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Students' Problem-Solving Skills Viewed from Polya's Problem-Solving Indicators

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Abstract. Problem-solving skills are one of the essential skills that must be mastered in the 21st century, as they can develop critical thinking skills and support effective daily decision-making. Based on this, problem-solving skills need to be mastered by everyone, including elementary school students. To measure problem-solving skills, we can use the four problem-solving indicators presented by George Polya, namely understanding the problem, devising the plan, carrying out the plan, and looking back. In reality, many students have not yet mastered problem-solving skills. Therefore, this study was conducted with the aim of describing the problem-solving abilities of sixth grade elementary school students. The research method used was descriptive-qualitative. The research subjects were 51 sixth-grade elementary school students. Each research subject completed a problem-solving test on the material of combined flat shapes, which consisted of eight story questions. The questions in this problem-solving test were adjusted to the problem-solving indicators according to George Polya. The results showed that 54.9% of students were able to understand the problem. As for the indicator of devising a plan, only 34.3% of students possessed this skill. Then, only 17.6% of students had the skill of carrying out the plan. Last, only 12.7% of students were able to look back at the problem solution.

Keywords: Problem solving, mathematics, 21st century skill

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INTRODUCTION

Problem-solving skills are one of the essential skills that must be mastered in the 21st century. This skill can develop critical thinking skills and support effective decision-making in everyday life (Cooney in Laila & Harefa, 2021). In addition, problem-solving skills are an important component in being able to adapt to the modern world (Gravemeijer et al., 2017). In the school environment, mathematical problem-solving skills support the improvement of student learning achievement. Students who are placed in situations that encourage them to solve problems using mathematical logic will improve their understanding of the material and their learning achievement (Stohlmann & Albarracín, 2016). Based on this, problem-solving skills need to be mastered by everyone, including elementary school students.

Many opinions explain the problem-solving process, one of which is George Polya. According to George Polya (in Klang et al., 2021), problem-solving indicators include the process of understanding the problem, devising a plan, carrying out the plan, and looking back. The explanation of each of Polya's problem-solving indicators is as follows.

First, the indicator of understanding the problem relates to the skill of ensuring that everything is known. Understanding the problem also relates to the skill of determining whether the data obtained is sufficient or not and determining what is being asked of the given problem. Second, the indicator of developing a plan relates to the skill of considering the problem from various

angles, thinking of the right strategy to solve the problem, and seeing the suitability of the strategy used in solving the problem. Third, the indicator implements a plan containing activities to implement the plan that has been made. In addition, mathematical modeling activities can also be carried out. This indicator can be used to ensure that the problem has been understood and the strategy for solving it is known. This will encourage problem-solving activities without hesitation. Finally, the review indicator is a stage for checking the completeness of the elements used in problem solving, considering solutions from various angles, completing incomplete elements, and carefully checking the correctness of the process that has been carried out previously (Fitriani et al., 2022; Yayuk & Husamah, 2020; Sulistyaningsih et al., 2021).

Previous studies have shown that students at various levels of education have low mathematical problem-solving skills. Research conducted by Fajria et al. (2025) shows that 70% of fifth-grade students at a school in Merauke have low mathematical problem-solving skills. This study found that the most mastered problem-solving indicator was understanding the question, while the most difficult problem-solving indicator was determining the strategy or formula to be used. A preliminary study conducted by Riyadi et al. (2021) showed that students' mathematical problem-solving skills were still relatively low. The mathematical problem-solving skills test in this study was conducted using multi-level story problems on the topic of flat shapes. Only 5 out of 22 (22.72%) third-grade students, 7 out of 28 (25%) fourth-grade students, and 4 out of 21 (19.05%) fifth-grade students were able to achieve all four of Polya's problem-solving indicators. The mathematical problem-solving skills test conducted by Klang et al. (2021) on three subtests, namely multiplication and division, proportions, and geometry, found that 269 students in the experimental class and 312 students in the control class had low problem-solving skills. The lowest average score was obtained by students in the experimental class on the geometry subtest, which was 0.89 out of a maximum score of 6.

This low problem-solving skill is caused by several factors. Students' low mathematical problem-solving skills may occur because they are not accustomed to dealing with problem-solving tasks, resulting in very low problem-solving outcomes (Kusumadewi & Retnawati, 2019). In addition, students' difficulties in mathematical problem solving are influenced by their inability to understand all or part of the problem due to a lack of imagination and experience; teachers rarely present problems related to everyday life; and teachers only focus on examples available in textbooks rather than teaching the principles behind each problem (Phonapichat et al., 2014). Furthermore, attitudes, self-confidence, interest, motivation,

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persistence, self-confidence, and the ability to manage emotions (frustration and anxiety) and anxiety have an effect during the problem-solving process. Positive affections such as enjoying the process of mathematical thinking and persistence in the face of failure greatly influence the success of problem solving. Conversely, negative affect hinders students' mathematical problem-solving process (Carlson & Bloom, 2005; Hidayat & Ayudia, 2019).

The impact of low mathematical problem-solving skills results in poor student learning outcomes in mathematics. Research conducted by Agustina et al. (2025) shows that 42.3% of learning outcomes in mathematics can be influenced by mathematical problem-solving skills. Students' low mathematical problem-solving skills can also cause difficulties in understanding abstract and complex concepts, hinder the development of critical thinking and collaboration skills, and cause students to have difficulty integrating knowledge and skills effectively in real-life situations (Susilawati et al., 2024).

The importance of problem-solving skills has prompted numerous studies on the subject. Previous studies have generally highlighted differences in students' overall achievement and have not identified each of Polya's mathematical problem-solving indicators. Identifying students' abilities in each indicator is important in order to provide a more detailed picture of their problem-solving skills. In addition, this can be used as initial data in making more detailed strategic planning for differentiated learning.

Therefore, this study was conducted by exploring students' problem-solving profiles. This study fills the gap in other studies by providing a qualitative description of students' problem-solving skills on each indicator of Polya's mathematical problem-solving. This distinguishes it from many previous studies. This study aims to describe mathematical problem-solving skills, particularly among sixth-grade elementary school students.

METHODOLOGY

This study was conducted using descriptive-qualitative methods. Data were collected through mathematical problem-solving skill tests. The tests were given in the form of story problems on the subject of combined area and consisted of eight questions. The questions were compiled based on the mathematical problem-solving indicators proposed by George Polya. After the data was collected, it was analyzed for each question in each student's answer to provide an overview of the students' mathematical problem-solving skills for each indicator.

The instrument used in this study was a set of tests of students' mathematical problem-solving skills on the subject of combined flat shapes. The instrument included a question grid, test

questions, and answer keys. The problem-solving skills test consisted of eight story problems divided into two main problems.

The participants in this study were 51 sixth-grade elementary school students. These students came from three different elementary schools in the West Java region. These three schools were chosen because they were similar in terms of school conditions and student abilities.

RESULTS AND DISCUSSION

The math problem-solving test was administered to sixth-grade students who had previously studied the combined area of flat shapes. The test focused on the combined area of flat shapes. This material is part of the Merdeka Curriculum, developed by the Indonesian Ministry of Education and Culture. Each indicator consisted of two questions. Based on the test results, the following results were obtained.

Table 1. Mathematical Problem Solving Test Results

Mathematical Problem Solving Indicators	Percentage
Understanding The Problem	54,90%
Devising The Plan	34,31%
Carrying Out The Plan	17,65%
Looking Back	12,75%

More than half of all students were able to answer questions on the indicator of understanding the problem correctly and achieved maximum scores. Students were able to explain the problems faced in these questions. Most students were able to record what they knew correctly. The problem-solving process at the problem-understanding stage became the indicator with the highest score on this test. A total of 54.90% of students had the ability to understand problems well. This is in line with research conducted by Fajria et al. (2025), which shows that the problem understanding indicator was the most mastered by students.

On the indicator of devising the plan, only 34.31% of students were able to do it correctly. The majority of students were only able to make a plan to solve the first problem correctly, which involved finding the area by subtracting the total area from the area of the part. As for the second problem, the majority of students still made mistakes in determining the plan to solve the problem. The most common mistake was made in dividing the combined flat shapes into squares, rectangles, and triangles to then calculate their areas. This obstacle is in line with

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previous studies, which show that students still have difficulty determining data from combined flat shapes and breaking down combined flat shapes into separate flat shapes to find the area of the combined flat shapes (Abadi & Amir, 2022; Salsabilah et al., 2023). This obstacle affects students' skills in determining a plan to solve problems.

Furthermore, although 34.31% of students were able to correctly devise a plan to solve the problem, only 17.65% of students were able to carry out the plan correctly. The most common mistake was in calculating the area of each part. Many students were incorrect in stating how to calculate the area for each flat shape. This may have occurred because students were rarely given non-routine problems involving combinations of flat shapes, so they found it difficult and confusing to answer the questions, ultimately answering randomly or making things up (Adhyan & Sutirna, 2022).

In the final stage, fewer students were able to do this. Only 12.75% of students were able to look back on their problem-solving using other methods. Students seemed confused when looking back and reflecting on their problem-solving results in new, related situations. The low number of students who were able to look back was also due to the low number of students who were able to carry out their plans. This indicator is the one that students master the least.

CONCLUSION

Problem-solving skills show significant differences in each indicator. Students' abilities decline significantly from the first indicator to the last indicator. Understanding problems is the indicator that most students master, with 54.90% of students able to do so. However, only 34.31% of students are able to formulate an appropriate plan to solve the problem. In the next indicator, the number of students who mastered it decreased significantly. Only 17.65% of students were able to implement the plan that had been developed, and only 12.75% of students were able to recheck the problem solution. These findings show that students are strong in understanding problems but have difficulty solving them.

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