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Exploring the Level of Numeracy and Mathematics Achievement of Grade 10 Students

Roel G. Silva*[1], Prof. Charity A. Aldover[2]
[1] Callejon National High School, San Antonio, Quezon, Philippines
[2] Batangas State University The NEU, Batangas City, Philippines
Corresponding Author e-mail: *roel.silva@g.batstate-u.edu.ph*

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Abstract
Aim: This study aimed to explore the level of numeracy and mathematics achievement of Grade 10 students and to examine the relationship between these two variables. Specifically, it sought to assess students' numeracy and mathematics achievement, determine whether a significant relationship exists between them, and identify learning difficulties to serve as bases for developing a Strategic Intervention Material.
Methodology: A cross-sectional descriptive-correlational design was employed using a researcher-made Numeracy Test (KR-20 = 0.9064) and a Mathematics Achievement Test (KR-20 = 0.9078). The respondents were 377 Grade 10 students randomly selected through stratified sampling from a total population of 18,179 students in the 1st and 2nd districts of Quezon Province. Data were analyzed using frequency, weighted mean, standard deviation, and Pearson's r correlation test.
Results: Findings revealed that most students were at the emergent numeracy level (M = 50.88, SD = 14.37) and exhibited low mastery across the three mathematics domains: Patterns and Algebra (M = 52.59), Geometry (M = 33.33), and Statistics and Probability (M = 41.04). Correlation analysis indicated a strong positive relationship between numeracy and overall mathematics achievement (r = .679, p < .001, 95% CI [.62, .73]).
Conclusion: The study concludes that numeracy is strongly and significantly associated with mathematics achievement, underscoring the need for targeted interventions to strengthen numeracy skills and improve strand-specific performance.
Keywords: *Numeracy, Mathematics Achievement, Strategic Intervention Material, Grade 10, Philippines*

INTRODUCTION

Mathematics is considered one of the most important school subjects because it is deeply connected to everyday life. Activities such as buying essentials, measuring distances, calculating quantities, and determining time and dates rely heavily on mathematics. As a result, educational authorities emphasize improving students' problem-solving and computational skills. To achieve these goals, the Philippine Mathematics Curriculum was organized around five key content areas: Numbers and Number Sense, Measurement, Geometry, Patterns and Algebra, and Statistics and Probability (Mathematics Framework for Philippine Basic Education, 2011). These areas are taught in a spiral progression, helping students gradually develop more complex thinking and problem-solving abilities.

However, students often do not meet the expected mastery levels in international assessments. In the 2018 and 2022 Program for International Student Assessment (PISA), the Philippines ranked among the lowest-performing countries, with many students not reaching the minimum proficiency level in mathematics (OECD, 2019; OECD, 2023). Similarly, in the Trends in Mathematics and Science Study (TIMSS), Filipino students scored far below the international average (Kelly et al., 2020). These results highlight persistent weaknesses in mathematical literacy that affect the entire education system. More recent analyses reveal that numeracy and foundational math skills remain urgent challenges in the Philippines and Southeast Asia (Bayod, 2021; Bernardo & Medallon, 2022; Phonapichat & Sornkhatha, 2023). At the same time, studies show that parental support, socioeconomic background, and early

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exposure to numbers significantly influence children's numeracy development across Asian contexts, including the Philippines (Cheung et al., 2021; Abenojar et al., 2025). These insights suggest that low achievement in mathematics is not only a classroom issue but is also shaped by broader socio-ecological factors.

At both national and regional levels, similar gaps persist. Between 2009 and 2015, the National Achievement Test (NAT) revealed an average Mean Percentage Score (MPS) of 47.79 in mathematics, far below the desired mastery level of 75. In Region IV-A (CALABARZON), the average MPS dropped even further to 40.02 (Abatayo, Pantallano, & Gumacial, 2018). Additionally, the Annual Status of Education Report (ASER, 2015) found that 50% of Grade 5 students in CALABARZON could not master basic Grade 2 math skills, while 44% of Grade 8 students struggled with Grade 5 math problems. These statistics underscore foundational learning gaps that may hinder performance in higher grade levels.

The COVID-19 pandemic exacerbated these challenges. As schools shifted to remote and blended learning, the Department of Education (DepEd) implemented the "Sulong Edukalidad" framework and streamlined the curriculum using the Most Essential Learning Competencies (MELCs) to sustain learning continuity (DepEd, 2020). In Quezon Province, Division Memorandum No. 051, s. 2020 mandated the administration of the Early Grade Mathematics Assessment (EGMA) for Grade 1 and the Numeracy Test for Grades 2–10 during the 2020–2021 school year. The test covered integers, fractions, decimals, place values, Roman numerals, simple geometry, and word problems involving money and business. Results showed that 70.96% of learners were classified as non-numerates, while only 29.04% were numerates (SDO Quezon, 2021). These findings emphasize serious deficiencies in basic arithmetic skills at the divisional level.

Beyond pandemic-related setbacks, numeracy remains a critical skill in today's VUCAD (volatile, uncertain, complex, ambiguous, and disruptive) environment shaped by globalization, artificial intelligence, and rapidly changing socio-economic demands. Recent research stresses that numeracy is not only an academic skill but also a life competency that influences informed decision-making, employability, and civic engagement (Sari, 2022; Reys & Reys, 2023; Pangilinan et al., 2025). Without a strong grasp of numeracy, students risk reduced opportunities in higher education, limited job prospects, and challenges in engaging meaningfully with society.

While several studies have examined mathematics performance at the national level, there is limited empirical research on the direct link between numeracy levels and strand-specific mathematics achievement among Grade 10 students in Quezon Province. No study has systematically measured both the numeracy levels and mathematics achievement of these students and examined their correlation. This study addresses this gap by analyzing numeracy and math achievement across strands (Patterns and Algebra, Geometry, Statistics and Probability) and by exploring the moderating role of spatial ability. By localizing the investigation to Quezon Province and using reliable researcher-made tests with strong internal consistency (KR-20 > 0.90), this study provides both theoretical and practical contributions. The findings aim to serve as evidence for designing targeted interventions to improve numeracy and strand-specific mathematics performance, ultimately supporting students' academic and lifelong success.

Theoretical Framework

This study is anchored on Information Processing Theory and Piaget's Theory of Cognitive Development, which together provide a cognitive foundation for understanding how numeracy supports broader mathematical achievement. Information Processing Theory posits that mathematical problem-solving requires efficient encoding, storage, and retrieval of information, with working memory and attentional control predicting success in computation and reasoning (Sweller, van Merriënboer, & Paas, 2019). Similarly, Piaget's framework highlights the developmental progression of logical and abstract thought, particularly during adolescence, when students develop proportional reasoning and formal deductive logic—skills essential for algebra, geometry, and statistics.

Based on these theories, this framework proposes that numeracy level positively predicts performance across mathematics strands. The numeracy–algebra link is expected to be stronger than the numeracy–geometry link, since algebraic reasoning is more closely tied to symbolic manipulation. Moreover, spatial ability is assumed to moderate the numeracy–geometry relationship, such that students with higher spatial skills demonstrate stronger connections between numeracy and geometry achievement. These perspectives align with recent findings emphasizing that educational interventions must be adaptive and context-driven to address students' varying competencies (Bontuyan, 2025).

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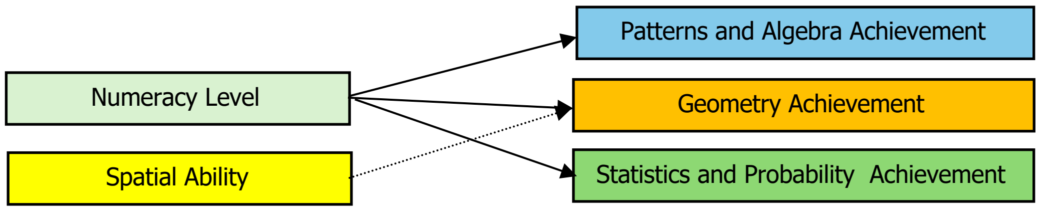
Conceptual Model: Numeracy and Mathematics Achievement



Statement of the Problem

Mathematics remains a critical foundation for students' academic and lifelong success, yet many learners continue to struggle in mastering essential numeracy skills and achieving satisfactory performance in the subject. Recent large-scale assessments, such as PISA and the National Achievement Test (NAT), consistently reveal that Filipino students underperform in mathematics compared to international and national benchmarks. These results highlight persistent gaps in numeracy, problem-solving, and conceptual understanding, particularly among secondary learners. In the Division of Quezon, anecdotal reports and preliminary assessments suggest that Grade 10 students encounter challenges in numeracy and demonstrate weak mastery across key mathematical strands such as Patterns and Algebra, Geometry, and Statistics and Probability.

Given these challenges, there is an urgent need to determine the current level of numeracy and mathematics achievement of Grade 10 students and to examine whether a significant relationship exists between these two variables. Further, it is essential to identify common difficulties faced by students in learning mathematics to serve as a basis for targeted instructional support. By addressing these gaps, the study aims to provide evidence-based recommendations that can guide the development of Strategic Intervention Materials (SIMs) and strengthen teaching–learning practices in mathematics.

Research Objectives

This study aimed to explore the level of numeracy and mathematics achievement of Grade 10 students in the Division of Quezon.

Specifically, it sought to:

1. Determine the level of numeracy of Grade 10 students.
2. Assess the mathematics achievement of Grade 10 students in terms of:
   2.1. Patterns and Algebra,
   2.2. Geometry, and
   2.3. Statistics and Probability.
3. Determine whether a significant relationship exists between the level of numeracy and mathematics achievement of Grade 10 students across the three strands.
4. Identify the common difficulties encountered by Grade 10 students in learning mathematics.
5. Provide evidence-based recommendations for the development of Strategic Intervention Materials (SIMs) to address identified gaps.

Research Questions

To achieve the stated objectives, this study sought to answer the following research questions:

1. What is the level of numeracy of Grade 10 students in the Division of Quezon?
2. What is the mathematics achievement of Grade 10 students in terms of:
   a. Patterns and Algebra,
   b. Geometry, and
   c. Statistics and Probability?
3. Is there a significant relationship between the level of numeracy and mathematics achievement of Grade 10 students across the three strands?
4. What common difficulties are encountered by Grade 10 students in learning mathematics?
5. What recommendations can be drawn for the development of Strategic Intervention Materials (SIMs) to address identified gaps?

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METHODS

Research Design

This study employed a cross-sectional descriptive–correlational research design to determine the relationship between students' numeracy and mathematics achievement. A cross-sectional design was chosen because data were collected at a single point in time, while a correlational approach was appropriate since the goal was to measure associations between variables rather than infer causation (Hunziker & Blankenagel, 2021). Similar designs have been widely applied in educational contexts to assess student learning outcomes and to establish baseline evidence for instructional improvements (Pangilinan, 2025).

Population and Sampling

The participants of this research were Grade 10 students from public and private schools in the 1st and 2nd Districts of Quezon Province. From the total population of 18,179 Grade 10 students, 377 respondents were determined using the Raosoft sampling calculator with a 5 percent margin of error and 95 percent confidence level. To ensure representativeness, a stratified random sampling technique was employed, with strata defined by school type (public and private), geographical district (1st and 2nd), and the schools within each district. The sample was proportionally allocated to each stratum based on the actual Grade 10 enrollment in the population, with a larger share from public schools due to their higher enrollment compared to private schools. Within each stratum, respondents were randomly selected. The actual number of participants matched the required sample size, resulting in a 100 percent response rate. In cases of nonresponse, such as student absences or refusals, replacements were randomly chosen within the same stratum to maintain proportional allocation and ensure representativeness (Sanchez, 2023).

Instrument

This study utilized researcher-made Numeracy and Mathematics Achievement Tests to minimize familiarity bias that might arise if division-issued assessments were used. The Numeracy Test comprised 50 multiple-choice items covering fractions, decimals, integers, place values, Roman numerals, basic geometry, and word problems on money and business. The Mathematics Achievement Test also contained 50 multiple-choice items aligned with the Grade 10 curriculum's Most Essential Learning Competencies, distributed across Patterns and Algebra, Geometry, and Statistics and Probability. Both instruments were constructed based on a Table of Specifications to ensure content validity. They were validated by three specialists in mathematics education and curriculum design, while pilot testing was conducted with 50 Grade 10 students in the 3rd District of Quezon Province. Reliability analysis yielded KR-20 coefficients of 0.9064 for the Numeracy Test and 0.9078 for the Mathematics Achievement Test, both indicating very high internal consistency (Bontuyan, 2025).

Data Collection

Following authorization from the Schools Division Superintendent and principals of participating schools, data were collected during the second semester of School Year 2023–2024. The instruments were administered through two modalities: limited face-to-face sessions for students without stable internet access, and Google Forms for those with reliable connectivity. The researchers coordinated with classroom advisers to schedule testing and ensure proper proctoring. Completed responses were consolidated into a secured database for statistical analysis. To enrich the quantitative results, short exploratory interviews were conducted with a small group of students ($n = 10$) who consented to participate, focusing on the reasons behind their difficulties in mathematics (Amihan & Sanchez, 2023).

Treatment of Data

The collected data were analyzed using quantitative methods and valid statistical procedures. Descriptive statistics in the form of mean scores and frequency distributions were used to describe student performance in the numeracy and mathematics achievement tests. Prior to correlation analyses, assumption checks were conducted to validate results, including tests for normality, linearity, and outliers. The analysis plan included: (1) describing Grade 10 students' numeracy levels using means and frequency distributions; (2) assessing mathematics achievement in Patterns and Algebra, Geometry, and Statistics and Probability through mean scores and frequency counts; (3) applying Pearson's correlation coefficient (r) to examine the relationship between numeracy and mathematics achievement, with Spearman's rank-order correlation (ρ) as a robustness check for skewed distributions; and (4)

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conducting item analysis by examining the frequency and percentage of incorrect responses to identify common difficulties. Corrections for multiple comparisons were also made to minimize the risk of Type I error. Results were systematically presented in tables for clarity.

Ethical Considerations

Because the study involved minors, strict ethical protocols were observed to protect participants. Approval was secured from the Schools Division Superintendent of Quezon Province and the principals of public and private schools in the 1st and 2nd Districts. Informed parental or guardian consent was obtained, along with student assent to ensure voluntary participation. The study's purpose, procedures, and potential benefits were clearly explained, and students were assured of their right to decline or withdraw at any time without penalty. Confidentiality and data privacy were strictly observed in accordance with the Data Privacy Act of 2012 and DepEd protocols. Responses from tests and interviews were anonymized and used solely for academic purposes. Digital data were securely stored with restricted access. For the interview phase, only students who provided additional consent participated, and their responses were treated with strict confidentiality. Finally, the research protocol underwent review by the Research Ethics Committee in the Division of Quezon Province and was approved prior to implementation.

RESULTS and DISCUSSION

This section presents the analysis and interpretation of data. Here, the respondents' assessment of their level of numeracy and mathematics achievement was highlighted. Also, students' level of numeracy and mathematics achievement were analyzed to determine the students' difficulties to address in making strategic intervention material (mathematics GEAR).

1. Students' Level of Numeracy

The level of numeracy deals with the capability of the students to understand and work with numbers, which is a vital aspect of mathematical literacy. This includes basic numeracy about simple worded problems involving fractions, decimals, integers, place values, Roman numerals, basic geometry and a sort of word problem about money or business. This was categorized as non-numerate, emergent, average numerate, and above average numerate. Table 1 shows the level of numeracy of Grade 10 students.

Table 1. Students' Level of Numeracy

Level of Numeracy	*Frequency*	*Percentage*
Non-Numerate	*6*	*1.59*
Emergent	*187*	*49.60*
Average Numerate	*161*	*42.71*
Above Average Numerate	*23*	*6.10*
TOTAL	***377***	***100***

Mean=50.88 (Emergent); SD=14.37; Min=8.00 (Non-numerate); Max=88.00(Above Average Numerate)

Mean Percentage Score Interval	*Level of Numeracy*	*Description*
0 – 25	*Non-Numerate*	*Demonstrates minimal or no knowledge of numbers; has difficulty with basic math tasks and lacks basic arithmetic skills.*
26 – 50	*Emergent*	*Demonstrates an initial awareness of numbers and basic mathematical concepts and can complete very simple numerical tasks under supervision.*
51 – 75	*Average Numerate*	*Demonstrates solid understanding of basic mathematics and is able to independently*

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		perform everyday numerical tasks.
76 – 100	*Above Average Numerate*	*Demonstrates strong mathematical skills and can handle complex calculations and problem solving, often exceeding typical arithmetic requirements in daily life.*

Results from the table show that the majority of the respondents (49.60%) are at the emergent level of numeracy. This is an indication that while these students have a basic knowledge of mathematics concepts, they still struggle with performing operations using fractions, decimals, and integers, and word problems. A mere 6.10% of the students attained the above average numerate level, indicating high performance in numeracy. On the other hand, a limited percentage (1.59%) is classified as non-numerate, indicating extreme difficulties in mastering basic mathematical skills. The calculated mean score of 50.88, at the emergent level, serves to support the concern that the majority of students demonstrate an initial awareness of numbers and basic mathematical concepts and can complete very simple numerical tasks under supervision and still far from achieving the anticipated numeracy competence for their grade. The wide score range (8.00–88.00) and high standard deviation (14.37) indicate varied numeracy awareness among students.

These findings are consistent with recent national and regional evidence showing weak foundational mathematics skills among Filipino learners. For example, Igarashi and Suryadarma (2023) document that a significant share of Filipino students in higher grades have not mastered foundational mathematics skills taught in early grades, which helps explain why many secondary students remain at emergent levels. National-level analyses also identify persistent low proficiency and heterogeneous performance across students (Bernardo et al., 2022). In addition, global monitoring of foundational learning after the pandemic highlights that many countries — including the Philippines — still face major learning gaps in numeracy and therefore require targeted recovery and acceleration interventions (UNICEF, 2023). Taken together, these studies support the conclusion that weak foundational numeracy is widespread and helps explain the large proportion of emergent numerate learners in the present sample.

In summary, the data highlight the need for more targeted instructional support to strengthen numeracy at its core levels. Interventions should not only focus on the very few who are non-numerate, but also on the much larger group of emergent numerate learners who remain at risk of falling behind if their basic skills are not reinforced.

2. Students' Mathematics achievement

Mathematics achievement refers to the student respondents' mastery of the most essential learning competencies in mathematics 10. The most essential learning competencies are patterns and algebra, geometry, statistics and probability, which are what student-respondents expected to learn.

Mean Percentage Score Interval	***Level of Mastery***	***Description***
35 – below	*Very Low Mastery*	*Demonstrates minimal understanding; needs significant improvement.*
36 – 65	*Low Mastery*	*Demonstrates basic understanding; improvement needed.*
66 – 85	*Average Mastery*	*Demonstrates adequate understanding; meets basic expectations.*
86 – 95	*Moving Towards Mastery*	*Demonstrates good understanding; approaching full mastery.*
96 – 100	*Mastered*	*Demonstrates excellent understanding; fully meets expectations.*

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2.1. Patterns and Algebra

Within this area, grade 10 students can formulate and solve problems involving sequences, polynomials, and polynomial equations in several disciplines using suitable and accurate representations. Table 2 shows the level of Grade 10 students' performance in solving problems in Patterns and Algebra.

Table 2. Students' Mathematics Achievement in Patterns and Algebra

Level of Mastery	*Frequency*	*Percentage*
Very Low Mastery	*63*	*16.71*
Low Mastery	*224*	*59.42*
Average Mastery	*73*	*19.36*
Moving Towards Mastery	*16*	*4.24*
Mastered	*1*	*0.27*
Total	***377***	***100***

Mean=52.59(Low Mastery); SD=18.35; Min=6.25(Very Low Mastery); Max=100.00(Mastered)

It can be observed in the table that more than half of the student-respondents, 59.42%, belong to the "Low Mastery" level, while another 16.71% have a "Very Low Mastery" level. This implies that over 76% of the students have not yet developed the anticipated competencies in comprehending and solving problems related to sequences, polynomials, and polynomial equations in different contexts. Only 19.36% showed "Average Mastery," while a very small percentage attained "Moving Towards Mastery" (4.24%) or "Mastered" (0.27%). The total mean of 52.59, classified as "Low Mastery," and standard deviation of 18.35, with a range of scores from 6.25 to 100.00, indicates extreme variability in student performance. The results demonstrate that Grade 10 students have basic understanding in Patterns and Algebra, which highlights the critical necessity for improved pedagogy and specific intervention.

These findings are consistent with recent Philippine studies. Rodrigo and Alave (2021) reported that public high school students displayed low achievement in Algebra during the new normal, particularly in handling quadratic and polynomial functions. Similarly, Salde (2023) emphasized that Grade 10 learners showed weak proficiency in solving quadratic and polynomial-related tasks, reflecting difficulty in higher-order algebraic reasoning. In another study, Abalde and Oco (2023) confirmed that mathematics performance among Filipino learners remains influenced by various factors, with algebraic competencies often emerging as a persistent challenge. Together, these studies support the present result, which shows that over 76% of Grade 10 students have Low or Very Low Mastery in sequences, polynomials, and polynomial equations.

2.2. Geometry

In this area, grade 10 students can solve circle and coordinate geometry problems. This entails identifying solutions involving circles and other associated words in other fields through correct and precise representations and solving geometric figure problems using the rectangular coordinate plane persistently and accurately. Table 3 indicates the performance level of grade 10 students in solving geometric problems.

Table 3. Students' Mathematics Achievement in Geometry

Level of Mastery	*Frequency*	*Percentage*
Very Low Mastery	*182*	*48.28*
Low Mastery	*187*	*49.60*
Average Mastery	*7*	*1.86*
Moving Towards Mastery	*1*	*0.27*
Mastered	*0*	*0.00*
TOTAL	***377***	***100***

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Mean=33.33(Very Low Mastery); SD=15.79; Min=0.00(Very Low Mastery); Max=90.91(Mastered)

From the data presented in Table 3, it can be viewed that most of the Grade 10 students are on the Low Mastery (49.60%) and Very Low Mastery (48.28%) levels in Geometry. This indicates that most of them have minimal or basic knowledge of geometrical concepts and require much improvement. Notably, no student achieved the Mastered level, and only one student indicated moving toward mastery. The calculated mean score of 33.33, which is in the category of Very Low Mastery, supports the finding that students are having difficulty with significant Geometry concepts such as proof of theorems related to circles, use of formulas, and graphing of geometric shapes on a coordinate plane. The standard deviation of 15.79 indicates a relatively broad range of scores, yet still suggests that most of the students are concentrated within the lower performance category. This emphasizes the need for direct instructional assistance and focused intervention in Geometry.

These results are consistent with Casanova, Cantoria, and Lapinid (2021), who found that many Grade 9 students in the Philippines demonstrated low levels of geometric thinking, with most limited to visualization-level reasoning about triangles. Similarly, Abdurrahman and Nofriyandi (2022) reported that over half of mathematics education students at the university level struggled to recall theorems, follow geometry problem-solving steps, and represent geometric ideas correctly. These findings demonstrate that challenges in mastering geometry are not limited to one grade level but are evident across different stages of the education system.

Therefore, the low mastery of geometry concepts requires instruction that prioritizes conceptual understanding, visual reasoning, and logical proof. Teaching strategies should integrate representational tools, visual tasks, and scaffolded exercises to strengthen spatial reasoning and help learners connect abstract geometry to real-life and coordinate-based contexts.

2.3. Statistics and Probability

In this area, grade 10 students are able to solve problems involving combinatorics and probability, and measures of position. These consist of accurate counting methods and probability in drawing conclusions and decision-making, and carrying out systematically a mini-research using the various statistical techniques. Table 4 indicates the performance level of grade 10 students in problem solving using statistics and probability.

Table 4. Students' Mathematics Achievement in Statistics and Probability

Level of Mastery	Frequency	Percentage
Very Low Mastery	*154*	*40.85*
Low Mastery	*203*	*53.85*
Average Mastery	*16*	*4.24*
Moving Towards Mastery	*4*	*1.06*
Mastered	*0*	*0.00*
TOTAL	***377***	***100***

Mean=41.04(Low Mastery); SD=15.89; Min=4.35(Very Low Mastery); Max=91.30(Mastered)

As seen in the table, most of the student-respondents were at a low mastery level and very low mastery, while only a few were considered to be at the level of moving towards mastery and average mastery. The mean score was 41.04, and the standard deviation was 15.89, representing low mastery, which indicates that most of the students have a basic understanding of statistics and probability and struggled to comprehend and use significant skills. These include solving problems for permutations and combinations, computing the probability of compound events, and recognizing measures of position like quartiles and percentiles.

These results are consistent with the findings of Dumale and Gurat (2023), who revealed that students demonstrated poor retention in probability concepts. Similarly, Quinio and Cuarto (2023) reported that many Senior High School students held misconceptions in Statistics and Probability that hindered correct application of formulas and concepts. In addition, Calma, Salvador, and Supan (2022) found that students' attitudes and knowledge toward statistics and probability were generally low, which affected their performance. Legarde (2023) further observed that many students performed worse when transitioning from General Mathematics to Statistics and Probability, highlighting the challenges in bridging conceptual understanding.

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The poor performance of students in Statistics and Probability indicates significant learning gaps in these subjects. The findings concur with several studies indicating that students are challenged by comprehending rules of probability, applying formulas appropriately, and connecting abstract concepts to practical problems. Meanwhile, the study demonstrates how essential these subject matters are in everyday life and why students must be well taught. This necessitates improved teaching methods that incorporate practical illustrations, visual aids, and frequent feedback, so that the students get a solid foundation in Statistics and Probability.

3. Relationship Between Students' Level of Numeracy and Mathematics Achievement

Table 5 shows the relationship between students' level of numeracy and mathematics achievement. Relative to the result it can be gleaned from the table that there is a significant relationship between the students' level of performance in numeracy and mathematics achievement across all areas. both demonstrate a strong positive correlation with students' numeracy performance.

Table 5. Relationship Between Students' Level of Numeracy and Mathematics Achievement

	r-value	*Degree*	*p-value*	*Decision on H0*	*Interpretation*
Patterns and Algebra	*.608*	*Strong Relationship*	*<.001*	*Reject*	*Significant*
Geometry	*.281*	*Weak Relationship*	*<.001*	*Reject*	*Significant*
Statistics and Probability	*.575*	*Strong Relationship*	*<.001*	*Reject*	*Significant*
Overall	*.679*	*Strong Relationship*	*<.001*	*Reject*	*Significant*

Among the three areas, Patterns and Algebra (r = .608) and Statistics and Probability (r = .575) demonstrate large positive correlations with numeracy. This indicates that students with stronger numeracy skills tend to perform better in these domains, which depend heavily on numerical reasoning, symbolic manipulation, and predecessor number/fraction skills. Empirical work supports this hierarchical relationship: mastery of basic numerical and fraction skills predicts later fraction and algebra achievement (Spitzer & Moeller, 2022), and early numeracy competence is a robust predictor of later mathematics outcomes more broadly (Davis-Kean et al., 2021).

By contrast, the numeracy–geometry correlation in this study is weaker (r = .281) though still significant. This pattern is plausible because geometry relies more on spatial visualization and spatial working memory than on pure computational numeracy. Research shows that spatial reasoning contributes disproportionately to geometry and measurement performance compared with number-based tasks (Harris et al., 2021), and that visuospatial working memory and spatial constructs explain unique variance in geometry-related outcomes (Giofrè et al., 2022).

Overall, the strong overall correlation between numeracy and general mathematics achievement (r = .679) underscores the foundational role of number skills for algebraic and statistical learning, while the weaker numeracy–geometry link suggests curriculum and interventions should (a) reinforce numeracy to boost algebra and statistics, and (b) also include spatial-reasoning training and visualization tasks to support geometry learning.

4. Difficulties Encountered by Grade 10 Students in Learning Mathematics.

The difficulties encountered by Grade 10 students were based on the result of numathematics achievement test. It was supported by an interview to student-respondents. Table 6 shows students' difficulties in mathematics with regards to the students' mathematics achievement. The table presents the areas where Grade 10 students experienced the most difficulty in the Mathematics Achievement Test, categorized by Most Essential Learning Competencies (MELCs) under Patterns and Algebra, Geometry, and Statistics and Probability.

Table 6. Difficulties Encountered by Grade 10 Students in Mathematics Achievement

Item No.	*Most Essential Learning Competencies*	*Difficulty Index*	*Description*
1	*Generates patterns*	*0.92*	*Very Easy*
2	*Illustrates an arithmetic sequence.*	*0.60*	*Moderately Difficult*
3	*Determines arithmetic means and nth term of an arithmetic sequence.*	*0.48*	*Moderately Difficult*

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4	Illustrates a geometric sequence.	0.71	Easy
5	Differentiates a geometric sequence from an arithmetic sequence.	0.67	Easy
6	Determines geometric means and nth term of a geometric sequence.	0.59	Moderately Difficult
7	Finds the sum of the terms of a given finite or infinite geometric sequence.	0.40	Difficult
8	Solves problems involving sequences	0.58	Moderately Difficult
9	Performs division of polynomials using long division and synthetic division.	0.37	Difficult
10	Proves the Remainder Theorem and the Factor Theorem.	0.33	Difficult
11	Factors polynomials.	0.28	Difficult
12	Illustrates polynomial equations.	0.81	Very Easy
13	Solves problems involving polynomials and polynomial equations.	0.33	Difficult
14	Illustrates polynomial functions.	0.69	Easy
15	Graph of polynomial functions.	0.37	Difficult
16	Solves problems involving polynomial functions	0.28	Difficult
17	Derives inductively the relations among chords, arcs, central angles, and inscribed angles.	0.42	Moderately Difficult
18	Proves theorems related to chords, arcs, central angles, and inscribed angles.	0.30	Difficult
19	Illustrates secants, tangents, segments, and sectors of a circle.	0.53	Moderately Difficult
20	Proves theorems on secants, tangents, and segments.	0.45	Moderately Difficult
21	Solves problems on circles.	0.31	Difficult
22	Derives the distance formula.	0.46	Moderately Difficult
23	Applies the distance formula to prove some geometric properties.	0.25	Difficult
24	Illustrates the center -radius form of the equation of a circle.	0.29	Difficult
25	Determines the center and radius of a circle given its equation and vice versa.	0.26	Difficult
26	Graphs a circle and other geometric figures on the coordinate plane.	0.19	Very Difficult
27	Solves problems involving geometric figures on the coordinate plane.	0.20	Very Difficult
28	Illustrates the permutation of objects.	0.44	Moderately Difficult
29	Derives the formula for finding the number of permutations of N objects taken r at a time.	0.21	Difficult
30	Solves problems involving permutations.	0.22	Difficult
31	Illustrates the combination of objects.	0.32	Difficult
32	Differentiates permutation from combination of objects taken at a time.	0.30	Difficult
33	Derives the formula for finding the number of combinations of n objects taken r at a time.	0.33	Difficult
34	Solves problems involving permutations and combinations.	0.38	Difficult
35	Illustrates events, and union and intersection of events.	0.66	Easy
36	Illustrates the probability of a union of two events.	0.75	Easy

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37	*Finds the probability of (A U B) .*	*0.23*	*Difficult*
38	*Illustrates mutually exclusive events.*	*0.43*	*Moderately Difficult*
39	*Solves problems involving probability.*	*0.46*	*Moderately Difficult*
40	*Illustrates the following measures of position: quartiles, deciles and percentiles.*	*0.52*	*Moderately Difficult*
41	*Calculates a specified measure of position (e.g. 90th percentile) of a set of data.*	*0.32*	*Difficult*
42	*Interprets measures of position.*	*0.50*	*Moderately Difficult*
43	*Solves problems involving measures of position.*	*0.21*	*Difficult*
44	*Solves problems involving measures of position.*	*0.67*	*Easy*
45	*Formulates statistical mini -research.*	*0.18*	*Very Difficult*
46	*Formulates statistical mini -research.*	*0.50*	*Moderately Difficult*
47	*Uses appropriate measures of position and other statistical methods in analyzing and interpreting research data.*	*0.15*	*Very Difficult*
48	*Uses appropriate measures of position and other statistical methods in analyzing and interpreting research data.*	*0.51*	*Moderately Difficult*
49	*Uses appropriate measures of position and other statistical methods in analyzing and interpreting research data.*	*0.58*	*Moderately Difficult*
50	*Uses appropriate measures of position and other statistical methods in analyzing and interpreting research data.*	*0.56*	*Moderately Difficult*

As can be seen in the table, the Grade 10 students' performance covered a wide range of difficulty: only five items (10%) were labeled very easy, and another five (10%) easy, suggesting comfort with a limited set of concepts. For example, students showed high competence in creating patterns (difficulty index = 0.92), graphing polynomial equations (0.81), and calculating simple probabilities (0.75). However, most test items fell under "moderately difficult" to "very difficult" categories (about 80%), revealing that many students are not well equipped for more complex reasoning, problem-solving, and applying mathematical concepts. Tasks in coordinate geometry, polynomial functions, permutations and combinations, and statistical interpretation were especially challenging.

To supplement the test findings, short exploratory interviews were conducted with a small group of students (n = 10) who consented to participate, focusing on the reasons behind their difficulties in mathematics. The group discussions revealed common issues such as forgetting formulas during problem-solving, confusion when applying multiple steps, and dependence on memorization rather than conceptual understanding. Some students also expressed that they felt less confident when facing questions that required interpreting graphs, tables, or abstract mathematical symbols. These responses help explain the low scores in coordinate geometry and statistics, where abstract thinking and higher-order reasoning are required.

The interviews, therefore, provided depth to the quantitative findings by showing not only what the students found difficult, but also why. For instance, the very low performance in interpreting statistical information (difficulty index = 0.15) was clarified when several students admitted that they were unsure how to connect statistical formulas with real-life data. Similarly, their struggles in graphing geometric shapes (0.19) aligned with reports of difficulty in visualizing and transferring equations into graphs.

These findings resonate with recent studies. Tan and Vighnarajah (2023) found that students often hold misconceptions in probability, such as incorrect application of formulas and limited understanding of concepts. Hasanah and Buasen (2021) observed that learners struggle with graphing polynomial functions due to insufficient skills in graphical representation. These studies highlight how abstract mathematical notations and weak conceptual grounding hinder students' understanding (Tan & Vighnarajah, 2023; Hasanah & Buasen, 2021). Thus, both the test results and the interview responses underscore the need for more interactive and concept-based teaching strategies in algebra, geometry, and statistics.

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5. Provide evidence-based recommendations for the development of Strategic Intervention Materials (SIMs) to address identified gaps.

According to recent studies, Grade 10 students exhibited emergent numeracy and low to very low mastery in mathematics attainment, specifically in Geometry, Algebra, and Statistics and Probability. These results emphasize the necessity of a thoughtfully planned Strategic Intervention Material (SIM) that reinforces students' numeracy foundation and addresses their particular challenges in higher math. A Contextualized Numeracy Toolkit (CNT) comprising visual models like number lines, fraction bars, and real-world word problems can facilitate students in developing numeracy levels ranging from emergent to average. This approach aligns with findings by Picat and Natividad (2023), who highlighted the effectiveness of contextualized interactive learning materials in enhancing students' understanding by connecting abstract ideas to everyday life.

For Geometry, an Interactive Geometry SIM that integrates visual problem-solving puzzles, coordinate graphing exercises, and proof-based activities can enhance learners' logical thinking and spatial intelligence. This is supported by Retnawati et al. (2025), who emphasized the importance of interactive learning materials in improving students' geometric reasoning skills. In Algebra, a Pattern Mastery Module focusing on polynomial operations, sequences, and functions through guided practice and error analysis can bolster students' problem-solving abilities. This approach is corroborated by Sugiarti and Retnawati (2024), who found that structured practice and error analysis significantly improve students' algebraic proficiency. In Probability and Statistics, a Real-Life Application Kit offering mini-research tasks, probability tree diagrams, and guided activities for permutations and quartiles can assist students in overcoming misconceptions. This is in line with the findings of Hu and Seng (2022), who noted that practical applications help students grasp complex statistical concepts more effectively.

Lastly, a Blended Numeracy Intervention (BNI) utilizing video explainers, peer collaborative tasks, and feedback checklists can sustain numeracy development across various fields. This is supported by Lozano-Lozano et al. (2020), who demonstrated that blended learning approaches enhance student engagement and understanding in mathematics. In summary, the herein-proposed SIM is a contextualized, multi-component intervention designed not only to build numeracy but also to strengthen mastery of major competencies in Geometry, Algebra, and Statistics and Probability.

Conclusions

Based on the salient findings, it can be concluded that the level of numeracy of Grade 10 students was generally classified as emergent, while their mastery of the most essential learning competencies in Mathematics 10 was low. A significant relationship was established between numeracy level and mathematics achievement, underscoring that students with stronger numeracy skills tend to perform better in Patterns and Algebra, Geometry, and Statistics and Probability. Students' difficulties stemmed from cognitive and instructional gaps, including weak conceptual understanding, problem-solving skills, and handling abstract concepts. These findings highlight the urgent need for targeted interventions to reinforce foundational numeracy skills and enhance achievement in specific mathematics domains. Strategic Intervention Materials (SIMs), if designed and validated properly, may serve as effective tools to address these difficulties and improve students' overall performance.

Recommendations

Focused Remediation Program – Mathematics instructors may be encouraged to conduct remedial sessions, particularly for students with emergent and non-numerate levels, employing contextualized and activity-based strategies. These can be conducted twice a week for one grading period, and their effectiveness can be gauged using pre- and post-assessments relating to the Most Essential Learning Competencies (MELCs).

Building Conceptual and Problem-Solving Capabilities – Because weak conceptual understanding and poor problem-solving were found to be significant weaknesses, employing learner-focused tactics like problem-based learning, error analysis, and pictorial models (e.g., number lines, fraction bars, and geometric manipulatives) is suggested. These must be incorporated in day-to-day lessons over at least one year so that measurable improvement can be achieved.

Capacity-Building for Teachers – The Mathematics Education Program Supervisor can conduct quarterly in-service training (INSET) to empower teachers in designing and infusing SIMs into the classroom practice. The training can cover workshops on contextualization, technology use, and the development of higher-order thinking skills (HOTS).

Future Research – In order to overcome study constraints, future research can broaden the scope by involving other divisions, regions, or grade levels to generalize the findings and establish whether similar trends are observed. In addition, a mixed-method design can also be embraced to gather qualitative information about student problems and instructor practices.

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