ISRG Journal of Multidisciplinary Studies (ISRGJMS)

ISRG PUBLISHERS
Abbreviated Key Title: isrg j. multidiscip. Stud.
ISSN: 2584-0452 (Online)
Journal homepage: https://isrgpublishers.com/isrgjms/
Volume – IV, Issue - V (May) 2026
Frequency: Monthly

Analysis of Junior High School Students' Mathematical Reasoning Ability in Solving Quadrilateral Problems

Ira Lavenia[1*], Lusiana Delastri[2], Inelsi Palengka[3], Suri Toding Lembang[4]

[1, 2, 3, 4] Master of Mathematics Education Program, Indonesian Christian University Toraja Jl.Jenderal Sudirman Number 9 Makale 91811, Tana Toraja

| **Received:** 11.05.2026 | **Accepted:** 18.05.2026 | **Published:** 25.05.2026

***Corresponding author:** Ira Lavenia

Abstract

The mathematical reasoning ability of junior high school students remains a major issue in mathematics learning. Many students still focus on the final answer and memorize formulas without understanding the underlying thought processes. This condition indicates that students' abilities to provide logical reasons, draw conclusions, and make generalizations are still relatively low. This study aims to analyze the mathematical reasoning ability of junior high school students in solving problems related to quadrilateral shapes. The research employed a qualitative descriptive method with subjects consisting of eighth-grade students from UPT SMP Negeri 1 Rembon, selected based on high, medium, and low academic ability levels. The research instruments included a mathematical reasoning test and interview guidelines for three main subjects. The data obtained were analyzed through the stages of data reduction, data presentation, and conclusion drawing. The results revealed that students' mathematical reasoning abilities were generally low. Most students were unable to make appropriate conjectures, perform correct mathematical manipulations, or provide logical justifications. Furthermore, students also faced difficulties in drawing conclusions from relationships between concepts in plane geometry.

Keywords: *Mathematical Reasoning, Plane Geometry*

INTRODUCTION

Mathematics is a subject that plays an important role in developing higher-order thinking skills, such as logical, analytical, critical, and systematic thinking. Mathematics learning does not only emphasize computational skills, but also requires students to be able to provide reasoning, draw conclusions, and construct arguments based on concepts and evidence. Mathematical reasoning ability is one of the essential aspects that need to be developed in the learning process, as through reasoning, students can understand relationships between concepts and solve problems meaningfully (Setiyawan, Fauziyah, & Fadholi, 2024).

DOI: 10.5281/zenodo.20374359

In the context of 21st-century education, mathematical reasoning is an integral part of higher-order thinking skills (HOTS). These skills are crucial for enabling students to דדומתהל complex problems, both in everyday life and in the workplace. Therefore, mathematics learning should be designed not only to achieve final results but also to develop students' thinking processes in depth.

The implementation of the Merdeka Curriculum also emphasizes the importance of developing critical, creative, and reflective thinking skills in the learning process. Students are expected not only to memorize formulas or solution procedures, but also to explain the reasoning behind the steps taken and to draw generalizations from a concept (Lestari, Mardiyana, & Slamet, 2022). This indicates that mathematical reasoning is a key competency that students must possess in modern learning.

However, various studies indicate that students' mathematical reasoning abilities are still relatively low. Many students experience difficulties in providing logical reasoning, constructing arguments, and drawing appropriate conclusions. This condition poses a challenge for teachers in designing learning processes that effectively foster students' reasoning abilities.

Qotrunnada, Herman, and Hasanah (2021) found that students often have difficulty when asked to explain their thinking processes or to justify the answers they obtain. Meanwhile, research by Anwar, Saiman, and Sofyan (2023) shows that students with moderate ability are only able to meet some indicators of reasoning, such as making conjectures, but are not yet capable of constructing complete and systematic arguments.

These findings are in line with international studies emphasizing that reasoning is the core of meaningful mathematics learning. Stylianides (2022) states that reasoning helps students understand the conceptual structure of a topic and build logical justifications in problem solving. In addition, Lithner (2017) reveals that many students still tend to use mechanical strategies and memorize procedures rather than develop deep conceptual understanding.

One topic that has great potential for developing mathematical reasoning is plane geometry, particularly quadrilaterals. This topic involves not only calculating area and perimeter but also understanding the properties of shapes and the relationships between them. Thus, students can be trained to think logically and systematically in solving problems.

Masruroh, Susanto, and Lestari (2022) state that learning plane geometry can train students to make conjectures, connect properties of shapes, and draw conclusions based on available information. Furthermore, Mubianti, Fera, and Siregar (2023) emphasize that understanding plane geometry concepts plays an important role in developing deductive reasoning and visual-spatial thinking skills. However, in practice, many students still tend to memorize formulas without understanding the underlying concepts (Sumiati & Agustini, 2021).

Based on the above description, it is important to conduct a deeper study on students' mathematical reasoning abilities, particularly in the topic of quadrilaterals. Therefore, this study aims to analyze the mathematical reasoning abilities of junior high school students in solving problems related to quadrilaterals. The results of this study are expected to provide an overview of the levels and characteristics of students' reasoning abilities, as well as to serve as a consideration for teachers in designing learning that emphasizes thinking processes, conceptual understanding, and the development of mathematical reasoning skills.

METHOD

This study uses a qualitative approach with a descriptive type that focuses on the reasoning process of students in solving problems, not on the final results of calculations. The study was conducted at the UPT SMP Negeri 1 Rembon with subjects of grade VIII students selected by purposive sampling of 6–8 people, representing high, medium, and low academic abilities based on teacher recommendations. From this group, three students each representing each ability category will be interviewed in depth to see the differences in their ways of thinking. The main instrument of the study is the researcher herself, with supporting instruments in the form of a mathematical reasoning test in the form of descriptive questions on rectangular plane figures, a semi-structured interview guide to explore students' thinking processes, and an observation sheet to record students' strategies and behaviors while completing the task.

RESULTS AND DISCUSSION

In this study, students were given mathematical reasoning questions about quadrilaterals which read: *"A rectangular shape with a length of 12 cm and a width of 8 cm. If one of the sides is widened to 16 cm but the area remains the same, then determine the size of the side.others and explain your reasons."* Based on the results of students' work, different variations in reasoning abilities were obtained.

Code Student	Student Answers	Reasoning Ability Analysis
Student A	Answer: "Initial area = 12×8 = 96 cm². If one side is 16 cm then the other side = 96 ÷16 = 6 cm." Reason: "Because the area remains the same then the length x new side = 96."	Student A successfully put forward the conjecture that "constant area → new side = 96 ÷ 16"; then carried out manipulation mathematically (division) correctly; but the explanation of the reason is rather brief without revealing that "width or length changes".
Student B	Answer: "The other side = 8 cm because it is still a rectangle." Reason: "Because the shape is still a rectangle, the other side remains the same."	Student B failed to perform the correct mathematical manipulation (wrong answer). Reasoning limited to shape associations ("still square length") without any analysis of area or change in size
Student C	Answer: "Initial area = 12×8 = 96 cm². If width = 16 then length ≠ 6 because 16×6 = 96 indeed, so the other side = 6 cm." Reason: "Because the area remains the	Student C successfully performed a fairly complete analysis: using the concept of area, performing mathematical manipulations, and explaining why the sides changed to keep the product constant. Mathematical reasoning was evident.

DOI: 10.5281/zenodo.20374359

	same and the shape is rectangular, the other side changes so that the product = 96."	

The three student assignments demonstrate that mathematical reasoning abilities vary among students. Students with high ability were able to understand the relationships between concepts and use them to draw logical conclusions, while students with average ability were only able to answer correctly but failed to provide in-depth reasoning.

Some students were able to understand the concept and demonstrate logical solution steps, while others still had difficulty connecting relevant concepts. This finding is in line with Sumarmo's (2010) opinion, which states that mathematical reasoning is the ability to think logically, draw conclusions based on known facts or concepts, and link several mathematical ideas to find the right solution.

Student C demonstrated high mathematical reasoning skills by identifying the relationship between the concepts of area, length, and width, then using these to draw the conclusion that a change in one side causes the other side to change, thus maintaining the same area. This student's thought process reflects the stages of deductive reasoning, which involves drawing logical conclusions from known principles. Student C also demonstrated a form of reasoning called*creative reasoning* (Lithner, 2008), namely when students use strategies and sound reasoning to build solutions based on conceptual understanding, not just memorizing procedures.

In contrast, Student A demonstrated moderate reasoning skills. He was able to perform mathematical manipulations correctly but lacked in-depth reasoning regarding the relationship between changes in the size of a side and the area of the figure. This indicates that the student is still at the intermediate stage.*imitative reasoning*, where the solution strategy is still based on previous examples or experiences without a strong conceptual understanding (Lithner, 2008).

Student B demonstrated poor mathematical reasoning skills. He was unable to connect the concepts of area and side size, and even provided reasons that were irrelevant to the given problem. According to Sumarmo (2010), this difficulty occurs because students do not yet fully understand the relationships between mathematical concepts and tend to think based solely on shape or visual characteristics.

Overall, the results of this study indicate that junior high school students' mathematical reasoning abilities on the topic of quadrilaterals vary. Some students are able to use concepts appropriately, but others are still limited to procedural application. Therefore, teachers need to provide learning that encourages students to explain the reasons behind each step of the solution, propose conjectures or hypotheses, and draw generalizations from the problems faced. Problem-based learning activities (*problem-based learning*) or group discussions can be an effective alternative to train students in developing their mathematical reasoning skills.

CONCLUSION

The research results show that junior high school students' mathematical reasoning abilities in solving quadrilateral problems vary. Some students are able to achieve mathematical reasoning ability indicators such as proposing conjectures, performing mathematical manipulations, providing logical reasons, and drawing conclusions, while others are unable to meet all of these indicators.

Students with high ability demonstrate deductive reasoning and are able to explain the relationships between concepts, while students with average ability tend to only follow procedural steps without in-depth reasoning, and students with low ability still think visually without understanding broad concepts thoroughly. These findings indicate the need for learning that places more emphasis on the mathematical thinking process, not just the final results of calculations. Teachers need to create learning activities that foster logical thinking skills, make assumptions, and draw conclusions based on understood concepts, so that students' mathematical reasoning abilities can develop optimally.

REFERENCES

1. Anwar, M., Saiman, S., & Sofyan, A. (2023). Students' mathematical reasoning ability in geometry material viewed from the level of academic ability.*Journal of Mathematics Education*, 17(2), 45– 56.
2. Agustina, T. (2022). Analysis of student errors in solving word problems on the perimeter and area of flat shapes.*Journal of Mathematics Education and Learning*, 6(1), 12–20.
3. Lestari, D., Mardiyana, & Slamet, I. (2022). Development of HOTS-based learning in the Independent Curriculum to improve students' mathematical reasoning.*Journal of Mathematics Education Innovation*,9(3), 231–240.
4. Lembang ST, Ba'ru Y. *Geometric transformation on carvings of Toraja Tongkonan houses*. *MAPAN: Jurnal Matematika dan Pembelajaran*. 2021;9(2):233–245.
5. Lembang ST, Baan A, Dewi R, Palipangan FB. *The analysis concept of integers counting operations in traditional Toraja games Si Goal and Si Patte*. *AIP Conference Proceedings*. 2022;040001. Doi: https://doi.org/10.1063/5.0104921
6. Lithner, J. (2008). A framework for creative and imitative reasoning. *Educational Studies in Mathematics*, 67(3), 255–276.
7. Lithner, J. (2017). Principles for designing mathematical tasks that enhance imitative and creative reasoning. *ZDM Mathematics Education*, 49(6), 937–949.
8. Masruroh, U., Susanto, H., & Lestari, P. (2022). Developing mathematical reasoning through learning quadrilaterals.*Journal of Mathematics Education Research*,9(1), 77–89.
9. Mubianti, R., Fera, M., & Siregar, H. (2023). Application of evidence-based learning in plane geometry material.*Journal of Mathematics Education Studies*,11(2), 101–112.
10. Putri, W., & Rahman, A. (2021). Spatial reasoning in geometry learning in junior high school.*Journal of Mathematics and Mathematics Education*,13(1), 50–59.
11. Qotrunnada, A., Herman, T., & Hasanah, U. (2021). Analysis of junior high school students' mathematical reasoning abilities on HOTS questions.*Journal of Mathematics Education Scholars*,5(2), 881–891
12. Setiyawan, D., Fauziyah, S., & Fadholi, A. (2024). Strengthening mathematical reasoning skills through

DOI: 10.5281/zenodo.20374359

contextual learning.*Indonesian Journal of Mathematics Education*,11(1), 1–10.
13. Sumarmo, U. (2010). Thinking and reasoning in mathematics learning. Bandung:*Indonesian education university*.
14. Sumiati, A., & Agustini, Y. (2021). Analysis of students' difficulties in understanding the concepts of quadrilaterals and triangles.*Journal of Mathematics Learning and Education, 7(2), 67–76.*
15. Stylianides, G. (2022). Reasoning-and-proving in school mathematics. *Educational Studies in Mathematics, 111(1), 3–22.*

DOI: 10.5281/zenodo.20374359