement, performance, and interest in learning the subject. According to Bosco et al., (2022) students' attitude toward mathematics can be measured in three domains namely negative attitude, tendency to avoid, and positive attitude. Often, many students develop negative attitudes toward mathematics due to their experiences of difficulties in understanding which associate with teaching strategies of math teachers (Hussein & Csikos, 2023), fear of failure, or lack of interest (Rozgonjuk et al., 2020). Consequently, they have a tendency to avoid this subject. This attitude is manifested in behaviors such as reluctance to engage in class discussions, preference for other subjects.

A study by Aguilar (2021) in the United States involving 350 Grade 11-12 students found that 77 percent do not prefer mathematics as a subject, with only 38 percent confident with their math knowledge, and 26 positively motivated to learn mathematics. Similarly, Wakhata et al. (2022) revealed that 851 Grade 11 students in Uganda generally did not like mathematics and often get bored and feel stressed when working with word problem. Likewise, studies in Fiji and Nigeria reported that many secondary high school students demonstrate negative attitudes toward mathematics, for example, they perceive mathematics as difficult,

dislike the subject, experience math anxiety, are less engaged in math classes, and prefer to study other subjects (Chand et al., 2021; Suleiman & Hammed, 2020).

In the Philippines, negative attitudes toward mathematics remain a significant concern among students. Research have shown that students generally are not motivated to learn mathematics because they consider it too difficult and complicated to understand, which is why they don't like learning this subject (Subia et al., 2018; Nolasco, 2025). According to Estonanto and Dio (2019), most senior high school students from STEM strand are found to have either high or moderate level of math anxiety. They often express fear, helplessness, and a tendency to avoid this subject. Similarly, Cerbito (2020) studied 868 grade 11 senior high students of different strands and reported that the average weighted mean of mathematical attitude in STEM, ABM, TVL, Prebacc-MARITIME, and HUMSS was below the required average. This suggests a negative attitude towards mathematics, indicating that students across strands are not motivated and willing to engage themselves in doing mathematics. In addition, Chi (2023) reported that Filipino students exhibit negative attitudes, including math anxiety, low self-efficacy, and lack of valuing the relevance of mathematics. Consistent with these findings, studies conducted in Davao region also reveal that students generally exhibit negative perceptions of mathematic. For example, Mangarin and Montefolka (2023) reported that 68 percent of Grade 12 students have negative attitude toward learning mathematics manifested in terms of confidence, value, and engagement in learning mathematics, while Gurang and Guhao (2024) reported that many senior high school students perceived themselves as not good at mathematics and lacked confidence in taking math tests.

Even if teaching strategies, learning styles, and motivation have been studied thoroughly, (El-Sabagh, 2021; Ishartono et al., 2021; Sasidharan & Kareem, 2023; Isa et al., 2022), little understanding still exists of how these variables together can shape students' attitude toward learning mathematics, particularly among senior high school students. Especially, none of those studies investigates the relationship between teaching strategies, learning styles, motivation, and students' attitudes toward mathematics using Structural Equation Modeling (SEM). This study addresses this gap by applying SEM to comprehensively model these relationships.

## Research Objectives

1. To determine the level of teaching strategies as perceived by the students in terms of:
  - 1.1 teacher-centered; and
  - 1.2 student-centered;
2. To determine the level of students' learning styles in terms of:
  - 2.1 visual;
  - 2.2 auditory; and
  - 2.3 kinesthetic;
3. To determine the level of student's motivation in learning mathematics in terms of:
  - 3.1 intrinsic value;
  - 3.2 self-regulation;
  - 3.3 self-efficacy;
  - 3.4 utility value; and
  - 3.5 test anxiety;

4. To determine the level of student's attitudes toward mathematics in terms of:
  - 4.1 negative attitude;
  - 4.2 avoidance; and
  - 4.3 positive attitude;
5. To determine the significant interrelationship between teaching strategies, learning styles, motivation, and student's attitudes toward mathematics;
6. To determine the best-fit model of students' attitudes toward mathematics; and
7. To determine significant causal links in attitudes toward mathematics.

## METHODOLOGY

This study employed a quantitative research design using a descriptive-correlational approach to attain its objectives. This design was highly appropriate for this study because it enabled the researcher to investigate the relationship between the attitudes of students toward mathematics and teaching strategies, motivation, and social learning styles without involving any external influences that potentially affect the outcomes. The descriptive approach allowed the researcher to collect data from a sample of students and summarize the current status of senior high school students. Furthermore, the correlational component allowed the researcher to identify patterns, trends, and correlations between the variables, such as how motivation and learning styles influence the attitudes of the students, without manipulating any conditions. This dual approach with the non-experimental quantitative by nature provided valuable insights about how the independent variables shape the attitudes of students toward mathematics (Creswell & Creswell, 2018; Miksza et al., 2023).

### Population and Sample

A total of 380 Grade 11 students, from different strands (STEM, ABM, HUMSS, and VOC-TECH) representing both male and female learners in the 2025-2026 school year were the research respondents. The sample size of 380 respondents was calculated using Raosoft software, with the standard assumptions of 95% confidence level, a 5% margin of error, and a 50% response distribution, with a population of 31,000 Grade 11 students enrolled in private schools across Davao Region. This sample size was allocated proportionally among the three schools - School A (168), School B (100), School C (112). The researcher employed a combination of purposive and cluster random sampling in the procedure. The combination of these two sampling techniques is suitable for the study since it prevents bias during sampling and enhances external validity by ensuring a broad representation of different educational settings, teaching approaches, and student learning experiences (Creswell, 2018; Fraenkel, Wallen & Hyun, 2019). The size of 380 was adequate for statistically computing the data that was acquired in preparation for solving the study's concerns.

The researcher secured all the necessary documents. This includes ethical clearance from Research Ethics Committee to guarantee compliance with policies and standards to conduct the study. Through the assistance of the teachers from the respective schools, informed consent forms were given to identified respondents' parents to inform them about their children's participation. Only individuals who had given informed consent from their parents were able to participate in the study. The researcher ensured that the participation was entirely voluntary. Respondents had the right to withdraw at any moment and for any reason.

### Statistical Tool

The following statistical tools for data treatment were utilized to analyze the data of the study:

**Mean.** This statistical tool was used to determine the levels of teaching strategies of teachers, and the levels of learning styles, motivation, and mathematical attitude among students.

**Standard Deviation.** This statistical tool was used to measure a set of data's dispersions from the mean. The larger the SD and the more important the magnitude of the mean value deviation, the higher the variability distribution.

**Pearson Product Moment Correlation.** This was used to determine the significance of the interrelationships between variables.

**Structural Equation Modeling (SEM).** This was used to examine the relationships among multiple variables and validate the proposed model. Especially, SEM analyzed how attitudes of students toward mathematics (endogenous variable) is influenced by exogenous variables namely teaching strategies, learning styles, and motivation. To assess the adequacy of the SEM model, several goodness-of-fit (GOF) indices were examined, including CMIN/DF, TLI, CFI, GFI, RMSEA, and PCLOSE. These indices were reported in the results section to ensure the validity and reliability of the SEM model. These statistical tools were deemed appropriate for analyzing the variables of the study.

## RESULTS

### Level of Teaching Strategies

Shown in Table 1 are the mean and standard deviation scores for the indicators of teaching strategies as perceived by the students in mathematics classrooms. The results show that both teacher-centered and student-centered are rated as high, indicating that these teaching strategies are often employed in mathematics classrooms. The relative standard deviations are low, suggesting that students' perceptions on teaching strategies are stable and representative of classroom practices.

Table 1. Level of Teaching Strategies

| Indicators       | Mean        | SD          | Descriptive Equivalent |
|------------------|-------------|-------------|------------------------|
| Teacher-centered | 3.27        | 0.46        | High                   |
| Student-centered | 2.97        | 0.55        | High                   |
| <b>Overall</b>   | <b>3.12</b> | <b>0.43</b> | <b>High</b>            |

### Level of Learning Styles

Shown in Table 2 are the mean and standard deviation scores for the indicators of learning styles. The overall mean indicates a high level of learning styles among the students with visual learning style is the most preferred among students, followed by kinesthetic and auditory styles. The relatively low standard deviation implies that the results are stable and reliable, demonstrating consistent learning preferences among a large student population, and suggesting that students generally demonstrate a strong inclination toward diverse learning styles.

Table 2. Level of Learning Styles

| Indicators  | Mean | SD   | Descriptive Equivalent |
|-------------|------|------|------------------------|
| Visual      | 3.61 | 0.50 | High                   |
| Auditory    | 3.35 | 0.61 | Moderate               |
| Kinesthetic | 3.47 | 0.59 | High                   |

|                |             |             |             |
|----------------|-------------|-------------|-------------|
| <b>Overall</b> | <b>3.46</b> | <b>0.54</b> | <b>High</b> |
|----------------|-------------|-------------|-------------|

### Level of Students' Motivation in Learning Mathematics

Shown in Table 3 are the mean and standard deviation scores for the indicators of students' motivation in learning mathematics. The overall mean is described as moderate, indicating that students' motivation is sometimes observed. The relatively low overall standard deviation suggests that students' responses are fairly consistent. In particular, students demonstrate high levels of motivation in terms of intrinsic value, self-regulation, utility value, while they exhibit a moderate level in terms of self-efficacy. Meanwhile, the low level of motivation in terms of test anxiety suggests a relatively higher level of test anxiety among students.

Table 3. Level of Students' Motivation

| Indicators      | Mean        | SD          | Descriptive Equivalent |
|-----------------|-------------|-------------|------------------------|
| Intrinsic Value | 3.53        | 0.93        | High                   |
| Self-regulation | 3.60        | 0.76        | High                   |
| Self-efficacy   | 3.02        | 0.94        | Moderate               |
| Utility Value   | 3.67        | 0.85        | High                   |
| Test Anxiety    | 2.10        | 0.87        | Low                    |
| <b>Overall</b>  | <b>3.17</b> | <b>0.63</b> | <b>Moderate</b>        |

### Level of Students' Attitudes Toward Mathematics

Shown in Table 4 are the mean and standard deviation scores for the indicators of students' attitudes toward mathematics. The results indicate that the students' attitudes toward mathematics is sometimes demonstrated. The relative low standard deviation implies that students' responses are highly consistent, suggesting that most of the students demonstrate a moderate level of attitude toward mathematics. In particular, negative attitudes and positive attitudes were moderate, while the reversed tendency to avoid indicator was high, indicating a positive disposition.

Table 4. Level of Students' Attitudes Toward Mathematics

| Indicators        | Mean        | SD          | Descriptive Equivalent |
|-------------------|-------------|-------------|------------------------|
| Negative Attitude | 2.60        | 0.74        | Moderate               |
| Tendency to avoid | 2.94        | 0.68        | High                   |
| Positive Attitude | 2.60        | 0.77        | Moderate               |
| <b>Overall</b>    | <b>2.70</b> | <b>0.34</b> | <b>Moderate</b>        |

### Significance of the Relationship Between Teaching Strategies, Learning Styles, Motivation, and Student's Attitudes Toward Mathematics

As shown in Table 5, all the exogenous variables have significant relationship with attitude towards mathematics ( $p < .05$ ). This means that teaching strategies, learning styles, and motivation are all significantly

correlated with attitude toward mathematics. Particularly, teaching strategies demonstrate a weak positive significant relationship with students' attitude toward mathematics ( $r = 0.175, p < .001$ ), while learning styles show a weak negative significant relationship with students' attitudes toward mathematics ( $r = -0.14, p < .006$ ). On the other hand, motivation exhibited a strong positive significant relationship with students' attitudes toward mathematics ( $r = 0.782, p < .001$ ).

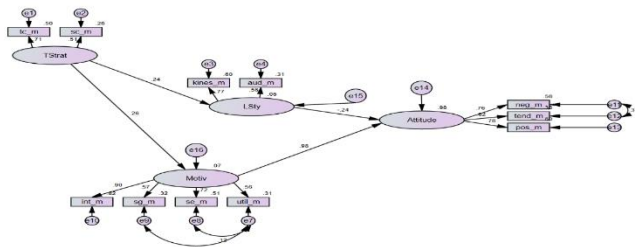
Table 5. Significance of the Relationships Between Teaching Strategies, Learning Styles, Motivation, and Student's Attitudes Toward Mathematics

| Variable            | Attitudes Toward Mathematics |         |             |
|---------------------|------------------------------|---------|-------------|
|                     | r                            | p-value | Remarks     |
| Teaching Strategies | 0.175                        | < .001  | Significant |
| Learning Styles     | - 0.14                       | < .006  | Significant |
| Motivation          | 0.782                        | < .001  | Significant |

**Best-fit Model of Students' Attitudes Toward Mathematics**

Represented in Figure 1 is the best-fit structural model of students' attitudes toward mathematics. It shows that teaching strategies significantly predict students' learning styles ( $\beta = 0.24$ ), and their motivation in learning mathematics ( $\beta = 0.26$ ). On the other hand, students' learning styles negatively predict their attitude towards mathematics ( $\beta = -0.24$ ), while motivation is the strongest predictor of attitude toward mathematics ( $\beta = 0.98$ ).

Figure 1. Best-fit Structural Model



To determine the best-fit model of attitude of the students towards mathematics, the goodness-of-fit indices were used to determine how well the model represents the observed data. As shown in Table 6.1, the CMIN/df for the best-fit model is 2.535, which satisfies the recommended threshold of less than 3, implying good model fit. All the incremental fit indices with NFI = 0.937, TLI = 0.941, CFI = 0.960, and GFI = 0.958 exceeded 0.90 suggest that the model fits the data well. Similarly, both Parsimony Normed Fit Index (PNFI = 0.630) and Parsimony Comparative Fit Index (PCFI = 0.646) exceed the recommended threshold of 0.50, indicating a good balance between model fit and parsimony. Meanwhile, the RMSEA value of 0.064 is below 0.08, and the p-CLOSE = 0.077 exceeds 0.05 further implies the model has a close fit to the population covariance matrix.

Table 6.1. Goodness of Fit Measures of the Best-Fit Model of Attitudes Toward Mathematics

| Index   | Criterion | Hypothesized Model | Remark   |
|---------|-----------|--------------------|----------|
| CMIN/df | <3        | 2.535              | Good Fit |

|         |       |       |          |
|---------|-------|-------|----------|
| NFI     | ≥0.90 | 0.937 | Good Fit |
| TLI     | ≥0.90 | 0.941 | Good Fit |
| CFI     | ≥0.90 | 0.960 | Good Fit |
| GFI     | ≥0.90 | 0.958 | Good Fit |
| PNFI    | >0.50 | 0.630 | Good Fit |
| PCFI    | >0.50 | 0.646 | Good Fit |
| RMSEA   | ≤0.08 | 0.064 | Good Fit |
| p-CLOSE | >0.05 | 0.077 | Good Fit |

### Underlying Implications of The Significant Causal Links in Attitudes Toward Mathematics

Table 6.2 represents the significant causal links in attitude towards mathematic based on the best-fit structural model. Results show that although teaching strategies do not have a significant direct effect on attitudes toward mathematics ( $\beta = .000$ ), they do influence attitude indirectly through learning styles and motivation ( $\beta = 0.199$ ). On the other hand, learning styles has a moderate significant direct effect on attitude ( $\beta = -.235$ ), and motivation has a significant direct effect on attitude ( $\beta = 0.978$ ).

Table 6.2. Standardized Direct, Indirect, and Total Effects on Students' Attitude Toward Mathematics

| Structural Path  | Direct Effect ( $\beta$ ) | Indirect Effect ( $\beta$ ) | Tota Effect ( $\beta$ ) |
|------------------|---------------------------|-----------------------------|-------------------------|
| TStrat →Attitude | —                         | 0.199*                      | 0.199*                  |
| LStyl →Attitude  | - 0.235*                  | —                           | - 0.235*                |
| Motiv →Attitude  | 0.978*                    | —                           | 0.978*                  |

Note: \* $p < .05$

## DISCUSSIONS

### Level of Teaching Strategies

Teaching strategies as perceived by students is described as high, indicating that both teacher-centered and student-centered are often employed in mathematics classrooms. This finding supports the claim of Kurniati and Surya (2017) that teaching strategies encompass both teacher-centered and student-centered approaches, which are essential in facilitating student learning. It also reinforces the conclusion drawn by Vale and Barbosa (2023) that math teachers generally employ a high level of diverse teaching strategies in the classroom to create an active learning environment, including effective collaborative work and mathematical communication.

The present results corroborate the study conducted by Wellberg (2024) who asserted that teacher-centered strategies remain prevalent in teaching mathematics. Similarly, Donkoh & Amoakwah (2024) emphasized that

in many educational settings with standardized exams are used as main assessment, large class sizes, or limited resources, teacher-centered approaches are still commonly employed. Furthermore, the high level of student-centered strategies supports the findings of Artuz and Roble (2021) who reported that student-centered practices are being adopted more frequently in teaching mathematics, as educators believe these strategies are more effective in supporting long-term academic success. It further reinforces the notion that promoting collaboration and learner autonomy has gradually become more common in math classrooms (Lumatauw et al., 2020; Wellberg, 2024; Permatasari et al., 2025).

Overall, although both teacher-centered and student-centered teaching strategies are practiced at a high level, teacher-centered strategies obtain a higher mean which implies that these practices are still more employed than student-centered. This result strengthens the conclusion that in many educational settings, particularly in traditional schools, teacher-centered strategies are still dominant (Stephan, 2020; Wellberg, 2024; Donkoh & Amoakwah, 2024).

### **Level of Learning Styles**

Students demonstrate a high level of learning styles, implying that students generally demonstrate a strong inclination toward diverse learning styles. This finding aligns with the report of Khatri and Khanal (2024) that students are not passive recipients of instruction; rather, they engage differently in learning mathematics with different learning styles. Moreover, Wahab and Nuraeni (2020) emphasized that students are aware of how they learn best, which can help them adapt their study habits and improve learning outcomes. The present outcome further supports the idea that students not only listen to explanations from the teacher, but they can be more active and learn more effectively when the learning environments align with their learning styles such as visual, auditory, and kinesthetic modalities (Khoirunnisa & Iba, 2022).

Visual learning style was found to be the most preferred among the three styles. This finding strengthens earlier conclusions reported by Khatri and Khanal (2024), that students generally feel more comfortable learning through visual means. It also supports the idea that most students experience a more interactive and interesting atmosphere in the learning process with visual learning approaches, enhancing understanding and retention (Putra et al., 2017; Hussin & Matore, 2023). Furthermore, kinesthetic learning style was also described as high, suggesting that this learning style is widely shared among students. The result supports the view of O'Brien (1945) and Simamora et al. (2025) that kinesthetic learners learn best through movement, manipulation, and direct interaction with learning materials. This finding aligns with the notion that kinesthetic learning is frequently manifested among students and is valued as an effective way to make lessons more engaging and interactive (Magulod, 2019; Vendiola, 2024; Simamora et al., 2025). On the other hand, auditory learning style was described as moderate, indicating that this learning style is sometimes evident among the students. This result supports the idea of Khatri and Khanal (2024), who reported that while auditory learning styles such as reading, or listening to explanations and lectures are practiced among students, these approaches are not as strongly preferred as visual and kinesthetic styles.

Overall, the result shows visual learning styles obtained the highest mean, followed by kinesthetic and auditory. The relatively low standard deviation values of the three learning styles implies that the results are stable and reliable, demonstrating consistent learning preferences among a large student population. This result is consistent with the view that most students prefer a visual learning style, followed by kinesthetic style, while auditory style is less preferred compared with the other two learning styles (Magulod, 2019; Masela & Subekti, 2021; Khatri & Khanal, 2024; Emban et al., 2025).

### **Level of Students' Motivation in Learning Mathematics**

Students' motivation in learning mathematics is described as moderate, indicating that students possess a fair but not strong drive to engage with mathematics. This result aligns with the findings reported by Schukajlow et al. (2023), that students in general demonstrate a moderate level of motivation in learning math, especially in terms of intrinsic value, self-efficacy, and utility value. It also substantiates the claim that while senior high school students are engaged, their motivational orientations toward mathematics is not consistently high (Campanilla, 2024; Balolong et al., 2025).

In particular, the high level of intrinsic value reinforces the findings of Rodríguez et al. (2021), who observed that students generally consider math interesting. This contributes additional support to the study of Adamma et al. (2018), who reported a high level of students' intrinsic motivation toward mathematics which is linked to persistence and success. Self-regulation was also rated as high, implying that students frequently demonstrate independent and proactive learning behavior. This present result reinforces the conclusion drawn by Balan and Jönsson (2025), who reported a high level of independence and proactive learning behavior among students, suggesting that students generally exert effort and monitor their own learning. In line with Fiorella et al. (2021), this finding emphasizes students' capability of identifying challenges, adjusting learning methods, and preparing for assessments in mathematics.

Meanwhile, the moderate level of self-efficacy suggests that although students have a reasonable belief in their ability to engage with mathematics, their confidence is not sufficiently stable to sustain optimal performance (Zakariya, 2022). This result aligns with the study of Clemente et al. (2024). Furthermore, students demonstrate a high level of utility value, implying that students generally rated math's usefulness positively. This result supports the findings reported by Bravo & Nobles (2023), that senior students placed a high value on learning mathematics, which in turn positively correlated with performance in the subject. It also reflects the view that older students tend to develop a deeper appreciation of mathematics as a vital life skill rather than merely a school subject (Metzger et al., 2019; Cerbito, 2020). Nevertheless, despite the reverse coding of the items, the relatively low mean suggests a high level of anxiety that students experience in situations related to mathematical testing. This evidence lends support to the study of Yarkwah et al. (2024), who reported high levels of mathematics test anxiety among senior high school students, with fear of failure being a major source. Similarly, Ablian and Parangat (2021) reported that elevated test anxiety reflects lower levels of positive emotional engagement with mathematics.

Overall, the finding suggests that students exhibit a moderate level of motivation in learning mathematics. In particular, test anxiety is dominant, which implies a low level of positive motivation, followed by utility value, self-regulation, and intrinsic value, of all which are described as high, implying a high level of positive motivation, while self-efficacy remains only moderate. These results imply that although students generally value mathematics and exert effort in learning it, they need to be more confident in their own mathematical abilities, and monitor their anxiety in math tests (Clemente et al., 2024; Yarkwah et al., 2024).

### **Level of Students' Attitudes Toward Mathematics.**

It should be noted that negatively worded items were reversed-coded prior to analysis; hence, higher mean scores indicate more positive attitudes toward mathematics. In this context, students' attitudes toward mathematics were rated as moderate, suggesting that their perceptions of the subject are generally balanced but not strongly positive. The result reflects the description of students' mathematical attitudes as a combination of beliefs, emotions, and behaviors that significantly influence engagement and learning outcomes (Hwang & Son, 2021; Levine and Pantoja, 2021). The finding aligns with Aquilina et al. (2024), who described attitude towards mathematics as a complex construct, frequently observed at a moderate level and dependent on the circumstances rather than consistently positive. Similarly, it also supports the view that students generally exhibit a neutral to moderately positive disposition toward the subject (Polala & Basmayor, 2024; Umac et al., 2025).

Particularly, both two indicators, which are negative attitude and positive attitude were rated as moderate, suggesting that although students occasionally experience unfavorable perceptions, such as lack of interest or difficulty in understanding the subject, they also recognize some value and interest in mathematics. This supports the view that students generally exhibit neither strong enthusiasm nor complete disengagement toward mathematics (Bosco et al., 2022; Hwang & Son, 2021; Polala & Basmayor, 2024). On the other hand, the indicator of tendency to avoid was rated as high, indicating a generally favorable behavioral orientation toward engaging in mathematical tasks and discussions among students. This finding contrasts with studies that reported high level of avoidance behavior among students (Estonanto & Dio, 2019; Wen & Dubé, 2022).

## Significance of the Relationship Between Teaching Strategies, Learning Styles, Motivation, and Student's Attitudes Toward Mathematics

The result shows that all the exogenous variables have a significant relationship with attitudes toward mathematics ( $p < .05$ ). This means that teaching strategies, learning styles, and motivation are all significantly correlated with attitudes toward mathematics. The present outcomes affirm the core assumptions of Expectancy-Value Theory (EVT) that both contextual and personal factors influence students' academic attitudes (Eccles & Wigfield, 2002).

Teaching strategies particularly demonstrate a weak positive relationship with students' attitudes toward mathematics ( $r = 0.175, p < .001$ ). This suggests that when the quality of teaching strategies improves, students' attitude towards mathematics tend to become more positive, although the magnitude of the relationship is weak. The result aligns with EVT's claim that instructional practices act as contextual influences shaping students' expectancy beliefs and task values. This finding is consistent with the study of Riegler-Crumb et al. (2019), who reported that students across diverse gender and racial/ethnic groups who experienced more inquiry-based learning in mathematics classrooms have more positive attitudes toward this subject in terms of confidence, self-efficacy, and interest. Similarly, Siller and Ahmad (2024) found that students who are actively involved in their learning process through collaborative activities and real-world problem-solving demonstrate high level of autonomy in learning mathematics and show a more favorable attitude towards the subject.

This finding also supports the assertion of Bature (2020) that instructional approaches are critical in shaping students' attitude towards mathematics. Moreover, the finding aligns with the notion that teaching strategies such as teacher-centered may help students build confidence and develop a more positive outlook toward mathematics (Stephan, 2020; Nasayao & Lingo, 2023), or student-centered strategies can foster students' critical thinking, encourage collaborative works can contribute to a positive learning environment, boosting confidence, enjoyment and active engagement in learning mathematics (Emanet & Kezer, 2020; Hokor & Sedofia, 2021; Wakhata et al., 2022).

Learning styles, on the other hand, show a weak negative relationship with students' attitudes toward mathematics ( $r = -0.14, p < .006$ ), indicating that certain learning style may tend to affect attitudes toward mathematics negatively. This significant relationship can be explained through EVT's emphasis on the alignment between individual characteristics and learning experiences. Teaching that aligns with students' learning styles empowers them and increases enjoyment and confidence, whereas a mismatch can cause anxiety and disengagement.

The negative effect, although minimal because the magnitude of the correlation is weak, supports the finding of Ishartono et al. (2021), who reported that some students, especially auditory and kinesthetic learners often face negative experiences in learning mathematics which focuses heavily on visual and written methods. Similarly, Sholihah & Aini (2023) discovered that auditory learners tend to experience boredom and anxiety when working with problem-solving that requires systematic approaches and minimizes verbal interaction. Also, Bearneza (2023) found that kinesthetic learners often struggle with abstract math concepts, showing lower motivation and negative attitudes compared to visual learners who benefited from diagrams. Overall, these findings suggest that different learning styles may influence students' attitudes toward mathematics differently, depending on how they engage and perceive mathematical information (Ishartono et al., 2021; Ikawati & Kowiyah, 2021). Learners whose preferred styles are not adequately supported by the instructional approach may be more likely to develop lesser positive attitudes toward mathematics.

Motivation was found to exhibit a strong positive relationship with students' attitude towards mathematics ( $r = 0.782, p < .001$ ). This implies that as the level of students' motivation in learning mathematics increases, so does their positive attitude towards the subject. Such result provides substantial support for EVT, which identifies that motivation encompasses expectancy beliefs (e.g., self-efficacy) and task values (e.g., intrinsic and utility value), as a central determinant of students' engagement and attitude. This outcome also confirms earlier findings by Casty et al. (2021) who observed that motivation and attitude are deeply intertwined

observable in one's performance and anxiety levels. In the same way, Hwang and Son (2021) reported that students who enjoy math and pursue math-related activities tend to develop more favorable attitude.

Moreover, this finding resonates with existing literature, which emphasizes the importance of motivation in academic settings (Fiorella et al., 2021), and its influence on students' attitudes toward specific subjects, including mathematics (Rodríguez et al., 2021; Sasidharan & Kareem, 2023). The result is consistent with the view that students with strong intrinsic motivation, self-efficacy and a clear understanding of utility value of mathematics tend to exhibit more positive attitudes, such as enjoying the lessons, dedicating more time for learning math, and prefer math than other subjects (Ukobizaba et al., 2020; Radišić et al., 2024).

Overall, among the three variables, motivation has the strongest relationship, suggesting that students' attitude towards mathematics are mostly linked to their motivation in learning the subject, while teaching strategies and learning styles show weak influences. The findings are strongly supported by the EVT, directly reflecting EVT's assertion that while contextual and personal factors shape learning experiences, internal beliefs and values are the strongest predictors of academic attitudes.

### **Best-fit Model of Students' Attitudes Toward Mathematics**

To determine the best-fit model of attitude of the students towards mathematics, the hypothesized structural model was first tested using Structural Equation Modeling (SEM). The overall model fit indices indicate that the hypothesized model did not adequately represent the interrelationships among teaching strategies, learning styles, motivation, and students' attitude towards mathematics. Thus, a model re-specification was conducted to achieve a better fitting structural model. In the model re-specification process, to improve the overall goodness of fit, the indicator visual learning and test anxiety were removed due to their weak relationship with their respective latent constructs, suggesting that these two indicators do not adequately represent the constructs they were intended to measure (Kline, 2016).

The best-fit model presents the relationships between the latent constructs and their observed indicators through factor loadings. In particular, both teacher-centered strategies (0.71) and student-centered strategies (0.51) are adequate to represent the teaching strategies construct. Kinesthetic (0.77) and auditory (0.56) demonstrate acceptable factor loadings to measure the learning styles construct. Similarly, intrinsic value (0.90), self-regulation (0.57), self-efficacy (0.72), and utility value (0.56) all effectively represent the motivation construct. Finally, negative attitude (0.76), tendency to avoid mathematics (0.78), and positive attitude towards mathematics (0.78) are all strong factor loadings to appropriately measure students' attitudes toward mathematics.

As shown in Figure 1, the best-fit model indicates that teaching strategies significantly predict learning styles. The positive coefficient of  $\beta = 0.24$  suggests that effective teaching strategies can develop students' favorable learning styles and engagement in learning activities. The result is consistent with the study of Pereyra (2020) who found that discussion-based and collaborative strategies encouraged auditory and social learning preferences, showing that teachers' methods actively shape students' tendencies. This finding supports the idea that instructional practices can positively influence students' learning behavior and cognitive engagement (Stephan, 2020; Khoirunnisa & Iba, 2022).

Also, teaching strategies can positively predict students' motivation in learning mathematics ( $\beta = 0.26$ ), indicating that as the teaching strategies become more effective, students' interest, perceived mathematical values, self-regulation, and confidence in learning mathematics will improve. This result supports the study of Vale and Barbosa (2023), who emphasized that effective math teaching strategies increase students' confidence, awareness of the importance of math, and engagement. Similarly, Alemany-Arrebola et al. (2025) supports that when students recognize the relevance of math in real-life situations, they are more likely to feel motivated, confident, and connected to the subject. This finding substantiates the claim that supportive instructional practices can foster students' academic motivation and engagement (Lo & Hew, 2021; Hwang & Son, 2021; Romero & Angeles, 2023).

Furthermore, the model shows that learning styles significantly predict students' attitude towards mathematics ( $\beta = -0.24$ ). The negative coefficient suggests that different learning styles may influence students' attitudes toward mathematics in varied ways. This relationship may possibly reflect the study of Abah et al. (2024), who observed that when teaching strategies do not align with students' preferred learning modalities, they may encounter difficulties in learning mathematics, which potentially lead to the development of negative attitudes toward the subject. This finding reflects the view that students' attitudes toward the subject may depend on how these activities are employed and matched with the learning styles (Bearneza, 2023; Mengote, 2024).

Notably, the best fit model shows that motivation appeared to be the strongest predictor of students' attitudes toward mathematics ( $\beta = 0.98$ ), indicating that motivated students tend to demonstrate more positive attitudes toward mathematics. The result supports the conclusion that improving the level of motivation can develop students' positive perceptions toward the subject (Hwang & Son, 2021; Radišić et al., 2024). This finding further affirms the findings of previous studies which emphasized the significance of intrinsic values, self-regulation, self-efficacy, and perceived mathematical values in shaping students' attitude towards mathematics (Paguican & Torreon, 2020; Pacaldo & Gardose, 2025; Feraco et al., 2022; Sasidharan & Kareem, 2023).

### **Underlying Implications of The Significant Causal Links in Attitude Towards Mathematics**

As shown in Table 6.2, teaching strategies have no significant direct effect on attitude towards mathematics ( $\beta = .000$ ). This outcome diverges from the conclusion that instructional practices directly influence students' attitude towards mathematics (Nasayao & Lingo 2023; Britwum et al., 2024; Ahmad, 2024). However, although teaching strategies did not affect attitude directly, they significantly shape students' attitude towards mathematics indirectly by improving students' motivation and learning styles, which in turn influence their attitude towards mathematics ( $\beta = .199, p < .05$ ). This finding aligns with the study of Awado et al. (2024), who explained that attitude does not operate as a pure direct outcome but rather as part of the indirect causal chain linking instructional approach to broader learning outcomes. The total effect of teaching strategies on attitude towards mathematics is  $\beta = 0.199$  further reflects the theoretical assumption that instructional practices influence affective learning through motivational and cognitive pathways (Caballero et al., 2025; Calibara & Belarga, 2024; Wahab & Nuraeni, 2020).

Learning styles, on the other hand, were found to have a significant direct effect on attitudes ( $\beta = -.235, p < .05$ ). The negative coefficient suggests that variations in students' learning preferences may influence how they perceive and respond to mathematics learning experiences. This finding is supported by Villegas-Ch et al. (2024), who emphasized that when the preferred learning styles are not fully accommodated by learning environment, students may struggle in processing and retaining information, which can decrease motivation and interest in learning, and increase frustration. Similarly, this result aligns with the findings of previous studies, which reported that mismatches between students' preferred learning styles and instructional methods can lead students to boredom and anxiety, contributing to decreased interest and develop a tendency to avoid towards the subject (Sulisawati et al., 2019; Bearneza, 2023).

Furthermore, motivation also demonstrated a significant direct effect on attitudes ( $\beta = 0.978, p < .05$ ), emerging as the strongest predictor of students' attitudes toward mathematics. This finding upholds the premise that motivation significantly predicts students' positive attitude towards mathematics. Students with high motivation tend to actively participate in classes, do their assignments, and take part in co-curricular activities that enhance their learning (Weidinger et al., 2020; Vu et al., 2021; Hwang & Son, 2021; Luo et al., 2023). The present evidence substantiates the claim that students with a high level of intrinsic value, self-regulation, and self-efficacy tend to demonstrate more positive emotional dispositions such as curiosity and a willingness to engage in learning mathematics (Radišić et al., 2024; Pacaldo & Gardose, 2025; Luo et al., 2023).

Overall, by examining the inter relationships among variable using structural equation model (SEM), the results suggest that motivation plays the most critical role in shaping students' attitude towards mathematics, followed by learning styles. On the other hand, while not directly influencing attitude, teaching strategies can indirectly influence student's attitude by fostering motivation and learning styles. This present evidence substantiates the claim that balanced integration of teaching strategies and learning styles will create a

supportive environment that boosts student motivation and positive attitude towards mathematics. (Carr et al., 2024; Muminu & Munadi, 2025).

## CONCLUSION

Based on the findings of the study, several conclusions were drawn. Math teachers generally apply diverse strategies in classrooms at a high level. Although both teacher-centered and student-centered teaching strategies are often observed, the practice of teacher-centered approaches is still employed more consistently and structured in mathematics classrooms. The learning styles are also oftentimes evident among the students. Most students preferred a visual learning style, followed by a kinesthetic style, while the auditory style was less preferred than the other two. Students' motivation in learning mathematics is sometimes observed. Although anxiety is dominant and self-efficacy is sometimes observed, the students generally demonstrate high positive motivation in learning mathematics in terms of utility value, self-regulation, and intrinsic value. However, variations in students' confidence and the presence of test-related anxiety may limit the development of stronger and more consistent motivation toward mathematics learning. Similarly, students sometimes demonstrate positive attitude towards mathematics. While they acknowledge the importance and interest of the subject, lingering perceptions of difficulty and differences in students' willingness to engage in mathematics learning may limit the development of stronger positive attitude. Furthermore, teaching strategies, learning styles, and motivation are all significantly correlated with attitude towards mathematics. While both teaching strategies and learning styles show a weak influence on students' attitude, students' motivation emerges as the most influential factor associated with their attitude toward the subject. The hypothesized model did not adequately represent the interrelationships among variables. A model re-specification was conducted by removing some indicators due to their weak relationship with their respective latent constructs. As a result, the revised model shows acceptable goodness of fit indices, indicating that teaching strategies, learning styles, and motivation are crucial in shaping students' attitude towards mathematics. Finally, the best-fit structural model demonstrates that motivation plays the most critical role in shaping students' attitude towards mathematics, followed by learning styles, while teaching strategies were found to indirectly influence students' attitudes by fostering motivation and learning styles.

## RECOMMENDATION

Math teachers may consider implementing student-centered strategies more often in the classrooms such as open-ended questioning, group work, collaborative tasks, inquiry-based instruction, or hands-on activities to enhance students' critical thinking, motivation, and participation. Considering the diverse learning styles among the students, teachers may provide a learning environment that prioritizes students' needs, interests, and abilities, particularly by incorporating visual representations, manipulatives, and activity-based learning, which align with students' preference for visual and kinesthetic learning. Since motivation was found to be the strongest predictor of students' attitudes toward mathematics, schools and math teachers may consider implementing strategies that foster students' readiness to learn. These strategies could include providing meaningful learning experiences, real-life applications of mathematics, positive feedback, and supportive classroom environments that can increase students' interest, build self-regulation, confidence, and resilience. Future researchers may validate and extend the proposed structural model by employing larger and more diverse samples across different regions and educational levels, while also refining measurement instruments for constructs that showed weak indicators.

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