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Analyzing numeracy Literacy skills of upper primary graders in real-world problem contexts

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Abstract:
Numeracy skill is a critical skill for elementary school students, enabling them to apply mathematical concepts in everyday contexts and make informed decisions. This study investigates the numeracy literacy skills of 55 fifth-grade students from Lhokseumawe City, Aceh Province. The students' numeracy skills were measured across three key indicators: counting, numerical relations, and arithmetic operations. A descriptive quantitative approach was used to assess students' abilities. The results indicated that while students performed well in basic counting and arithmetic tasks, they struggled with tasks involving numerical relations and distinguishing quantities. The highest performance was observed in "counting an object verbally" (73%), while the lowest average score was in "distinguishing the quantity of an object" (41%). The study emphasizes the importance of integrating real-life scenarios into math instruction to improve numeracy skills. It also highlights the need for teacher training, scaffolded learning strategies, and the incorporation of higher-order thinking skills (HOTS) in the curriculum. The findings offer valuable insights for educators and policymakers aiming to enhance numeracy skills in elementary education, with implications for both academic performance and practical application.

Keywords: Math for Elementary; Numeracy Skill; Upper Primary Graders.

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Introduction

Numeracy is a fundamental life skill that enables individuals to apply mathematical knowledge in everyday contexts, solve problems, and make informed decisions. It involves not only the ability to calculate but also to interpret, reason, and use numbers effectively in real-life situations (Mmasa & Anney, 2016; Runtu et al., 2023). In educational settings, numeracy literacy skill equips students with critical thinking and

problem-solving abilities essential for functioning in a rapidly changing, information-rich society. The ability to reason with numbers is increasingly crucial in today's data-driven world, yet many individuals lack the necessary skills to effectively interpret and use quantitative information (Ellen, 2020; Reyna & Brainerd, 2023; Wallace et al., 2019). Statistical literacy and quantitative reasoning are fundamental for making informed decisions in various domains, including health and finance (Burrill, 2022; Ellen, 2020). While precise calculations are sometimes required, qualitative reasoning about quantitative phenomena is often more relevant in decision-making processes (Dix, 2021). Paradoxically, focusing solely on literal numbers and mechanical computations can be counterproductive. Instead, emphasizing the extraction of meaningful gist from numerical information has been shown to improve decision-making abilities and facilitate transfer to new contexts (Reyna & Brainerd, 2023). To address widespread innumeracy, educational curricula should incorporate real-world data analysis and foster the development of foundational concepts that enable students to engage with complex datasets (Burrill, 2022).

However, findings from international assessments indicate that numeracy remains a significant challenge among Indonesian students. According to the Programme for International Student Assessment (PISA), Indonesian students scored an average of 379 in mathematics in 2018, substantially below the OECD average of 487. While there was a modest increase from previous cycles 360 in 2003 to 386 in 2015 the score declined again in 2018, with approximately 71% of students performing below minimum competency standards (Gradini & Firmansyah, 2020; Saputri et al., 2023). These findings underscore the urgent need to enhance students' mathematical thinking and literacy, beginning in the early years of formal education.

One core issue contributing to this low performance is the gap between mathematics as taught in classrooms and its application in real-life contexts. Traditional instruction often emphasizes procedural fluency such as memorizing formulas—without helping students understand how mathematical ideas relate to everyday situations. For example, students may correctly solve 2×3 or 3×2 yet struggle to apply these operations appropriately in real-world scenarios such as medication schedules, where sequencing can affect outcomes (Chang, 2023; Perdana & Suswandari, 2021; Ridwan et al., 2023). This distinction highlights the importance of developing numeracy skills, which extends beyond mere calculation to encompass reasoning, contextual understanding, and the ability to draw logical conclusions from quantitative data.

Numeracy skill, therefore, refers to the ability to use mathematical reasoning to interpret and analyze information and to make sound decisions based on numerical data (Sobkow et al., 2020; Wallace et al., 2019). It includes understanding numerical relationships, performing arithmetic operations, analyzing patterns, and interpreting graphs or skills that are foundational to the mathematics curriculum (Milutinović, 2020; Vessonen et al., 2023). In Indonesia, these elements are reflected in the 2013 Curriculum, which integrates numeracy components such as number sense, algebra, geometry, measurement, and data interpretation across grade levels (Gal et al., 2020; Rusdi et al., 2020). Recent studies have highlighted the importance of numeracy in elementary education, particularly for prospective teachers. Numeracy involves the ability to access, use, interpret, and communicate mathematical information in various contexts (Yustitia et al., 2021). Research has shown that prospective elementary school teachers with high numeracy skills can identify relevant mathematical information and apply known procedures, while those with low ability struggle to develop opinions

about the information (Yustitia et al., 2021). Statistics and probability have been identified as areas of weakness in numeracy tests for education students (Asmara & Purnomo, 2023). To address these challenges, researchers suggest emphasizing data and uncertainty literacy in teacher education programs (Asmara & Purnomo, 2023). Additionally, incorporating consumer and financial literacy contexts in numeracy education has been recommended for developing students' mathematical competency, particularly in junior high school (Cam et al., 2020).

The development of numeracy skills progresses gradually, beginning with informal counting and number recognition in early childhood advancing to formal symbolic reasoning and problem-solving in upper elementary grades (Girard et al., 2021; Hamidi et al., 2024). At this stage, students are expected not only to perform basic operations but also to apply them meaningfully through word problems and contextual exercises. This period is, therefore, critical for nurturing both mathematical understanding and the ability to transfer knowledge to unfamiliar, real-world contexts.

This study aims to analyze the numeracy skills of fifth-grade students, focusing on their performance across three specific indicators: counting, numerical relations, and arithmetic operations, all within real-world problem contexts. While numerous studies have examined students' general mathematics achievement or attitudes toward mathematics, fewer have explored how upper primary students apply curriculum-based numeracy skills in practical, contextualized assessments. Additionally, existing research tends to emphasize test scores while neglecting analysis of student reasoning and misconceptions in specific problem domains-particularly in Indonesian elementary settings.

The novelty of this study lies in its specific focus on analyzing numeracy skills through a custom-designed test instrument grounded in national curriculum indicators and contextual problem scenarios. Unlike prior studies, this research not only assesses student outcomes numerically but also explores their strategies and patterns of thought across defined indicators. Furthermore, the study highlights the practical challenges students face when transferring mathematical knowledge from school tasks to real-life situations, a focus that is rarely addressed in depth within the Indonesian elementary school context. Compared to existing works, this study offers a more targeted investigation of indicator-based numeracy performance through tasks that simulate authentic decision-making situations.

The contribution of this study lies in its focused analysis of how fifth-grade students apply curriculum-based numeracy skills in real-world problem contexts area that remain underexplored, particularly in Indonesian elementary education. While previous research has addressed general mathematical achievement or student attitudes, this study provides practical, classroom-oriented insights by examining how students reason through contextualized numeracy tasks aligned with national curriculum standards. It also offers a methodological contribution by combining quantitative scoring with qualitative analysis of student responses, which helps reveal specific misconceptions, reasoning gaps, and strengths that are not visible through test scores alone. These findings offer both theoretical implications by contributing to the understanding of applied numeracy development and practical value for teachers and curriculum planners seeking to design more effective instructional strategies grounded in real-world mathematical thinking.

Research Methods

This study employed a descriptive quantitative research design to analyze the numeracy skills of fifth-grade students in the context of real-world problem-solving. The research was conducted at Sukma Bangsa Elementary School, an institution that integrates contextual and inquiry-based learning in its instruction. A total of 55 fifth-grade students participated in the study. The design focused on describing students' performance based on their responses to a numeracy skills test constructed around curriculum-based indicators and contextualized scenarios.

Data Collection Techniques

Two data collection techniques were utilized:

1. Numeracy Skill Test

The primary instrument for data collection was a numeracy skill test consisting of 12 items. This test was designed to assess students' abilities across three main dimensions: counting, numerical relations, and arithmetic operations. Each item was constructed based on specific indicators that reflect students' ability to apply mathematical knowledge in everyday contexts.

2. Document Analysis

Document analysis was conducted on students' written responses to the test. This technique allowed the researchers to examine how students approached and reasoned through the given problems, thereby supporting the qualitative interpretation of their numeracy skill levels. The test instrument underwent a content validation process by two subject matter expert lecturers in Primary Education (PGMI) at IAIN Lhokseumawe who were experienced in the numeracy field. Based on their feedback, several revisions were made to improve the clarity and appropriateness of the test items. The finalized instrument was then administered to the target participants.

Table 1. Indicators of Numeracy Skill

Aspect	Indicators	Item number	Total
Counting	Counting an object verbally	2, 4, 10	3
	Identify the number of objects	12, 1, 5	3
Numerical Relations	Distinguishing the quantity of an object	8, 9, 11	3
Arithmetic Operation	Doing basic math operations	3, 6, 7	3

Data Analysis

The data were analyzed using a thematic analysis approach, which is suitable for identifying, analyzing, and interpreting patterns (*themes*) within qualitative data (Creswell, 2015; Jones, 2023). The thematic analysis process consisted of the following stages:

1. Data Preparation-Organizing and transcribing raw data from students' test responses.

2. Initial Reading-Conducting an in-depth reading of the data to gain familiarity and preliminary insights.
3. Coding-Assigning codes to meaningful segments of data based on the indicators of numeracy skills.
4. Theme Development-Grouping codes into broader themes aligned with the study's objectives.
5. Interpretation – Drawing conclusions about students' numeracy skill levels based on recurring themes and patterns.

This qualitative analysis enabled the researchers to interpret the depth and variation in students' responses and to evaluate how well students applied numeracy concepts in practical contexts. The findings of this study are presented based on the average score of each numeracy skill indicator assessed using a four-point scale.

Results and Discussions

Results

The results of this study are presented in two parts. First, we describe the overall performance of students using descriptive statistics and visualizations to explore the distribution of numeracy skill scores. It is followed by a comparative analysis of student performance across four key indicators of numeracy skills. Second, we analyze representative student responses to selected test items, categorized by indicator, to gain deeper insight into patterns of reasoning, misconceptions, and calculation strategies.

Table 2. Mean scores of numeracy skills by indicator

Aspect	Indicators	Average Value	Percentage
Counting	Counting an object verbally	2.90	73%
	Identify the number of objects	2.01	50%
Numerical Relations	Distinguishing the quantity of an object	1.65	41%
Arithmetic Operation	Doing basic math operations	2.27	57%

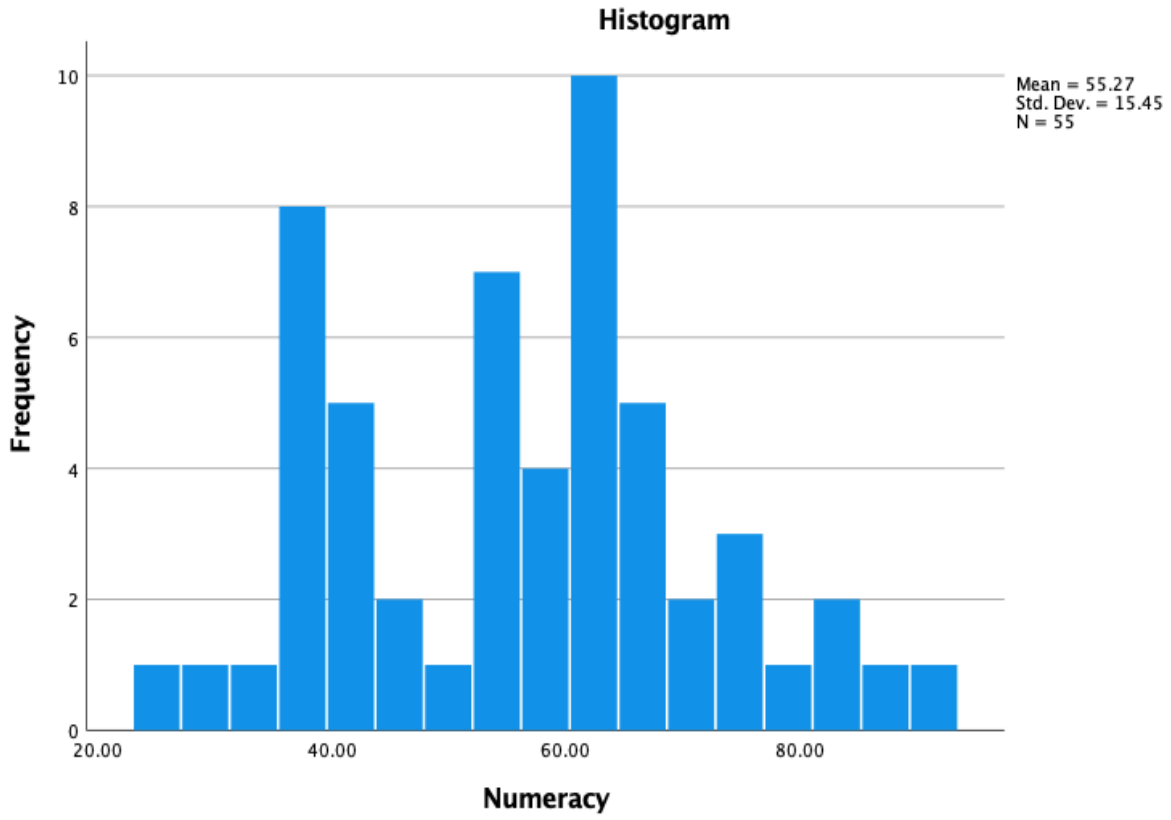
Based on Table 2 shows that the highest average score was achieved in the indicator "counting an object verbally" (2.90), indicating that most students were able to understand and apply basic counting skills. The second highest score was in "performing basic math operations" (2.27), suggesting that students had moderate success in applying arithmetic procedures. However, students showed weaker performance in "identifying the number of objects" (2.01) and particularly in "distinguishing the quantity of an object" (1.65), reflecting challenges in interpreting quantitative relationships.

Descriptive statistics and distributions of numeracy scores

To examine the overall distribution of numeracy skills, we analyzed the test results of 55 fifth-grade students. The histogram (*Picture 1*) shows that students' numeracy scores ranged widely, with most scores clustering around the mean. The statistical summary of the total numeracy scores is presented in Table 3.

Table 3. Descriptive Statistics of Numeracy Skill Scores

Numeracy Skill	Statistic
Minimum	25,00
Maximum	91,67
Range	66,67
Median	56,25
Mean	55,27
St.Deviation	15,45

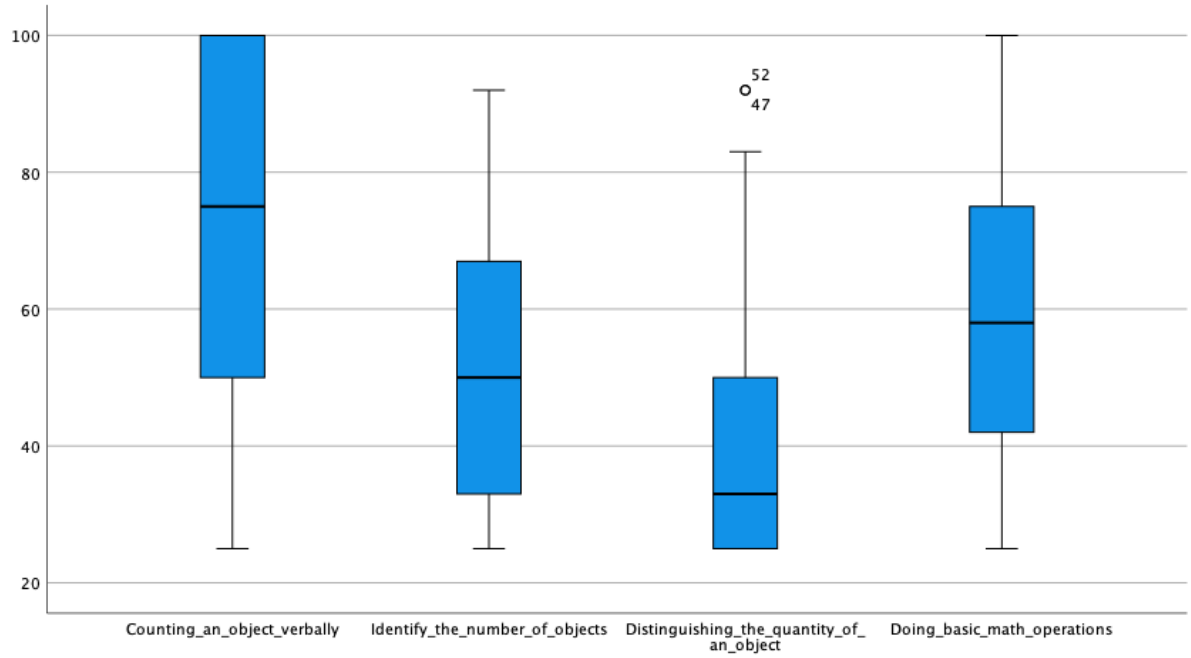


Picture 1. Histogram of Numeracy Skill Scores Range

As illustrated in Picture 1, the distribution of numeracy scores is moderately symmetrical, with a slight concentration of frequencies near the center. The mean score was 55.27, with a standard deviation of 15.45, indicating a moderate level of variability in student performance.

Comparison across numeracy skill indicators

To further analyze students' numeracy skills, scores were disaggregated by four curriculum-based indicators: Counting an object verbally, Identifying the number of objects, Distinguishing the quantity of an object, and Doing basic math operations. The boxplot in Picture 2 presents the score distributions for each indicator. Visually, the boxplots indicate apparent differences in central tendency and spread among the four skill areas.



Picture 2. Boxplots of numeracy skill indicators

Among the indicators, *Counting an object verbally* and *Doing basic math operations* show higher medians and broader ranges, suggesting stronger and more variable student performance. In contrast, *Distinguishing the quantity of an object* displays the lowest median score and narrower spread, indicating consistent but lower performance across students.

To determine whether the differences among the four numeracy skill indicators were statistically significant, a Kruskal–Wallis test was conducted. This non-parametric test was selected based on the results of a Shapiro–Wilk normality test, which indicated that the distribution of scores for all four indicators significantly deviated from normality. Specifically, the indicator *Counting an Object Verbally* had a Shapiro–Wilk statistic of 0.88 ($p < .001$), *Identifying the Number of Objects* had a value of 0.91 ($p < .001$), *Distinguishing the Quantity of an Object* had a value of 0.79 ($p < .001$), and *Doing Basic Math Operations* had a value of 0.94 ($p = .007$). As all p-values were below .05, the assumption of normality was violated for each indicator, justifying the use of the Kruskal–Wallis test. The results of the test are presented in Table 4.

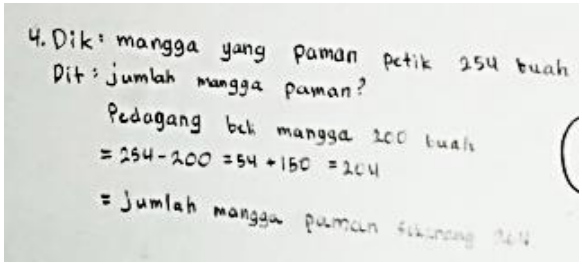
The Kruskal–Wallis test revealed a statistically significant difference in students' performance across the four numeracy skill indicators, $\chi^2(3, N = 55) = 48.41$, $p < 0.001$. This result confirms that students' numeracy skills differ meaningfully depending on the

specific indicator assessed, supporting the conclusion that skill development is uneven and highlighting the need for targeted instruction in the weaker domains.

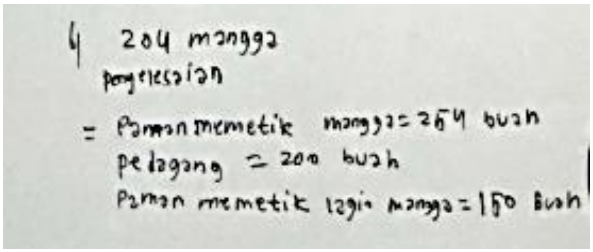
Table 4. Kruskal–Wallis Test Results

Test	Value
Kruskal–Wallis H	48.411
Degrees of Freedom	3
Asymp. Sig. (p)	0.000

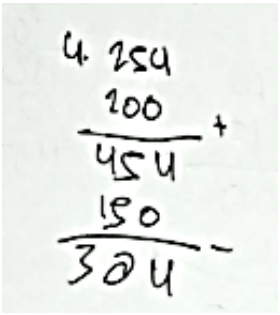
Item-level analysis by indicator
Indikator 1-Counting an Object Verbally
Sample Question: Number 4
"Uncle harvested 254 mangoes, sold 200, then picked another 150. How many mangoes does he have now?"



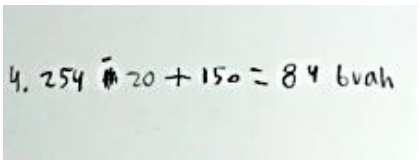
Picture 3. Answer Type A Number 4



Picture 4. Answer Type B Number 4



Picture 5. Answer Type C Number 4



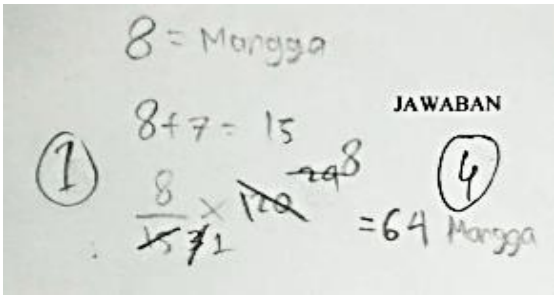
Picture 6. Answer Type D Number 4

Correct Answer (Picture 3): Students accurately identified the operations (subtraction and addition), computed 254 − 200 = 54, and then added 150, reaching the correct total of 204 mangoes.

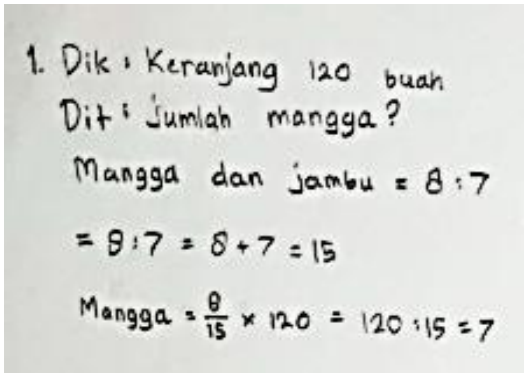
Incomplete Answer (Picture 4): Students identified known and asked for information but failed to complete the calculation.
Incorrect Operation (Picture 5): Students misinterpreted the word "sold" as an addition and "picked" as a subtraction, indicating misconceptions about context-based operations.

Misreading Data (Picture 6): Students misread the quantity sold (noting 20 instead of 200) but applied the correct operations, demonstrating partial understanding.
These results suggest that while many students can identify relevant operations, some struggle with interpreting contextual cues and reading numerical data accurately.

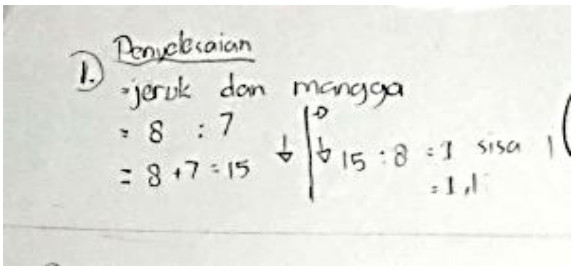
Indicator2- Identifying the Number of Objects
Sample Question: Number 1
"A basket contains 120 fruits, with a mango-to-guava ratio of 8:7. How many are mangoes?"



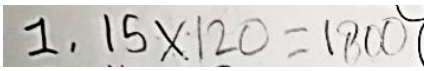
Picture 7. Answer Type A Number 1



Picture 8. Answer Type B Number 1



Picture 9. Answer Type C Number 1



Picture 10. Answer Type D Number 1

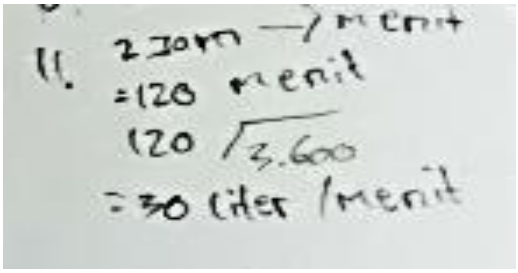
Correct Answer (Picture 7): Students applied ratio logic correctly by finding the total parts (8+7=15), calculating 120 ÷ 15 = 8, and then multiplying 8 × 8 = 64.

Minor Calculation Error (Picture 8): Students understood the concept but made an arithmetic mistake or failed to include a conclusion.

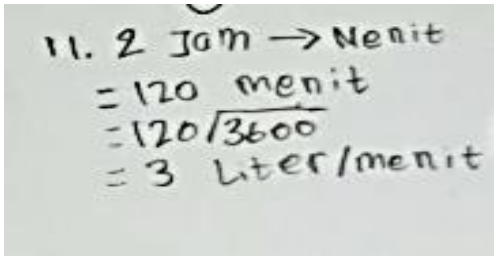
Incorrect Application (Picture 9): Students identified the ratio but failed to use it correctly in calculations.

Misinterpretation (Picture 10): Students misunderstood the problem entirely but were able to perform multiplication, indicating fragmented understanding.
This analysis shows that although some students grasp proportional reasoning, many require additional support in applying it accurately.

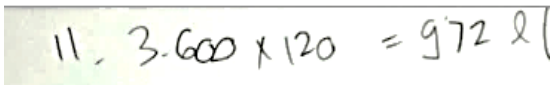
Indicator 3-Distinguishing Quantity
Sample Question: Number 11
"A tank holds 3,600 liters and empties in 2 hours. How much water flows per minute?"



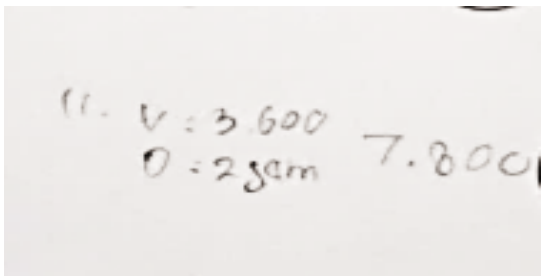
Picture 11. Answer Type A Number 11



Picture 12. Answer Type B Number 11



Picture 13. Answer Type C Number 11



Picture 14. Answer Type D Number 11

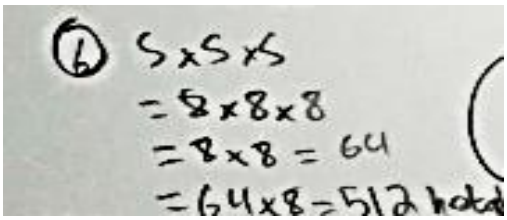
Correct Answer (Picture 11): Students converted hours to minutes and divided 3,600 by 120, correctly concluding 30 liters/minute.

Minor Miscalculation (Picture 12): Students followed the proper process but made a computational mistake in the final step.

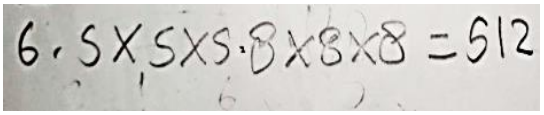
Conceptual Error (Picture 13): Students used multiplication instead of division, showing confusion about the concept of rate.

Incomplete Answer (Picture 14): Students wrote a numerical response (e.g., 7,800) without explanation, indicating a lack of reasoning.
These responses highlight significant gaps in students' ability to work with rates and interpret quantities in dynamic contexts.

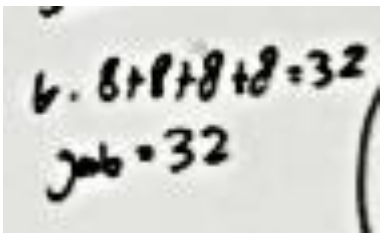
Indicator 4-Performing Basic Math Operations
Sample Question: Number 6
"A large cube is built using smaller cube boxes with side lengths 8. How many boxes are used?"



Picture 15. Answer Type A Number 6



Picture 16. Answer Type B Number 6



Picture 17. Answer Type C Number 6

Correct Answer (Pictures 15-16): Students applied the volume formula ($s^3 = 8 \times 8 \times 8 = 512$) to calculate the number of units.

Incorrect Concept (Picture 16): Some students used addition instead of exponentiation (e.g., 8 + 8 + 8 + 8), revealing confusion between volume and perimeter or surface area. These responses indicate that while many students understand volume calculation, some have difficulty distinguishing between different geometric operations.

Discussions

The results of this study reveal that fifth-grade students' numeracy skills are still in the developmental stage. With an average overall score of approximately 55.27 out of 100 and a median of 56.25, the findings suggest that while students can manage basic skills like counting and performing arithmetic operations, they struggle with more complex numeracy components. Specifically, performance was notably lower in the indicators of *distinguishing quantities* and *identifying the number of objects*, both of which involve interpreting quantitative relationships and proportional reasoning.

The Kruskal–Wallis test further confirmed that students' performance differed significantly across the four assessed indicators ($p < .001$), demonstrating uneven development. The highest scores were seen in *counting an object verbally*, suggesting that foundational skills are better acquired, whereas *distinguishing quantity* had the lowest average and median, highlighting a consistent area of weakness. It reinforces the notion that while procedural knowledge may be in place, conceptual understanding and contextual application remain limited for many students.

Literature on numeracy skills emphasizes the importance of applying mathematical concepts in daily life, particularly for students in the upper primary grades, where the ability to think critically and apply mathematical knowledge to real-world contexts is essential (Fawziawati, 2022; Mmasa & Anney, 2016). Upper primary students are expected to bridge the gap between learning mathematical concepts in

school and using those concepts in practical, everyday situations, which is why strengthening numeracy skills is a priority during this stage (Sobkow et al., 2020; Wallace et al., 2019).

To address these challenges, educational practices for fifth graders can be developed to foster numeracy skills. Teachers should focus on helping students connect abstract mathematical concepts with real-world applications through contextual problem-solving tasks. Incorporating real-life scenarios that require students to apply mathematical reasoning in diverse contexts is critical. By contextualizing problems, students are better able to understand the relevance of what they learn and how it relates to their own experiences (Mahmud & Pratiwi, 2019; Yuliawanti et al., 2019). Additionally, scaffolded learning strategies that progressively introduce more complex problems will allow students to build their numeracy skills incrementally. It aligns with educational theories that emphasize the importance of constructivist approaches, where students learn by building on prior knowledge and applying it to increasingly challenging situations (Piaget, 1950; Vygotsky, 1978). Furthermore, providing opportunities for collaborative learning can enhance numeracy skills by encouraging students to share strategies and solve problems collectively, promoting deeper understanding through peer interaction (Goos & O'Sullivan, 2023).

The development of numeracy skills in elementary school students has been a topic of considerable research. Numerous studies emphasize that early intervention and continuous support are critical for developing strong numeracy skills (de Carvalho et al., 2023; Ekowati et al., 2019). Research suggests that students who receive explicit instruction on numeracy concepts in context perform better in applying these concepts to everyday situations (D. Azizah & Fadlikah, 2023). For example, studies show that teachers who integrate numeracy into cross-curricular activities, such as science or geography, provide students with opportunities to apply their mathematical knowledge in non-mathematical contexts (Ridwan et al., 2023). These approaches help develop numeracy as a life skill rather than just an academic subject. Additionally, research by (A. R. Azizah et al., 2024) emphasizes the importance of higher-order thinking Skills (HOTS) questions, which challenge students to apply their numeracy skills in more complex and novel situations. Thus, promoting numeracy skills requires an emphasis on critical thinking, problem-solving, and real-world application throughout elementary education.

Finally, the implications of improving numeracy skills go beyond international assessments like PISA. While higher numeracy skill scores are a key factor in enhancing national rankings, numeracy skill also has broader implications for student empowerment and socio-economic development. Numerate individuals are better equipped to manage personal finances, engage in informed decision-making, and understand data presented in everyday contexts, such as news media or consumer products (Sobkow et al., 2020; Wallace et al., 2019). Improving numeracy skills also helps reduce inequality, as individuals with stronger numeracy skills are more likely to pursue higher education and achieve economic success. Therefore, the implication for policymakers is clear: enhancing numeracy skills in elementary education has long-term benefits for both individuals and society. In addition, numeracy skills are foundational for success in other disciplines, including science, technology, engineering, and mathematics (STEM), which are key drivers of innovation and national competitiveness in the modern world (Almarashdi & Jarrah, 2023; Satrio Ardiansyah et al., 2024).

Strengthening numeracy skills can be seen as a holistic approach to building a knowledgeable and capable citizenry.

Conclusions and Suggestions

This study aimed to analyze the numeracy skills of fifth-grade students, focusing on their ability to apply mathematical concepts in everyday contexts. The findings revealed that while students demonstrated competence in basic counting and arithmetic operations, their skills were significantly weaker in tasks involving numerical relations and distinguishing quantities. The highest average score was found in the indicator "counting an object verbally," followed by "performing basic math operations." However, the indicators "identifying the number of objects" and "distinguishing the quantity of an object" yielded considerably lower scores, highlighting specific areas of weakness in students' numeracy skills. These results emphasize the importance of strengthening contextual problem-solving and ensuring that students can connect mathematical concepts with practical applications.

To enhance numeracy skills, educators need to incorporate real-life scenarios into their teaching, promoting the development of critical thinking and reasoning skills. Additionally, the curriculum should include more contextualized math problems that bridge the gap between abstract concepts and real-world problem-solving. Teachers must be supported through professional development, focusing on techniques that emphasize contextual learning and the cultivation of higher-order thinking skills (HOTS). Scaffolded learning strategies should be implemented to gradually increase task complexity, helping students apply mathematical concepts to progressively challenging situations.

Furthermore, assessments should provide immediate feedback to identify and address gaps in students' understanding. Future research could explore the effectiveness of specific teaching strategies for improving numeracy skills, particularly those incorporating real-world applications, and investigate the influence of socio-economic and cultural factors on numeracy development. Improving numeracy skills is not only crucial for academic performance but also for equipping students with essential life skills. By adopting these recommendations, educators and policymakers can foster numeracy skills as a core skill that extends beyond the classroom, benefiting students in various academic and practical contexts. In addition, future studies may consider exploring the relationship between students' numeracy skills and other influencing factors such as gender, self-efficacy, or learning styles. These variables could offer deeper insights into the development of numeracy and support more targeted instructional interventions. Finally, future research may also adopt a mixed-methods approach to combine quantitative insights with qualitative data such as student interviews or classroom observations, offering a richer understanding of how numeracy skills develop and are applied.

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