ANALYSIS OF STUDENTS' MATHEMATICAL REASONING ABILITY ACHIEVEMENTS USING *RESOURCE-BASED LEARNING*

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Abstract. *Mathematical reasoning ability is an important competency that underlies problem solving and drawing logical conclusions in mathematics learning. However, many students still face difficulties in developing this ability, especially if the learning process does not support exploration and active involvement. The Resource-Based Learning (RBL) learning model is proposed as an alternative that can overcome this challenge. This study uses a quantitative descriptive approach to analyze the effectiveness of RBL in improving students' mathematical reasoning ability. A total of 115 students were selected through a saturated sampling method. Data were obtained through the Prior Mathematical Knowledge Test (PAM) and the Inductive Reasoning Test, which grouped students into high, medium, and low groups. The results showed that the Transductive Reasoning indicator had the highest achievement in all categories, with students in the high group recording an average score of 95.69%, the medium group 87.70%, and the low group 82%. In contrast, Analogical Reasoning showed the lowest achievement, with an average score of 30.17% (high achievement), 17.62% (medium), and 9% (low). The Generalization Reasoning and Relational Reasoning indicators recorded relatively high achievements, reflecting students' ability to analyze patterns and draw general conclusions from limited data. RBL has been shown to be effective in improving mathematical reasoning skills by encouraging exploration of learning resources, collaboration between students, and critical discussion. These results confirm that the RBL learning model is able to support the development of students' mathematical reasoning skills at various levels of achievement, with special focus needed on improving lower indicators such as Analogical Reasoning.*

Keywords: *Achievement Level, Learning Engagement, Mathematical Reasoning, Quantitative Descriptive, Resource-Based Learning.*

1. INTRODUCTION

Mathematical reasoning is an essential skill for middle school students, as it equips them to analyze problems, formulate logical arguments, and apply systematic methods to solve complex mathematical tasks (Rittle-Johnson, et al., 2015) . The development of reasoning skills plays a critical role in helping students understand basic concepts in algebra, geometry, and data analysis, which are essential components of the middle school curriculum. However, the teaching and learning process in many classrooms often fails to provide sufficient opportunities for students to explore, think critically, and engage with mathematical problems in meaningful ways (Hiebert, et al., 2007) .

To address this issue, According to Hetmanenko (2024) *Resource-Based Learning* (RBL) has emerged as a promising learning model. By utilizing a variety of learning resources such as textbooks, digital platforms, and collaborative activities, RBL encourages active engagement, autonomy, and critical thinking among students. Research shows that incorporating RBL into mathematics instruction improves students' reasoning abilities by encouraging them to explore learning resources independently, collaborate with peers, and reflect on their learning process.

This study aims to analyze the achievement of students' mathematical reasoning abilities in mathematics through RBL for junior high school students. Using a quantitative descriptive approach, data were collected through reasoning tests. The findings of this

study are expected to provide insight into how RBL can be implemented effectively to improve reasoning skills at various achievement levels, offering valuable strategies for educators to improve mathematics proficiency in diverse classroom contexts. According to Farlina et al. (2018) and Uden et al. (2022) the *Resource-Based Learning (RBL)* learning model allows students to engage in the use of various sources for learning by accessing, evaluating, and utilizing various types of learning resources, both in digital and non-digital forms, to support the learning process independently or collaboratively. Thus, RBL is expected to help improve critical thinking skills, creativity, and problem- solving abilities. According to Rowntree, students need additional learning resources beyond those provided by teachers and prefer to choose materials that suit their individual learning styles. RBL allows students to learn more freely and comprehensively, improving their abilities. When students engage with technology, they must be proficient in it and manage their time effectively. In RBL, teachers need to have skills in pedagogy, evaluation, and feedback, while students use a variety of resources to solve problems, recognizing that each student has unique learning talents and preferences.

Research on students' mathematical reasoning abilities using the *Resource-Based Learning* (RBL) learning model is very important in understanding the extent to which this model can support the development of students' logical and analytical thinking abilities. The RBL learning model, which focuses on the utilization of various learning resources so that learning can be carried out optimally, offers great potential in improving mathematical reasoning skills, which are one of the essential abilities in mathematics education. Therefore, this study was designed to evaluate and analyze students' achievement in the aspect of mathematical reasoning after the implementation of RBL. Thus, the results of this study are expected to contribute to the development of more effective learning strategies in improving students' mathematical abilities. Theoretical references such as those put forward by Jonassen (1999) regarding the importance of resource-based learning in building experience-based knowledge, as well as findings from Uyen et al. (2022) regarding the success of RBL implementation in improving conceptual understanding, support this research framework.

2. LITERATURE REVIEW

2.1 Mathematical Reasoning Ability

Mathematical reasoning is a fundamental aspect of mathematics education, which plays an important role in developing students' logical and analytical thinking skills. Several recent studies have examined various approaches to improving this ability. For example, research conducted by Khoirunnisa and Meilisari (2025) by conducting a systematic literature review on efforts to improve mathematical reasoning skills, highlighted various effective learning methods in this context. In addition, research conducted by Sukirwan et al. (2018) and the results of this study students still face obstacles in handling reasoning in general. The quality of students' mathematical reasoning is still dominated by imitation reasoning, where the problem situations faced by students tend to be fixated on the application of routines in daily lessons. Another study conducted by Rahmawati and Astuti (2022) by analyzing the mathematical reasoning abilities of high school students on the material of two-variable inequalities, provides insight into the challenges and solutions in teaching the topic. These findings emphasize the importance of implementing diverse and innovative learning models to improve students' mathematical reasoning abilities.

2.2 Resource-Based Learning Model

Resource-Based Learning (RBL) is an educational approach that emphasizes the use of multiple resources to facilitate student-centered learning. Although a specific literature review of Scopus-indexed journals for the period 2021–2024 is limited, foundational works provide valuable insights into the RBL model. Specifically, Rakes' (1996) article "Using the Internet as a Tool in a Resource-Based Learning Environment" discusses the integration of internet resources to support RBL. This article highlights the shift from traditional teaching methods to a more flexible resource-based approach. Additionally, Jumonville (2012) in *the Encyclopedia of the Sciences of Learning* offers a comprehensive overview of RBL, discussing its theoretical foundations and practical applications. The entry emphasizes the importance of aligning learning resources with learning objectives to improve educational outcomes. These foundational works affirm the adaptability and effectiveness of RBL in meeting diverse learning needs, especially in the context of technological advancements and the increasing availability of digital learning resources.

3. RESEARCH METHODS

This study uses a quantitative descriptive research approach with a sample of 115 junior high school students. Based on the initial assessment of mathematical knowledge, the sample is categorized into three ability groups: high, medium, and low. The high ability group consists of 29 students, the medium ability group consists of 61 students, and the low ability group consists of 25 students.

This study used a mathematical reasoning ability test and an observation sheet as instruments. The questions containing 6 questions were designed to collect data on students' mathematical reasoning abilities. The observation sheet was used to monitor the activities of teachers and students during mathematics lessons using the *Resource- Based Learning learning model. The observation sheet was used to monitor the activities of teachers and students during mathematics lessons using the Resource-Based Learning* method.

The research procedure is carried out through several stages, namely:

1. **Preparation**: Prepare research instruments, ask permission from the school, and determine the research implementation schedule.
2. **Implementation**: Provide a mathematical reasoning ability test to participants in a predetermined class.
3. **Data Collection**: Collecting test results from participants.
4. **Data Analysis**: The collected data was analyzed using descriptive and inferential statistical techniques to determine the achievement of students' mathematical reasoning abilities using the *Resource-Based Learning model*.

The results of the data analysis will be used as a basis for answering research questions and drawing conclusions about the effectiveness of *Resource-Based Learning* in improving students' mathematical reasoning abilities. This research is expected to provide a significant contribution to the development of more effective learning models in mathematics.

4. RESULTS AND DISCUSSION

In this study, three meetings and two pretest meetings were conducted at the beginning and a posttest was given at the end of the meeting. The steps in the mathematics learning process using the *Resource-Based Learning Model* are explained in the following table 1:

Table 1. Steps of the *Resource-Based Learning Model*

Stages	Teacher	Student
Introduction	The teacher provides apperception **(giving many questions with Socratic questions)** and motivation to facilitate learning.	Students answer questions given by the teacher.
Core	The teacher introduces the problem **(or asks a question) / *presenting questions or problems*)** which will be discussed using various learning resources.	Students determine the purpose of the problem **(identify the information in the question or *problem*)**.
	Teachers provide learning resources that students can use to answer questions or problems **(direct students to resources to solve issues or problems/ provide information).** resources to answer a given learning problem or issue).	Students understand the purpose of a question or problem, they can (identify) **relevant information and decide how to obtain it.**
	Teachers support students by showing that information can come from a variety of learning materials, including print media, digital media, experts, and other sources (guiding the selection of sources for problem solving/ informing to answer the given problem).	Students make plans to collect information from various learning sources to solve problems (planning information searches).
	The teacher asks students to document the information they collect on a worksheet (offering a method for students to record their findings/ provide a way for students to record their information).	Students seek information from various learning sources (taking information from sources/sources) seek information from the source) .
		Students compile information collected from various learning sources (collecting information).
		Students find specific information that is relevant to the problem presented by the teacher (identifying the information needed).
		Students organize the information they have collected and then document the information obtained to solve problems (organizing information/ organize information).
	The teacher asks students to present the information they have analyzed and the work they have completed (presenting findings).	Students present the information they have analyzed and the work they have completed (presenting findings/ presentation

		information).
Closing	The teacher assesses students' work (gives an evaluation).	Students complete the work given by the teacher

Description of teacher activities in learning using the *Resource-Based Learningmodel* can be seen in table 2.

Table 2. Percentage of Teacher Activities in Learning Using *Resource-Based Learning*

Student group	date 1		to 2		the 3rd	
	Percentage	Criteria	Percentage	Criteria	Percentage	Criteria
Tall	70%	Enough	90%	Good	90%	Good
Currently	80%	Enough	90%	Good	100%	Good
Low	80%	Enough	100%	Good	100%	Good
Average	76.7%	Enough	93.3%	Good	96.7%	Good

Teacher activity in learning using the *Resource-Based Learning model* showed a significant increase in each session. At the first meeting, teacher activity was recorded at an average of 76.7%, because teachers were still in the adjustment stage with students, so the time spent on mathematics learning was relatively less. However, at the second meeting, teacher activity increased to 93.3%, and at the next meeting it reached 96.7%. This reflects the increasingly good adaptation and effectiveness of teachers in implementing the method. A summary of student activity during the study with learning using the *Resource-Based Learning model* is available in Table 3.

Table 3. Percentage of Student Activities in Learning Using *Resource-Based Learning*.

Student Group	date 1		to 2		the 3rd	
	Percentage	Criteria	Percentage	Criteria	Percentage	Criteria
Tall	75%	Enough	87.5%	Good	100%	Good
Currently	87.5%	Good	100%	Good	87.5%	Good
Low	75%	Enough	87.5%	Good	100%	Good
Average	79.2%	Enough	91.7%	Good	95.8%	Good

The percentage of student engagement with *the Resource-Based Learning* (RBL) model increased consistently in each session. At the initial meeting, student activity was recorded at an average of 79.2%, because they were still in the adaptation stage with the new approach. However, at the second meeting, student engagement increased to 91.7%, and at the third meeting it reached 95.8%. This increase shows that students are increasingly comfortable and skilled in utilizing additional learning resources, such as books, computers, and multimedia, to support their learning process. Figure 1 shows students using textbooks and problem-solving guides as learning resources.

Figure 1. Students Learn Using Textbooks and Teaching Modules

Next, Figure 2 illustrates students using computers and the internet as educational tools. They utilize these learning resources to find solutions to problems given by the teacher.

Figure 2. Highlighting Students Who Utilize Computers and the Internet as Part of Their Learning Process.

Then Figure 3 shows students using various multimedia tools for learning, such as PowerPoint presentations, instructional videos, and math applications such as GeoGebra. Students stated that the use of multimedia increases the accessibility and enjoyment of the learning process. This is in line with research conducted by Krause et al. (2017) . Furthermore, multimedia is considered a very effective method in mathematics education Maki et al. (2018); Tralisno & Alfi (2023).

Figure 3. Students Engaged in Learning Through the Use of Multimedia

Figure 4. The teacher uses a Power Point presentation to explain the material about cubes and cuboids. This presentation helps students understand the definition and components of cubes and cuboids. Visual media, such as PowerPoint, can improve student performance. This is in line with research conducted by Muliyana et al. (2022).

Figure 4. Power Point Used by Teachers

Figure 5. Students present their research results from various sources. This process helps to increase their resilience after they have invested significant effort in researching and utilizing various sources. Al Ghifari et al. (2022) highlighted the importance of mathematical values reflected in mathematical activities.

Figure 5. Students Learn to Present Their Results

Table 4 shows the results of the post-test of students' mathematical reasoning abilities in high, medium, and low classes using RBL Learning.

Table 4. Students' Mathematical Reasoning Ability Achievements Using RBL Learning

No.	Inductive Reasoning Indicators	Maximum Score	Percentage of Achievement	Average Value	Percentage of Achievement	Average Value	Perecentage of Value	Average Value
			High Group		Medium Group		Low Group	
1	Students can carry out the process of drawing conclusions from limited observation results applied to certain cases (**Transductive Reasoning**), such as identifying diagonal planes and diagonals of planes, and explaining the shape of diagonal planes in rectangular prisms.	4	95.69%	3.83	87.70%	3.51	82.00%	3.28

2	Students can carry out the process of drawing conclusions based on similarities in processes or	4	30.17%	1.21	17.62%	0.70	9.00 %	0.36
	data (Analogical Reasoning), such as determining the similarity of the volume of cubes in the given image.							
3	Students can carry out the process of drawing general conclusions based on limited data (Generalization Reasoning), such as using arithmetic concepts to determine the surface area of the 4th and 10th images, based on the three images given.	**4**	**86.21%**	**3.45**	**61.89%**	**2.48**	**57.00%**	**2.28**
4	Students can estimate answers,		**58.6**		**46.7**		**41.0**	

	solutions, or trends: interpolation and extrapolation, such as using the concept of greatest common factor to reason about the probability of making a cube from a rectangular prism of given dimensions.	**4**	**2%**	**2.30**	**2%**	**1.90**	**0%**	**1.64**
5	Students can provide explanations of models, facts, properties, relationships, or patterns, such as explaining a model of the relationship between the volume of a pool and the volume of water and the time required.	**4**	**81.03%**	**3.24**	**70.90%**	**2.80**	**69.00%**	**2.76**
6	Students can use relational patterns to analyze situations and form	**4**	**93.97%**	**3.80**	**73.77%**	**3.00**	**62.00%**	**2.5**

	conjectures, such as analyzing a company's situation in minimizing the cost of producing boxes by relating the surface area of the boxes to the cost of production.							
	Average		**74.29%**	**17.83**	**59.95%**	**14.39**	**53.41%**	**12.82**

Table 4 shows that students' mathematical reasoning ability varies based on student group categories (high, medium, and low) and types of inductive reasoning indicators. Students in the high group category have the highest average achievement (74.29%) and the highest average score (17.83). They excel in the *Transductive Reasoning indicator* with an achievement of 95.69% and *Relational Reasoning* of 93.97%. Students in the medium group category achieved an average achievement of 59.95% with an average score of 14.39. The indicators with the best results were *Transductive Reasoning* (87.70%) and *Relational Reasoning* (73.77%), although there was a gap compared to the high category. Students in the low group category showed an average achievement of 53.41% with an average score of 12.82. Although the *Transductive Reasoning indicator* (82%) was the highest, the achievement in other indicators was lower, especially in *Analogical Reasoning* (9%).

Furthermore, the mathematical reasoning ability score using RBL (posttest) is shown in Figure 6 as follows:

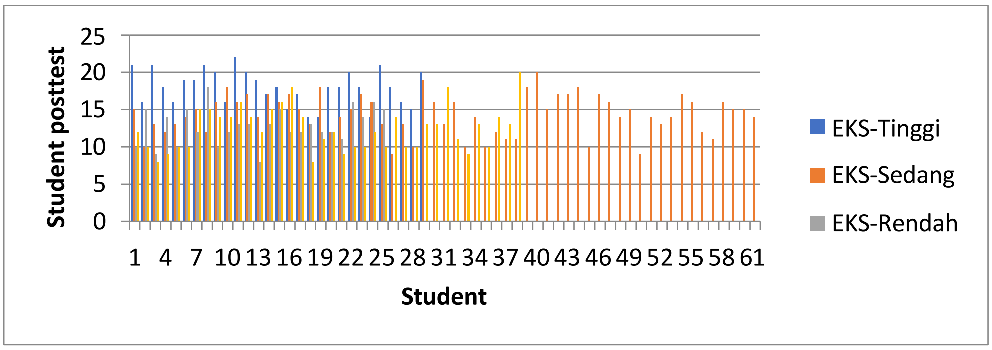

Figure 6. Students' Mathematical Reasoning Ability Achievement (posttest) in Each Class

The following is the average mathematical reasoning ability for each indicator shown in Figure 7 as follows.

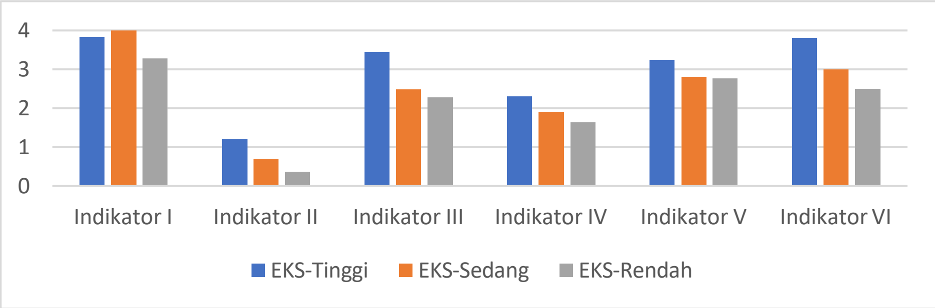

Figure 7. The Average Achievements of Students' Mathematical Reasoning Abilities for Each Indicator

The results of the analysis of the average mathematical reasoning ability of students based on six indicators show significant variations in achievement. The *Transductive Reasoning indicator* has the highest level of achievement, reflecting students' ability to draw conclusions from limited observations, such as identifying diagonal shapes on blocks. This shows that students excel in specific case-based analysis skills.

In contrast, the *Analogical Reasoning indicator*, which tests students' ability to draw conclusions based on similarities in processes or data, showed the lowest achievement. This indicates the need for a more intensive learning approach to improve students' ability to recognize and apply mathematical analogies.

In addition, indicators such as *Generalization Reasoning* and *Relational Reasoning* also show quite good achievements, reflecting students' ability to draw general conclusions from limited data and analyze relational patterns to make predictions. This indicator underlines the importance of exploration-based learning to strengthen understanding of mathematical concepts and applications.

Overall, these results indicate that the Resource-Based Learning (RBL) learning model is able to encourage the development of mathematical reasoning skills, although more attention is needed on indicators that show lower results, such as *Analogical Reasoning*. By strengthening learning strategies, the potential for increasing student achievement in all indicators can be optimized.

The following is a discussion of each question and student answer indicator in the mathematical reasoning ability test for junior high school (SMP) students.

Question 1.
1. A block PQRS.TUVW
a. Draw one of the diagonal planes on the block.
b. What is the shape of the diagonal plane of the block? State and explain!
C. Mention the names of the diagonal planes!
d. How many diagonals are there in the beam?

Answer 1.

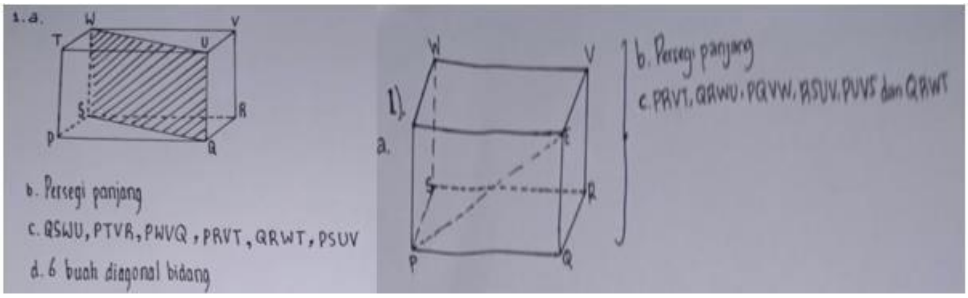

Figure 8. Student Answers to Question Indicator Number 1

In Figure 8. The first question indicator, students in the high, medium, and low groups are generally able to draw conclusions from limited observations in certain cases. In the task of drawing the PQRSTUVW Block, identifying, mentioning, and calculating the diagonal plane, most of the high group students managed to answer correctly. But there are some students who are confused to distinguish the diagonal plane and the diagonal plane.

Question 2.

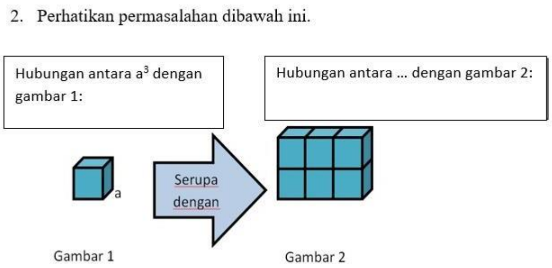

Figure 9. Question Indicator 2: Mathematical Reasoning Ability

In indicator question number two, students in all four classes generally have difficulty in drawing conclusions based on similarities in processes or data. In the High, Medium, and Low Groups, students are still unable to draw conclusions based on similarities in processes or data. For example, students are confused when determining the similarities between data in Figures 1 and 2 in question number 2. Many students choose not to answer the question because they are hesitant and confused. It can be observed that this indicator has the lowest percentage compared to other indicators in each class.

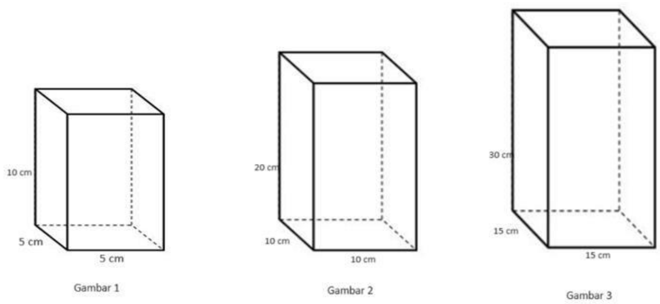

Figure 10. Question Indicator 3: Image Pattern

Question3.

3. Pay attention to the image pattern above by following the pattern in images 1,2,3. Calculate the surface area of the block in the 4th image, then without calculating one by one, determine the surface area of the block in the 10th image.

Answer 3.

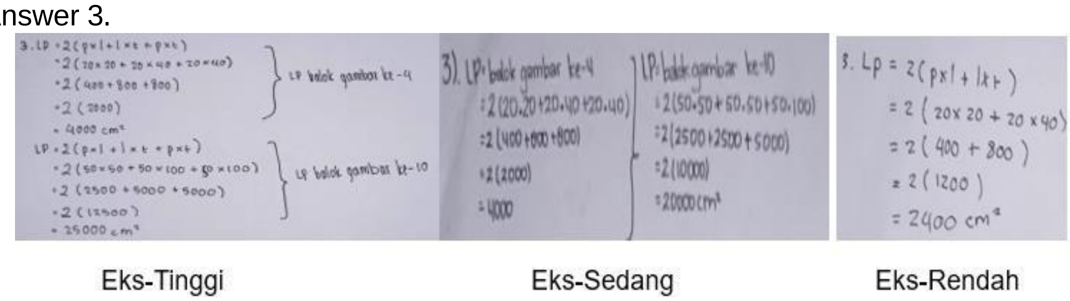

Figure 11. Student Answers to Question Indicator Number 3

In the indicator of question number three, students in all four classes were quite successful in drawing general conclusions from limited data. This can be seen from the fact that this indicator reached more than 50% in each class. Most students understand that the available data, such as figure 1 and other figures, have related patterns. Most students in the high and medium groups can associate the length, width, and height of the image of the size of the block following the pattern. While for the low group, there are still some who have not been able to associate the image pattern.

Question 4.
4. A wooden block is 60 cm long, 15 cm wide, and 30 cm high. From the block, can small cubes be made with the same volume as the block? What size of cubes can be made, explain!

Answer 4.

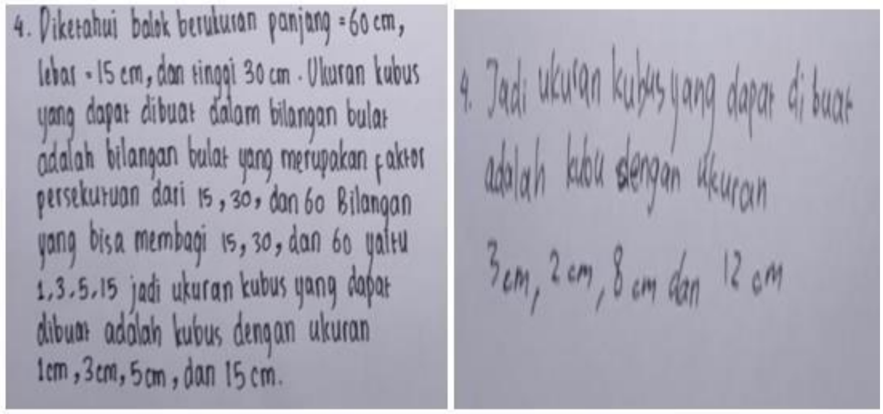

Figure 12. Student Answers to Question Indicator Number 4

In the fourth question indicator, students in general, whether in the high, medium, or low group categories, have good performance in estimating answers, solutions, or trends through interpolation and extrapolation. This can be seen from the students' responses, where students rarely leave their answers blank, and most write down their understanding, even if only partially.

Question 5.
5. Here is a fish pond measuring 2m x 3m x 1.5m

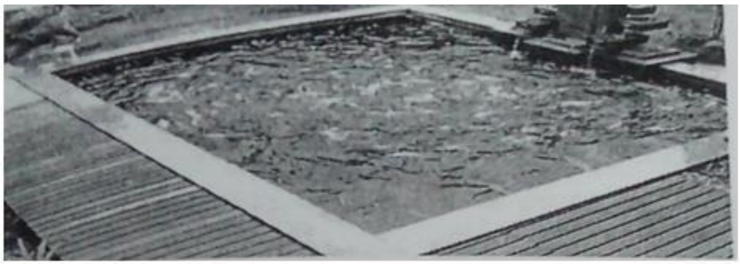

Figure 13. Question Indicator 5: Fish pond

Rangga will fill the pool with water to its fullest. If it takes 20 minutes to fill 1m3, how long will it take to fill the pool? Explain why.

Answer 5.

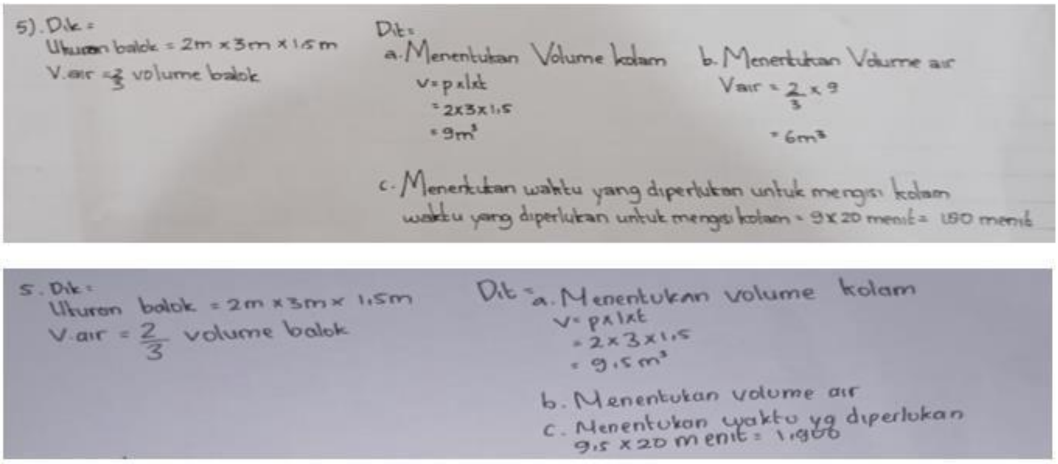

Figure 14. Student Answers to Question Indicator Number 5

In the indicator of question number five, in explaining models, facts, properties, relationships, or patterns, for the high, medium, and low student categories, all showed a fairly good percentage of achievement. This shows that students are able to explain models, facts, properties, relationships, or patterns in mathematics well. For example, when explaining the relationship between volume and the time needed to fill a fish pond, most students can connect it effectively. However, some students are confused in connecting the volume of the pond with the time needed to fill it.

Question 6.
6. "Abah" rice stall will make 2 boxes for customers who take their food home. The first box measures 20cm x 15cm x 5cm while the second box measures 15cm x 10cm x 7cm. If the price of the box material is Rp. 10/cm2, which box can reduce the cost of box production? Explain! How much money must the company spend if it makes 65 boxes?

Answer 6.

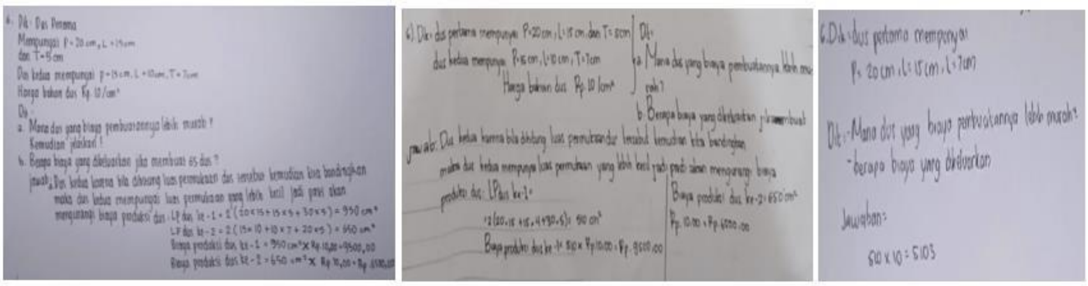

Figure 15. Student Answers to Question Indicator Number 6

In the sixth indicator, in the use of relational patterns to analyze situations and make assumptions, students in the high, medium, and low groups all showed quite good achievement percentages. This shows that students are able to use relational patterns to analyze situations and make assumptions in mathematics effectively. For example, in using the surface area formula of a rectangular prism to make a box and then analyzing the relationship between the surface area and the cost of making the box to minimize production costs, most students make good connections.

CONCLUSION

The learning process in high, medium, and low category student groups using the Resource-Based Learning (RBL) learning model was effective according to the observation sheet. The percentage of teacher and student activity increased at each meeting, with the final percentages of 96.7% and 95.8%, respectively. High group students had better results than medium and low groups. In addition, there was no difference between students in the medium and low groups. The average post-test score showed that the experimental class was superior (High Group = 17.97, Medium Group = 14.34, and Low Group = 12.8). The increase in mathematical reasoning ability can be seen from the average normalized gain score: High Group = 0.69, Medium Group = 0.50, and Low Group = 0.43 with a moderate increase category.

Based on the indicator analysis, students in the high group category showed the best achievement in *Transductive Reasoning* (95.69%), while students in the medium and low group categories also showed quite good results, at 87.70% and 82%, respectively. The *Analogical Reasoning indicator* had the lowest achievement in all categories, with an average score of 30.17% for students in the high group category, 17.62% for students in the medium group category, and 9% for students in the low group category.

Although the *Generalization Reasoning* and *Relational Reasoning indicators* show quite good results, further efforts are still needed to improve students' abilities in more complex indicators such as *Analogical Reasoning* . These results confirm that the RBL approach based on exploration of learning resources, collaboration between students, and critical discussions is able to support the development of mathematical reasoning skills significantly.

Thus, the implementation of RBL can be an effective solution to improve students' mathematical thinking skills. However, there is a need for the development of additional strategies to overcome students' difficulties, especially in more challenging aspects of reasoning.

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