# An Exploration of Topic-wise Mastery in Mathematics and its Relationship with Students' Motivation, Perception, and Interest.

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Received: 27 November 2025; Accepted: 29 December 2025

**Abstract:** This study investigates the heterogeneity of topic-wise mastery in mathematics and its relationship with affective factors among Malaysian secondary school students. Despite documented national weaknesses in international assessments such as PISA (*PISA 2022 Results (Volume I)*, 2023) it remains unclear which specific curriculum topics pose the greatest challenges. Using a quantitative design, the achievement of 50 Form 2 students was assessed across five core mathematical domains: Algebra, Geometry, Statistics, Probability, and Straight Lines. Affective factors, including Motivation, Perception, and Interest, were measured via a survey questionnaire. Repeated Measures ANOVA revealed a highly significant main effect of topic on student achievement ($p < 9.255 \times 10^{-31}$). Multiple Linear Regression (MLR) analysis indicated that affective factors were not statistically significant predictors of achievement for any individual topic. These findings highlight the necessity of a topic-wise diagnostic approach and suggest that extrinsic, structural factors, such as instructional quality, are the dominant influences on topic-wise success, calling for targeted pedagogical interventions in abstract domains.

**Keywords:** Diagnostic Test, Mathematics Education, Topic-wise Mastery, Secondary School

## Introduction

Mathematics is a compulsory subject in Malaysian secondary schools and serves as a foundation for the advancement of science, technology, and innovation. It equips students with essential skills such as logical reasoning, critical thinking, and problem-solving. However, recent international assessments have revealed concerning trends in Malaysian students' mathematics performance, highlighting the need for targeted interventions. Since 1999, Malaysia has participated in major international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA). Malaysia's PISA mathematics score declined significantly from 440 in 2018 to 409 in 2022, falling below the OECD average of 472 points. Only 41% of Malaysian students achieved at least Level 2 proficiency, compared to the OECD average of 69% (*PISA 2022 Results (Volume I)*, 2023). These findings suggest that many Malaysian students lack the fundamental competencies expected at their grade level. Wong & Wong (2019) similarly reported fluctuations in Malaysian students' mathematics performance across international assessments, reinforcing the need for deeper investigation into specific areas of difficulty.

Given these challenges, analyzing mathematics achievement from a topic-wise mastery perspective has become increasingly important. Literature indicates that students' proficiency varies significantly across content domains such as Number, Algebra, Geometry, and Data & Probability (Mullis et al., 2016., 2020) International assessments like TIMSS highlight that students may perform moderately overall while still experiencing substantial weaknesses in specific domains. Without domain-specific analysis, weaknesses especially in algebraic manipulation or geometric reasoning have risk being overlooked. Researchers therefore recommend using diagnostic tools and topic-specific assessments to identify misconceptions and gaps in understanding (Fiorella et al., 2021; Yuanita et al., 2018). This aligns with the Malaysian Form 2 KSSM curriculum, which emphasizes reasoning, problem-solving, and application of knowledge across varied cognitive domains. Evaluating mastery across Algebra, Geometry, Statistics, Probability, and Straight Lines (Coordinate Geometry) thus provides a meaningful and contextually relevant analysis of students' competencies.

Beyond cognitive mastery, affective factors such as motivation, perception, and interest also influence mathematics learning. Motivation, grounded in Self-Determination Theory (Ryan & Deci, 2020) and Expectancy-Value Theory (Wigfield & Eccles, 2000), shapes students' engagement with mathematical tasks. Intrinsically motivated students demonstrate greater persistence, more positive attitudes, and higher achievement (Hossein-Mohand & Hossein-Mohand, 2023). Perception, including beliefs about the value, relevance, and difficulty of mathematics, is similarly important; positive perceptions and high self-efficacy correlate with stronger achievement, whereas negative perceptions and anxiety contribute to avoidance and poorer performance (Ahmed et al., 2012; Omar et al., 2022; Zakariya, 2022). Interest, as conceptualized in the Four-Phase Model of Interest Development ((Hidi & Ann Renninger, 2006), enhances engagement and long-term persistence, particularly benefiting lower-achieving students (Fiorella et al., 2021; Wong & Wong, 2019).

These affective factors are interrelated: motivation can shape perceptions, and motivation, perception, and interest collectively influence performance and engagement (Fiorella et al., 2021; Hossein-Mohand & Hossein-Mohand, 2023). However, most existing studies focus on overall mathematics achievement rather than domain- specific proficiency. There is a gap in research regarding how topic-wise mastery relates to these affective constructs, particularly among Malaysian secondary school students. Local studies often examine these factors independently, with limited integration into a unified model of topic-specific mastery.

To address these gaps, the present study examines Form 2 students' topic-wise mastery across five key mathematical domains which are Algebra, Geometry, Statistics, Probability, and Straight Lines. This study investigates the relationship between mastery and students' motivation, perception, and interest. These topics are critical for progression into the upper-secondary science stream, where students must demonstrate sufficient mastery to enter STEM-focused classes. By adopting a topic-specific and affective lens, this study provides nuanced insights into students' mathematical strengths and weaknesses, supporting educators in designing targeted interventions to improve mathematics learning outcomes in Malaysia.

## Methodology

This study employed a quantitative research design using purposive sampling, recruiting 50 Form 2 students drawn from three Form 2 classes in a secondary in Kuantan, Malaysia. The classes were chosen based on accessibility and school approval. Students from the selected classes who agreed to participate were included in the study. Form 2 students were chosen because they have learned the mathematics topics assessed in this study and are at an important stage of academic development.

### *Instruments*

Two primary instruments were used for data collection:

1. Mathematics Diagnostic Test: This instrument was designed to evaluate topic- wise mastery. It covered five specific domains: Algebra, Geometry, Statistics, Probability, and Straight Lines (Coordinate Geometry). The test comprised objective (multiple-choice) and subjective (problem-solving) sections, each with 10 questions. Content validation was conducted by experienced school mathematics teachers to ensure alignment with the Form 2 national curriculum.

2. Survey Questionnaire: This measures the three affective factors (Motivation, Perception, and Interest) towards mathematics. This questionnaire utilized a Likert scale format to quantify students' self-reported attitudes and beliefs.

### *Data Collection*

The data collection was executed in three sequential phases to ensure the validity and reliability of the administered instruments. The Preparation Phase involved securing all necessary institutional and ethical approvals prior to accessing the school and participants. The two primary research instruments, which are the Mathematics Diagnostic Test (achievement) and the Survey Questionnaire (affective factors) were finalized, with the diagnostic test undergoing content validation by experienced Form 2 subject teachers to ensure strict alignment with the current national curriculum syllabus.

The Administration Phase involved physically administering the instruments to the 50 Form 2 students at the selected school via purposive sampling. The data collection was carried out in a single session within a controlled, standardized exam setting, under the supervision of the school's teacher, to minimize bias and ensure standardized conditions across all participants. The Data Management Phase involved coding and collating the raw scores from the Diagnostic Test, which generated five separate achievement scores (one for each topic) for every student, alongside the quantified responses from the affective factor survey, preparing the data matrix for statistical computation.

### *Data Analysis*

All statistical analyses were conducted using R software. The analysis addresses the two research objectives through distinct statistical approaches. The first analysis used to address Research Objective 1 (evaluation of topic-wise mastery), a One-Way Repeated Measures Analysis of Variance (ANOVA) was performed. This method was chosen because the achievement scores for the five mathematical topics were

measured on the same group of 50 students, which controls for inter- subject variability, increasing the statistical power of the test. A significant F-test was followed by Bonferroni post-hoc comparisons to identify the specific topic pairs that exhibited significant mean score differences.

Secondly, to address Research Objective 2 (examining the relationship between achievement and affective factors), Multiple Linear Regression (MLR) was employed. Five separate MLR models were constructed, one for each topic, with the topic achievement score serving as the dependent variable and the three affective factors (Motivation, Perception, and Interest) as the independent predictors. This analysis assessed the unique contribution and statistical significance of each affective factor in explaining the variance in domain-specific achievement.

## Results and Discussion

A total of 50 Form 2 students participates in the study consisting of 27 male students (54%) and 23 female students (46%). This relatively balanced gender distribution ensures that the findings reflect perspectives and performance patterns that do not heavily favor one gender over the other (Table 1). The demographic profile establishes a clear context for interpreting the subsequent results.

**Table 1: Gender Distribution of Respondents**

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 27 | 54% |
| Female | 23 | 46% |
| Total | 50 | 100% |

*Analysis on the Topic-Wise Mastery*

Students' mastery was examined across five major mathematics topics comprising Algebra, Geometry, Probability, Statistics, and Straight Lines. The descriptive analysis revealed notable differences in performance across topics (Table 2). Statistics recorded the highest mastery level with a mean score (M = 5.70, SD = 2.17), suggesting that data-related content may be taught more effectively or perceived as more intuitive due to its concrete nature and frequent real-world applications. Similar patterns have been observed in international large-scale assessments, where contextualized and data-based tasks are generally more accessible to students (*PISA 2022 Results (Volume I)*, 2023).

In contrast, Straight Lines the lowest mean score (M = 0.88, SD = 1.27), indicating considerable difficulty with abstract reasoning and coordinate geometry. This finding aligns with evidence from PISA and TIMSS, which consistently report that Malaysian students struggle with higher-order mathematical thinking, particularly in topics involving algebraic representation and abstract reasoning (Mullis et al., 2020; *PISA 2022 Results (Volume I)*, 2023).

Algebra (M = 3,17, SD = 1,74) and Probability (M = 3.10, SD = 2.86) showed moderate performance, while Geometry reflected slightly weaker achievement (M = 2.48, SD = 2.01). The relatively similar achievement across these three topics suggests that students experience comparable levels of difficulty when dealing with symbolic manipulation and spatial reasoning.

**Table 2: Descriptive Statistic Analysis for Students' Mastery Scores Across All FiveTopics**

| Topic | Mean | Standard Deviation (SD) |
|---|---|---|
| Algebra | 3.17 | 1.74 |
| Geometry | 2.48 | 2.01 |
| Probability | 3.10 | 2.86 |
| Statistics | 5.70 | 2.17 |
| Straight Lines | 0.88 | 1.27 |

A one-way Repeated Measures ANOVA was conducted to determine whether the differences in mean scores across the five topics were statistically significant. Due to violation of the sphericity assumption, the Greenhouse-Geisser correction was applied. The results showed a significant overall difference in topic-wise mastery, with F(4, 196) = 54.33, $p$ < 0.05, with a large effect size (generalized $\eta^2$ = 0.363 (Table 3). This confirms that the variation observed in the descriptive analysis was not due to random chance but reflected meaningful disparities in student achievement across mathematical domains.

The post hoc pairwise comparisons revealed that Statistics performed significantly better than every other topic, while Straight Lines performed significantly worse than all other topics. In contrast, the differences between Algebra, Geometry, and Probability were not statistically significant, suggesting that students experienced a similar level of difficulty across these three domains. Overall, the findings indicate three distinct performance clusters: high mastery in Statistics, moderate mastery in Algebra, Geometry, and Probability, and low mastery in Straight Lines.

**Table 3: One-Way Repeated Measures ANOVA Summary**

| Effect | Dfn | Dfd | SSn | SSd | F | p | $p < 0.05$ | Generalized Eta Squared ($\eta^2$ ) $G$ |
|---|---|---|---|---|---|---|---|---|
| Intercept | 1 | 49 | 2350.089 | 513.161 | 224.402 | $6.366 \times 10^{-20}$ | Sig. | 0.690 |
| Topic | 4 | 196 | 603.596 | 544.404 | 54.528 | $9.255 \times 10^{-31}$ | Sig. | 0.363 |

**Note:** The Greenhouse-Geisser correction was applied due to a violation of the sphericity assumption.

*Analysis on the Affective Factors*

Students' affective factors were measured in terms of motivation, perception, and interest using a five-point Likert scale (Table 4). Motivation recorded the highest mean score (M = 3.65, SD = 0.50), indicating that students generally recognized the importance and usefulness of mathematics. However, perception (M = 2.79, SD = 0.40) and interest (M = 2.88, SD = 0.34) were slightly below the neutral midpoint. This suggests that although students are externally motivated to learn mathematics, they do not consistently hold positive feelings toward the subject nor exhibit strong intrinsic interest. These mixed affective responses may help explain why motivation alone does not necessarily translate into strong topic-specific achievement.

**Table 4: Descriptive Statistic Analysis of the Affective Factors**

| Affective Factors | Mean | SD |
|---|---|---|
| Motivation | 3.65 | 0.50 |
| Perception | 2.79 | 0.40 |
| Interest | 2.88 | 0.34 |

*Analysis on Relationship Between the Affective Factors and Mathematics Achievement*

First and foremost, the study determines whether motivation, perception, and interest predict students' achievement, Multiple Linear Regression models were developed for the total mathematics score and for each of the five mathematical topics (Table 5). All necessary assumptions of linear regression, including normality of residuals, homoscedasticity, linearity, and multicollinearity thresholds, were satisfied after minor data transformations, ensuring that the findings are statistically reliable.

Across all six regression models, none of the affective factors significantly predicted students' performance in any topic. The p-values for overall model fit ranged from 0.14 to 0.57, indicating no significant relationships. In addition, the $R^2$ values were low, ranging from 0.04 to 0.11, suggesting that motivation, perception, and interest collectively explained less than 12% of the variance in performance.

Similar findings have been reported in recent studies, which suggest that affective variables may have limited explanatory power when achievement is measured at a topic-specific level rather than as an overall mathematics score (Schukajlow et al., 2017; Tosto et al., 2016).

Although interest consistently showed the strongest positive trend, particularly in Algebra and Straight Lines, the effects did not reach statistical significance. This suggests that while students' interest may contribute modestly to engagement, topic-specific mastery is more strongly influenced by factors such as instructional quality, prior knowledge, cognitive readiness, and topic complexity rather than affective disposition alone.

Recent research supports that instructional practices and cognitive factors play a more dominant role than affective factors in predicting mathematics performance, especially in abstract topics (Guo et al., 2015). These findings contrast with studies that report strong relationships between affective factors and general mathematics achievement, possibly due to the focused, topic-specific measurement used in this study and the relatively small sample size (Howard et al., 2021).

**Table 5: Multiple Linear Regression Coefficients Analysis of All 6 Models**

| Topic | Predictor | $\beta$ | SE | $t$ | $p$-value | $\beta_{std}$ | VIF |
|---|---|---|---|---|---|---|---|
| **Total Score** | Motivation | 1.888 | 2.307 | 0.819 | 0.417 | 0.131 | 1.289 |
| | Perception | 1.088 | 3.049 | 0.357 | 0.723 | 0.060 | 1.414 |
| | Interest | 4.849 | 3.167 | 1.531 | 0.133 | 0.232 | 1.152 |
| **Algebra** | Motivation | -0.037 | 0.562 | -0.066 | 0.948 | -0.011 | 1.289 |
| | Perception | -0.114 | 0.742 | -0.153 | 0.879 | -0.026 | 1.414 |
| | Interest | 1.409 | 0.771 | 1.827 | 0.074 | 0.278 | 1.152 |
| **Geometry** | Motivation | 0.374 | 0.655 | 0.571 | 0.571 | 0.093 | 1.289 |
| | Perception | -0.000 | 0.866 | 0.000 | 1.000 | 0.000 | 1.414 |
| | Interest | 1.226 | 0.899 | 1.363 | 0.179 | 0.210 | 1.152 |
| **Probability** | Motivation | 0.224 | 0.937 | 0.239 | 0.812 | 0.039 | 1.289 |
| | Perception | 1.427 | 1.238 | 1.153 | 0.255 | 0.198 | 1.414 |
| | Interest | 0.398 | 1.286 | 0.309 | 0.759 | 0.048 | 1.152 |
| **Statistics** | Motivation | 1.046 | 0.671 | 1.560 | 0.126 | 0.252 | 1.289 |
| | Perception | 0.357 | 0.886 | 0.402 | 0.689 | 0.068 | 1.414 |
| | Interest | 0.623 | 0.921 | 0.676 | 0.502 | 0.103 | 1.152 |
| **Straight Lines** | Motivation | 0.317 | 0.402 | 0.788 | 0.435 | 0.124 | 1.289 |
| | Perception | -0.435 | 0.531 | -0.819 | 0.417 | -0.135 | 1.414 |
| | Interest | 1.057 | 0.551 | 1.918 | 0.061 | 0.286 | 1.152 |

## Conclusion

This study concludes that Form 2 students demonstrate uneven mastery across mathematics topics, with strong performance in Statistics but considerable difficulties in Straight Lines, Algebra, Geometry, and Probability, indicating gaps in abstract reasoning and coordinate geometry. Although students reported moderate motivation and neutral perceptions and interest, these affective factors did not significantly predict achievement in any topic, suggesting that cognitive readiness, instructional quality, and topic complexity may play a more influential role in shaping performance. The findings highlight the importance of topic-specific diagnostic assessments and targeted instructional interventions that address students' weaknesses, particularly in abstract domains, while also emphasizing that improving affective factors alone is insufficient to enhance achievement. Overall, the study provides insight into the need for more focused pedagogical approaches to support students' mathematical understanding at the lower secondary level.

## Acknowledgement

I would like to express sincere appreciation to the International Islamic University Malaysia (IIUM), particularly the Department of Computational and Theoretical Sciences (CTS) of Kulliyyah of Sciences, for providing a supportive academic environment and the necessary facilities throughout the completion of this study. The guidance, resources, and opportunities offered by the department have greatly contributed to the successful completion of this research. I would also like to extend my gratitude to the National STEM Association for their support, particularly through the Mini Theater STEM Pahang project, which involved students who contributed to this study. Their cooperation and commitment provided valuable support to the data collection process and enriched the overall quality of this research.

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