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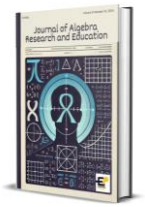

Exploring Numeracy Skills in Algebra: A Cognitive Reasoning Analysis of Middle School Students in Indonesia

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Abstract

This study aims to describe the numeracy ability of students at the cognitive level of reasoning grade VIII State Junior High School 5 Rambah Hilir in solving algebraic domain numeracy problems. This study uses a qualitative approach with a descriptive type. The subjects in this study are students in grades VIII-3 of State Junior High School 5 Rambah Hilir which totals 23 students. Then 6 students with qualifications 2 students with high numeracy skills, 2 students with moderate numeracy skills and 2 students with low numeracy skills were selected as interview subjects. The technique of checking the validity of the data uses triangulation techniques. The results of the study showed that the numeracy ability of students at the cognitive level of reasoning at State Junior High School 5 Rambah Hilir, namely students with a high level of numeracy ability at the cognitive level of reasoning, were able to meet the three indicators of numeracy ability at the cognitive level of reasoning, namely namely analyzing data and information, evaluating, and inferring. Students with a level of numeracy ability at the cognitive level of moderate reasoning are only able to meet two indicators of numeracy ability at the cognitive level of reasoning, namely analyzing data and information, and evaluating. Students with a low level of numeracy ability at the cognitive level of reasoning are only able to meet one indicator of numeracy ability at the cognitive level of reasoning, namely analyzing data and information.

Keywords: Cognitive Level of Reasoning; Numeracy Ability Analysis; Numeracy Questions.

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1. Introduction

Indeed, mathematics is a cornerstone of education and a vital tool for fostering critical thinking, problem-solving, and analytical skills. Its applications extend far beyond the classroom, influencing fields such as engineering, economics, medicine, and technology. The emphasis on mathematics in Indonesia's National Education System (Law No. 20 of 2003) underscores its importance in equipping students with the foundational skills necessary for both personal and professional success. Cahyani, Iskandar, Sukmawati, and Raza (2024) highlight how mathematics not only supports scientific and technological advancements but also enhances everyday decision-making and logical reasoning. By integrating mathematics into primary and secondary education, Indonesia aims to cultivate a generation capable of addressing complex challenges and contributing to global innovation. This aligns with the broader goal of education systems worldwide to prepare students for a rapidly evolving, knowledge-driven society.

The educational system has undergone reforms, including the shift from the National Examination to the National Assessment in 2021 (Mursyidah, Lidinillah, & Muharram, 2023). The National Assessment evaluates not only individual student achievement but also the overall education system, focusing on inputs, processes, and outcomes (Kemendikbud, 2021). It comprises three components: Minimum Competency Assessment (MCA), Character Survey, and Learning Environment Survey. The MCA assesses literacy and numeracy skills (Pusmenjar, 2020), with numeracy testing students' reasoning abilities. Reasoning requires identifying and applying mathematical concepts to solve non-routine problems (Mullis & Martin, 2017) and involves analyzing and interpreting mathematical statements through symbolic or verbal representation (Abidin et al., 2017).

The 2023 Education Report for State Junior High School 5 Rambah Hilir highlights both progress and areas for improvement in students' reasoning and numeracy skills. While the 7.51% increase in reasoning skills (reaching 57.72%) is a positive development, the overall skill level remains moderate, indicating that further efforts are needed to elevate students' proficiency. The analysis of the MCA numeracy content domains reveals that students' performance across numbers, algebra, geometry, data, and uncertainty is relatively consistent, with average scores ranging from 55% to 59%. However, algebra stands out as the weakest area, with a score of 55.28%, despite a 6.57% improvement from the previous year. This suggests that while progress is being made, algebra remains a challenging domain for students, requiring targeted interventions to enhance understanding and performance.

Analysis of students' reasoning abilities at SMP Negeri 5 Rambah Hilir shows that their ability level is still at a medium level. To improve numeracy skills, especially reasoning, it is important to analyze student performance based on specific reasoning indicators (Putri et al., 2019) . By breaking down reasoning abilities into measurable indicators, such as logistical reasoning, problem solving, pattern recognition, abstract thinking, critical thinking, and

mathematical communication, teachers can identify weak areas. For example, whether students can apply deductive or inductive reasoning effectively, or whether they have difficulty solving complex problems with systematic steps. This analysis will help teachers design targeted interventions, such as using logic games (Kania & Ratnawulan, 2022), teaching problem-solving frameworks (Malepa-Qhobela & Mosimege, 2022), or utilizing visual aids (Nissa et al., 2021) to facilitate understanding of abstract concepts.

In addition, regular monitoring of student progress through formative assessments is very important for the effectiveness of the strategies implemented. By providing feedback and adjusting teaching methods based on student needs, teachers can ensure that each indicator of reasoning develops optimally. Creating a learning environment that supports and encourages a growth mindset will also help students see challenges as opportunities for growth, not as obstacles. With this systematic approach, it is hoped that students' numeracy and reasoning abilities at SMP Negeri 5 Rambah Hilir can improve significantly, building a strong foundation for learning and problem solving in the future.

2. Methods

This study employs a qualitative descriptive research approach. Descriptive research aims to depict phenomena, events, and occurrences in the present (Sudjana & Ibrahim, 2001). This aligns with Achmadi & Narbuko (2015), who state that descriptive research seeks to explain current issues based on collected data through presentation, analysis, and interpretation. The researcher, therefore, will describe the research object comprehensively and factually.

The subject selection technique used in this research is purposive sampling. The research subjects comprise all 23 students from Class VIII-3 at State Junior High School 5 Rambah Hilir. From this group, six students will be selected based on their responses to the numeracy test for further interviews. Research instruments include test questions, interview guides, and documentation. Before use, the test instruments underwent a trial to assess their quality, covering validity, discrimination index, difficulty level, and reliability.

The validity test results showed that of the six questions, two were invalid, and four were deemed valid and suitable for research. The discrimination index analysis found one question with very poor discrimination, two with poor discrimination, and three with good discrimination. Three questions, classified as valid with good discrimination and moderate difficulty, were selected for the study. Reliability was tested using Cronbach's Alpha, yielding r11 = 0.9599, indicating high reliability. Data analysis followed the qualitative model proposed by Miles and Huberman (1984), consisting of data reduction, data display, and conclusion drawing.

3. Results and Discussion

3.1 Results

The data of this study was obtained from the results of the cognitive level numeracy ability test given to students in grades VIII-3 of State Junior High School 5 Rambah Hilir. It consists of 3 questions and each question has an indicator of numeracy ability at the cognitive level of reasoning, namely understanding information, analyzing, and inferring. The following is a more complete description of the data analysis of the results of numeracy skills at the cognitive level. After being given the questions of the numeracy ability test at the cognitive level of reasoning

to students in grades VIII-3 of State Junior High School 5 Rambah Hilir, data on the results of the cognitive level numeracy ability test of students were obtained based on each indicator. The results of the analysis can be seen in the following table 1:

Table 1 - Description of Analysis of Numeracy Ability Cognitive Level Reasoning

Indicator	Percentage	Categories
Analyze data and Information	88%	High
Evaluate	78%	Medium
Conclude	14%	Low

Based on Table 1, it can be seen that the percentage of numeracy skills at the cognitive level of students for each indicator is good. It was obtained that the indicator with the highest percentage was analyzing data and information, namely with a percentage of 88% with a high category. In this case, students are very good at analyzing the data and information on the problems presented. The cognitive level of reasoning in numeracy skills refers to the ability of students to understand, analyze and solve mathematical problems. In this case, the ability of students to evaluate is 78%. This shows that students are good at evaluating the problems in the question. However, in this case, students still have shortcomings in concluding the results of the analysis given.

Based on the results of the test conducted in grades VIII-3, data on students' numeracy skills were obtained based on indicators of numeracy skills at the cognitive level of reasoning which can be seen in Table 2:

Table 2 - Data Description of Numeracy Ability Test Results at the Cognitive Level

Categories of Numeracy Skills	Mean	Categories
High	94.4	High
Medium	69.6	Medium
Low	16.7	Low

From Table 2, it can be seen that the level of students' numeracy ability at the cognitive level of reasoning is not equal. Where there are 2 students with high numeracy ability category, and 15 students with medium numeracy ability category, and 6 students with low category. Based on the classification above, then analysis and selection of subjects to be interviewed are carried out. Six subjects were selected to be interviewed from each of the categories of high, medium, and low numeracy abilities.

The consideration for the selection of the subject is that they have obtained algebra material in the mathematics subject of grade VIII and are selected based on the category of numeracy ability at the cognitive level of reasoning. The reason the researcher took AA and FP subjects was because AA and FP subjects had the highest scores. The reason for taking GT and SS subjects is because GT and SS subjects have moderate scores and are the 2 highest scores in the medium category. As for low numeracy skills, the researcher took the subjects T and SK because they had the lowest scores and were the 2 highest scores in the low category.

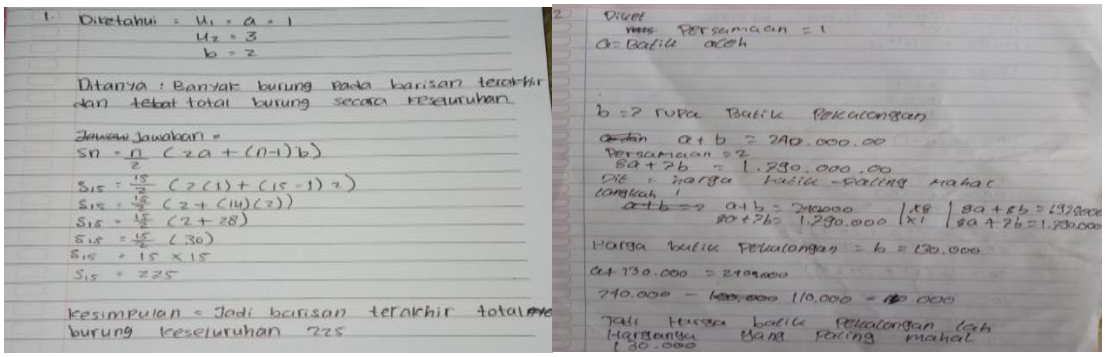

Figure 1 Student Answer High Category

Based on the results of tests and interviews conducted by researchers on AA subjects, it can be concluded that AA subjects are able to analyze data and information on questions. The subject is also able to assess problem-solving strategies and alternative solutions that are appropriate to the problem. The subject is also able to draw conclusions based on the results of the data analysis obtained. Based on the results of tests and interviews conducted by researchers on FP subjects, it can be concluded that FP subjects are able to analyze data and information on questions. The subject is also able to assess problem-solving strategies and alternative solutions that are appropriate to the problem. The subject is also able to draw conclusions based on the results of the data analysis obtained.

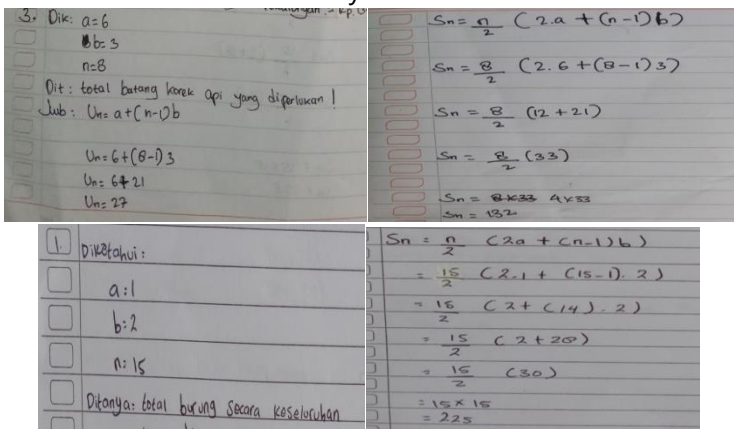

Figure 2 Student Answer Medium Category

Based on the results of tests and interviews conducted by researchers on GT subjects, it can be concluded that GT subjects are able to analyze data and information on questions. The subject is also able to assess problem-solving strategies and alternative solutions that are appropriate to the problem. The subject is also able to draw conclusions correctly, but the subject forgets to write them down. Based on the results of tests and interviews conducted by researchers on SS subjects, it can be concluded that SS subjects are able to analyze data and information on questions. The subject is also able to assess problem-solving strategies and alternative solutions that are appropriate to the problem. The subject is also able to draw conclusions correctly, but the subject does not write it on the answer sheet because the factor thinks that the completion process only reaches the calculation stage.

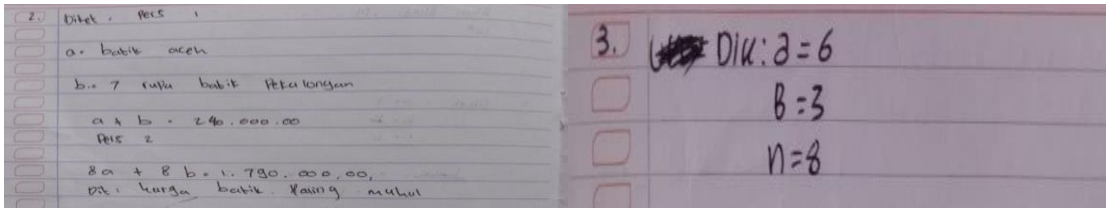

Figure 3 Students Answer Low Category

Based on the results of the test and interviews conducted by the researcher on subject T, it can be concluded that subject T can analyze data and information on the question. However, there is an error in answering it due to the lack of thoroughness. The subject has not been able to assess the problem-solving strategy and alternative solutions that are appropriate to the problem. So that the subject is unable to solve the problem that exists and does not get the appropriate answer result. Based on the results of tests and interviews conducted by researchers on SK subjects, it can be concluded that SK subjects can analyze data and information on questions. However, the subject has not been able to assess the problem-solving strategy and alternative solutions that are appropriate for the problem. So that the subject is unable to solve the problem that exists and does not get the appropriate answer result.

3.2 Discussions

The results of this study provide a comprehensive overview of the numeracy skills at the cognitive level of reasoning among eighth-grade students at State Junior High School 5 Rambah Hilir, particularly in solving algebra domain problems. The analysis reveals significant variations in students' abilities across different indicators of reasoning, namely analyzing data and information, evaluating, and concluding. These findings highlight both strengths and areas for improvement in students' numeracy skills, offering valuable insights for educators to design targeted interventions.

The data shows that students excel in analyzing data and information, with 88% of students achieving a high level of proficiency in this indicator. This indicates that students are capable of understanding and interpreting the information presented in mathematical problems, which is a crucial first step in problem-solving. For example, subjects AA and FP, who were categorized as high achievers, demonstrated a strong ability to analyze problems and identify appropriate strategies for solving them. This strength suggests that the current teaching methods effectively develop students' analytical skills, which are foundational for higher-order thinking in mathematics. Although Subject FP did not write the conclusion on the answer sheet due to forgetfulness, they were able to explain their conclusion clearly during the interview. This aligns with Maulidina et al. (2019), which states that students with high numeracy skills can analyze various forms of information, solve real-life problems, and interpret their analyses to make well-informed decisions.

While students performed well in analyzing data, their ability to evaluate problem-solving strategies and alternative solutions was moderate, with a score of 78%. This indicates that while students can assess the validity of their approaches, they may struggle with critically evaluating multiple solutions or identifying the most efficient strategy. For instance, subjects GT and SS, who were in the medium category, were able to evaluate solutions but often overlooked writing down their conclusions. This suggests that students may need more

practice in articulating their thought processes and justifying their choices, which are essential components of critical thinking. Students with modium level numeracy abilities also fulfilled all three indicators. Subjects GT and SS analyzed and recorded the information from the questions correctly. They chose suitable problem-solving strategies and reached accurate solutions. However, Subject GT forgot to write the conclusion, while Subject SS believed problem-solving ended at calculation and did not include a conclusion.

The most significant area of weakness was in the ability to draw conclusions, with only 14% of students achieving a high level of proficiency. This low performance highlights a critical gap in students' reasoning skills, as drawing conclusions is a vital step in problem-solving that synthesizes analysis and evaluation. Subjects T and SK, who were in the low category, struggled to complete this step, often due to a lack of thoroughness or an inability to connect their analysis to a final solution. This suggests that students may need more structured guidance in understanding how to synthesize information and communicate their findings effectively.

Students with low level numeracy abilities met only the first indicator, analyzing data and information. Subjects T and SK could list known information but often omitted what was being asked. They failed to select appropriate strategies or solutions and left problem-solving steps unanswered. According to Anggraini & Setianingsih (2022); Cahyani, Iskandar, Sukmawati & Raza (2024); Naufal & Handayani, (2023); Safitri, Rohaeti & Afrilianto, (2018) errors in math problem-solving often stem from a lack of habit in writing known information and required actions. Additionally, Subject T could not interpret the analysis results. Consequently, subjects T and SK struggled with conceptual mastery and failed to solve problems accurately. The findings indicate that students with low numeracy skills at the cognitive reasoning level only met the indicator for analyzing data and information.

4. Conclusions

Based on the results of the research that has been carried out, it has been shown that the numeracy ability of students at the cognitive reasoning level of State Junior High School 5 Rambah Hilir, namely students with a high level of numeracy ability at the cognitive level of reasoning are able to meet the three indicators of numeracy ability at the cognitive level of reasoning, namely analyzing data and information, evaluating, and inferring. Students with a level of numeracy ability at the cognitive level of reasoning are only able to meet two indicators of numeracy ability at the cognitive level of reasoning, namely analyzing data and information, and evaluating. Students with a low level of numeracy ability at the cognitive level of reasoning are only able to meet one indicator of numeracy ability at the cognitive level of reasoning, namely analyzing data and information.

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