

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



CAPABILITY ANALYSIS MATHEMATICAL PROBLEM SOLVING HIGH SCHOOL STUDENTS ON GEOMETRY TRANSFORMATION MATERIAL

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| **Received:** 11.05.2026 | **Accepted:** 18.05.2026 | **Published:** 24.05.2026

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Abstract

Mathematical problem-solving ability is an essential competence for high school students, especially in geometry transformations, which require conceptual understanding and higher-order thinking skills. However, studies show that students' problem-solving abilities in this topic remain at a moderate level, with many students struggling at the stages of understanding the problem and reviewing their solutions. This study aims to analyze high school students' mathematical problem-solving abilities on geometry transformation material based on Polya's steps, to identify the most mastered indicators, and the influencing factors. This research employed a descriptive qualitative approach involving 10 purposively selected eleventh-grade students of SMA Negeri 5 Tana Toraja in the 2024/2025 academic year. The main instrument was essay questions based on Polya's indicators: understanding the problem, devising a plan, carrying out the plan, and looking back. Data were analyzed descriptively using a structured scoring rubric. The results show that most students are in the moderate ability category, with devising a plan being the most mastered stage (85%), while looking back is the lowest (35%). The main contributing factors are the lack of practice with story problems and limited habituation in reflecting on results.

Keywords: *Problem Solving Abilities, Polya, Geometric Transformation*

INTRODUCTION

Every Mathematical problem-solving skills are one of the basic skills that high school students must have as part of essential mathematics competencies. This ability not only includes skills in solving math problems, but also includes the ability to think critically, creatively, and logically in dealing with complex problems.

In the context of mathematics learning, problem-solving is one of the main indicators of students' success in understanding mathematical concepts in depth. This ability is also a benchmark in assessing the effectiveness of the learning process. As explained by Sapitri (2019), mathematical problem solving is a skill that students must have because through problem solving, students can

apply mathematical concepts in real life and develop high-level thinking skills.

Although important, the results of the study show that the mathematical problem-solving ability of high school students is still relatively low to moderate. For example, research at SDN Gunungpati 02 Semarang showed that only 26.92% of students had high mathematical problem-solving skills, while most were still in the medium and low categories. This shows the need for systematic efforts to improve these abilities through proper learning and accurate measurements.

The results of Zakiyah et al.'s (2018) research show that high school students in West Bandung Regency have a very good ability to understand problems (85.5%), but the ability to strategize and check answers is still relatively low. This indicates that although students can understand the problem, they have difficulty in the next stage.

Students' motivation and initial experience are also factors that affect mathematical problem-solving skills. Siswono (2018) stated that students' initial experience, background, desires, and motivation are very influential in the problem-solving process. Students who are motivated and have enough experience tend to be better able to solve math problems well. Therefore, motivational learning is indispensable to enhance these abilities.

In addition, a relevant and engaging learning context can improve students' problem-solving skills. Alfiah (2021) in her research showed that learning based on Islamic context in geometric transformation materials can positively affect students' problem-solving abilities, although there are variations in abilities based on students' cognitive styles. This indicates the importance of choosing the appropriate learning context to improve mathematical skills.

Geometric transformation material is an important part of the high school mathematics curriculum because it plays a role in building students' geometric visualization and reasoning skills. Transformational concepts such as translation, reflection, rotation, and dilation not only teach the change in position and shape of a building, but also hone students' ability to think logically and systematically to solve problems related to geometry.

However, learning geometry transformation in high school still faces various obstacles, one of which is the difficulty of students in understanding concepts and applying them in problem solving. This is strengthened by data from the Education Assessment Center of the Ministry of Education and Culture (2018) which shows that only around 28.51% of students are able to answer geometry transformation questions correctly in the National Exam. This difficulty is caused by the lack of variety of learning resources and learning media that are able to visualize the concept of transformation effectively, so that students have difficulty in connecting abstract concepts with real applications in problem solving problems.

Furthermore, research by Fajar Prasetya Karso (2016) emphasized that mastery of the concept of geometric transformation greatly affects students' mathematical problem-solving skills. Geometry transformation provides a rich context for developing spatial visualization and mathematical reasoning skills that are an important part of problem solving. However, students often have difficulties when dealing with complex transformations such as

rotation and reflection on more complex wakes, as well as in constructing mathematical proofs algebraically.

Based on the description above, it can be concluded that the analysis of the mathematical problem-solving ability of high school students is very important to be carried out. This analysis will provide an overview of the extent to which students master the stages of problem solving, especially in geometry transformation materials and aspects that need to be improved. Thus, the results of the analysis can be the basis for developing more effective learning strategies to improve students' overall mathematical skills.

RESEARCH METHOD

This study uses a qualitative descriptive approach that aims to analyze the mathematical problem-solving ability of high school students in geometry transformation materials based on Polya steps. The subjects of the study were 10 students in grade XI of SMA Negeri 5 Tana Toraja for the 2024/2025 Academic Year who were selected purposively based on the researchers' considerations and the suitability of the material on geometry transformation in class XI in the even semester. The main instrument used is a description of problem-solving ability indicators according to Polya, namely understanding problems, planning solutions, implementing solutions, and re-checking the results of solutions. The preparation of the instrument began with a literature review and adjustments to the characteristics of geometry transformation materials at the high school level.

Data is collected through a description test that requires students to explain the problem-solving process in a sequential and systematic manner. Students' answers were analyzed using an assessment rubric that had been developed based on the Polya indicator, with assessment categories ranging from very good to poor. Data analysis was carried out descriptively by grouping the results of students' answers according to indicators and ability categories, and identifying factors that affect problem-solving skills in geometry transformation materials.

This method is based on the goal to be achieved, which is to provide an overview of the level of students' mathematical problem-solving ability, the most dominant indicators, and the factors that affect students' success and obstacles in solving geometry transformation problems.

RESULTS AND FINDINGS

The subjects of this study are 10 students in grade XI of SMA Negeri 5 Tana Toraja for the 2024/2025 Academic Year based on the researchers' considerations and the suitability of the Geometry Transformation discussion material in grade XI in the even semester. In this discussion, the 10 subjects will be named with different codes to make it easier to read the research results.

In this study, a description question was used with an indicator of problem-solving ability based on the Polya stage. The following are the results of the mathematical problem-solving ability test on geometry transformation materials from 10 selected subjects with data sorted by category:

Table 1

<i>Subject Code</i>	<i>Value</i>	<i>Categories</i>
<i>S1</i>	93,75	Height
<i>S2</i>	75	Medium

S3	68,75	Medium
S4	62,5	Medium
S5	62,5	Medium
S6	62,5	Medium
S7	62,5	Medium
S8	56,25	Low
S9	50	Low
S10	37,5	Low

Based on the table above, it can be seen that out of 10 students there is one student with a high problem-solving ability, six students with a medium category, and 3 students with a low category. This shows that students' mathematical problem-solving ability in geometry transformation materials based on Polya steps is moderate.

Table 2: Percentage of emergence indicators of students' mathematical problem-solving ability:

INDICATOR	PERCENTAGE OF INDICATOR EMERGENCE	CRITERIA
UNDERSTANDING THE PROBLEM	55%	Medium
PLAN TROUBLESHOOTING	85%	High
IMPLEMENTING PROBLEM SOLVING	77.50%	Medium
DOUBLE-CHECK THE RESULTS	35%	Low
AVERAGE INDICATOR	63.13%	Medium

From the table above, it can be seen that the highest percentage of problem-solving ability indicators is the problem-solving planning indicator, which reaches 85%. The medium criterion is in the indicator of understanding the problem, which is 55% and implementing problem solving at 77.50%. Meanwhile, the lowest indicator of problem-solving ability is to double-check the results with a percentage of 35%.

Based on this study, it was found that the most dominant mathematical problem-solving indicator was mastered by grade XI students of SMA Negeri 5 Tana Toraja in solving geometry transformation problems was at the stage of planning problem solving (85%).

The following is a discussion of the results of the analysis based on indicators of mathematical problem-solving ability:

1. Understanding the Problem

In the stage of understanding the problem, there are only a few students who write down the information that is known and asked correctly and completely, they write down the data and understand

the context of the problem thoroughly so that they can formulate the problem clearly. The student has a strong understanding of mathematical concepts and the ability to read and understand problems well.

There is one student who can understand most of the information in the question and write down important information, but there are some details that are incomplete or inappropriate. One other student only wrote down the basic information that was known. However, these students are still able to grasp the core of the problem in the problem.

While most students do not write down the results of identifying the information that is known and asked in the question. This is due to a lack of experience in dealing with story problems.

2. Plan Troubleshooting

At the stage of planning problem-solving, with a deep understanding of the concepts, most students are able to design the solution steps systematically and logically using the concept of proper geometry transformation. Although there are still those who do not write the results of identification at the stage of understanding the problem.

Two students planned the completion well but were less than optimal in choosing the most efficient method. These students have a sufficient understanding of concepts but still have difficulty in determining formulas and making solution steps that are appropriate to the problem.

At this stage, there are also students who plan the completion steps in a simple but incomplete manner that makes the completion process difficult. It is caused by a lack of practice in designing problem-solving strategies.

3. Implementing Problem Solving

In carrying out problem solving, most students take the right solution steps, using formulas and concepts of geometric transformation correctly and carefully. This is due to the level of mastery of the material and the accuracy of students in working on the questions.

Some students carry out inconsistent completions, make mistakes in concepts or calculations, have difficulties in carrying out completions, and some even do not complete the problems. This is due to a lack of strong understanding of concepts and lack of practice, as well as poor mastery of the material and basic math skills.

4. Double-Check the Results

Based on the results of the study, the percentage of occurrence of this indicator is the lowest, which is only 35%. There is only one student who draws the right and clear conclusion according to the results of the problem solving. Most of the other students draw wrong conclusions and even do not draw conclusions at all even though the answers obtained are of correct value at the stage of implementing problem solving.

This indicator draws conclusions that is a weak point for students in solving mathematical problems, especially in geometric transformation story problems. Indicators draw conclusions become the stage that students forget due to several factors, mainly because they are in a hurry to solve the problem or feel satisfied with the answers obtained without explicitly writing down the conclusions. This is supported by research by Grace & Sianipar

(2020) which found that students who forget to draw conclusions are usually caused by an unfamiliarity in writing the conclusion. In addition, inthoroughness and lack of habit to double-check answers are also the main causes of students not drawing conclusions correctly.

Another influencing factor is the lack of a deep understanding of the problem and the problem-solving process, so students tend to focus on calculations alone without proceeding to the stage of inference or drawing conclusions. According to Rumasoreng & Sugiman (2014), forgetting and lack of attention are also the causes of students' difficulties in solving story problems, including in the stage of drawing conclusions. In this context, students who are in a hurry or are not used to writing conclusions often miss this important stage so that the results of problem solving become incomplete and inaccurate.

Thus, to overcome this problem, it is necessary to give students the habit to always write down the entire solution process to the explicit conclusion, as well as to practice precision and the habit of re-examining the results of their work so that the problem-solving process becomes more complete and systematic.

CONCLUSION

Based on the results of the analysis of the mathematical problem-solving ability of high school students on geometry transformation materials using Polya steps, it can be concluded that in general the ability of students is in the medium category. Of the 10 students who were the subjects of the study, only one student had high ability, six students were in the medium category, and three students were in the low category. The most dominant indicator mastered by students was at the stage of planning problem-solving (85%), while the indicator with the lowest achievement was re-examining the results (35%).

Factors that affect students' problem-solving skills include understanding basic mathematical concepts, learning motivation, initial experience, and the learning context used. Students who have high motivation and sufficient learning experience tend to be better able to understand and solve geometry transformation problems well. However, there are still many students who have difficulty at the stage of understanding the problem and re-examining the results, which is generally due to the lack of practice in the story question, as well as the lack of habituation to reflect on the results.

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