# Students' Mathematical Problem-Solving Ability Based on Pedagogic Analysis of Mathematics Learning

Siti Patunah[1], Tatang Herman[2*)]
[1]Universitas Pendidikan Indonesia
[2] Universitas Pendidikan Indonesia
*)tatangherman@upi.edu

**Abstract**
Students' mathematical problem-solving skills are an important ability to have. One of the factors that can affect mathematical problem-solving ability is the teacher's pedagogic in learning mathematics. This study aims to analyze the pedagogical aspects of mathematics learning. The research method used is a qualitative approach with a descriptive method. The research subjects consisted of 35 grade VIII students in one of the schools in the city of Bandung. Data collection was carried out through observation of the mathematics learning process, test items of mathematical problem-solving skills, and the implementation of interviews with teachers and students. Data analysis was carried out by calculating the percentage of answers to the item test for mathematical problem-solving ability and analyzing the pedagogic learning of mathematics. The results showed that the average mathematical problem-solving ability as a whole reached 64.5%, indicating a medium category. The lowest indicator of mathematical problem-solving ability is the recheck indicator. Based on the analysis of pedagogic aspects in mathematics learning on mathematical problem-solving abilities related to teachers' ability to use learning methods and technology. This means that learning methods and technology are important in improving students' mathematical problem-solving skills.
**Keywords:** Mathematical problem-solving ability; Teacher’s pedagogical competency

## Introduction

Students' ability to solve problems is still important in the context of education because it is the basis for finding solutions to a problem to achieve certain goals. Problem-solving is a process of understanding a problem to plan and implement its solution (Schoenfeld, 2016). Students' ability to solve problems in an educational context involves their ability to solve problems by collecting facts and understanding mathematical concepts (Miftah et al., 2021; Suswari & Herman, 2020). In addition, problem-solving skills are the main goal in mathematics learning which requires individuals to think systematically, logically, and critically and not give up until they find a solution to a problem (Afriansyah et al., 2020; NCTM, 2014).

The importance of problem-solving skills is owned by students because it is one of the foundations of various other mathematical skills. Branca (1980), mentioned the importance of problem-solving skills possessed by students, which is the general purpose of mathematics teaching, problem-solving which includes methods, procedures, and strategies

is the core process in the mathematics curriculum, and is a basic ability in learning mathematics. In addition, students can use problem-solving to identify data adequacy, make mathematical models of a problem, select and apply strategies to solve problems, explain a result, and perform mathematics meaningfully (Taufiqiyah & Malasari, 2023).

In problem-solving, reasoning skills have an important role. Through good reasoning skills, students are able to solve the problems they face effectively (Agustin et al., 2023). Reasoning ability is an important aspect in mathematics that involves logical, analytical, and critical thinking patterns (Saputri & Herman, 2022). The curriculum also states that reasoning is a key component of high-level mathematical thinking skills and is considered a basic competency that students must master (Kusumawardani et al., 2018). Mathematical reasoning skills are important for students because they help students understand the usefulness of mathematics, making it easier for students to understand and solve mathematical problems. Thus, mathematical reasoning skills are part of the importance of problem-solving skills.

Despite the importance of problem-solving skills, students with good problem-solving skills are still few (Abjad et al., 2022; Mariani & Susanti, 2019; Nasution et al., 2023). Sriwahyuni, Krisnawati dan Maryati (2022), found that students made mistakes in 3 out of 4 indicators of problem-solving ability. In line with that, several findings of students with low problem-solving abilities were found that were reviewed based on various aspects such as initial ability, learning style, and fighting spirit. One of the factors for low problem-solving skills is that students are not used to solving problems in the form of a problem. It shows that students are not used to using context in a given problem. In the learning process, it is important to use contextual problems as a bridge to connect the material with real life. Contextual problems are problems that are in accordance with the situation that students are experiencing, in accordance with real life, and close to students (Mefiana & Juandi, 2023).

The process of learning mathematics is often considered difficult by some students. Rizky & Sritresna (2021) said that the difficulty of learning mathematics is due to a lack of interest in learning mathematics due to boring learning. The difficulties that students experience must be able to be overcome during learning. One of the efforts to overcome difficulties is with tenacity and determination which are very important traits in the problem-solving stage as students learn mathematics. When teachers give assignments in the form of problems that must be solved, the steps that need to be taken by students involve understanding the problem, determining strategies or approaches to thinking, formulating

the problem into mathematical representations, applying mathematical procedures to find answers, as well as checking and evaluating the answers and ways of thinking used (Cahyani & Setyawati, 2016).

In the learning process, of course, the teacher's pedagogic ability is needed in practicing mathematical problem-solving skills. Pedagogic competence involves the ability of educators to understand students in adapting educational learning (Istianingsih Hermawati & Andayani, 2020). Teachers play an important role in directing students to have mathematical problem-solving skills through methods used in the learning process (Sanusi et al., 2021). So, it indicates that teacher pedagogy plays a role in understanding students and teachers' ability to use mathematics learning methods. Based on NCTM (2000), it is explained that more specifically, there are three components of mathematical pedagogic knowledge, namely: (1) Pedagogic curricular knowledge (PCrK), which is knowledge related to teaching materials, technology, and teaching sources, (2) Pedagogic content knowledge (PCnK), which is knowledge related to procedures for describing mathematical concepts and procedures, and (3) Pedagogic instructional knowledge (PIK), which is knowledge related to teaching strategies and class organization. This pedagogic knowledge plays an important role in creating quality mathematics learning.

Problem-solving is using (i.e., transferring) existing knowledge and skills to answer unanswered questions or difficult situations (Widayanti & Dwi Nur'aini, 2020). This is important for life because problems are things that we face every day, especially in the learning process. In line with that, problem-solving is an effort to find a way out to achieve the goal. It also requires readiness, creativity, knowledge, abilities, and its application in daily life. In addition, problem-solving is an unknown problem that contains the meaning of a high-level thinking process and is important in learning mathematics. Mathematical problem-solving skills are the ability to identify the elements that are known and asked, and the adequacy of the elements needed, the ability to create or compile mathematical models, the ability to choose and develop solution strategies, the ability to explain and check the correctness of the answers obtained (Arief et al., 2024).

Based on the description related to mathematical problem-solving ability with pedagogic aspects, this study aims to analyze pedagogical mathematical problem-solving ability in mathematics learning. Mathematical problem-solving skills in mathematics learning have an important role in improving students' cognitive abilities. So the existence of this research can help in providing information related to the factors that cause the low

ability to solve mathematical problems in mathematics learning from a pedagogical aspect. In addition, it is an evaluation material for teachers to improve pedagogical skills in mathematics learning to overcome the problem of mathematical problem-solving skills.

## Method

This type of research is descriptive research with a qualitative approach. The research was conducted in a school in West Java, Indonesia. The subject of this study is class $8^{th}$ grade in one of the schools in the city of Bandung, which totals 30 people. The selection of these 30 people is based on the consideration that the number is representative of obtaining sufficient data to describe the abilities of $8^{th}$ grade students in general, as well as considering the efficiency of time and resources in conducting research. The data collection techniques used in this study are semi-structured tests and interviews. The purpose of using test instruments is to measure the understanding and ability of the research subject in certain aspects that are the focus of the study, while semi-structured interviews are used to dig deeper information, gain the subject's perspective firsthand, and enrich the data obtained through the test. Data collection to measure problem-solving ability was obtained by using non-routine problem-solving questions in the form of essays, where the questions met 4 indicators of problem-solving ability Polya (1973), namely understanding the problem, devising a plan, carrying out the plan, and looking back. The researcher also conducted observations and unstructured interviews to explore the answers to be analyzed.

The pedagogic competencies analyzed in this study are based on NCTM (2000), which reveal that there are three components of mathematical pedagogic knowledge, namely: (1) Curricular pedagogic knowledge (PCrK), which is knowledge related to teaching materials, technology, and teaching resources, (2) Content pedagogic knowledge (PCnK) related to knowledge of procedures for describing mathematical concepts and procedures, (3) Instructional pedagogic knowledge (PIK), related knowledge with teaching strategies and class organization. The three pedagogic components were analyzed on students' mathematical problem-solving abilities in mathematics learning.

Meanwhile, the problem-solving ability items applied in this study include indicators of problem-solving ability according to Polya (1973), namely (1) Understanding problem, (2) Devising a plan, (3) Carrying out the plan, and (4) Looking back. The data is collected through the calculation of the percentage of student answers and will be described in the form of percentages for each indicator of mathematical problem-solving ability. The

determination of the percentage of problem-solving ability and each indicator uses the following formula, namely:

*Percentage of Mathematical Problem-Solving Ability*

$$\frac{\sum X}{n} \times 100\%$$

With the caption ∑X is the score of the number of mathematical problem-solving skills obtained, and n is the maximum score. After obtaining the percentage of answers to mathematical problem-solving skills and the percentage of each indicator, it can be interpreted using the following categories (Hiebert, 2007):

**Table 1.** Categories of Mathematical Problem Solving Ability

| Interval | Category |
|---|---|
| X > 87 | High |
| 53 – 87 | Middle |
| X < 53 | Low |

After obtaining research data, a pedagogic competency analysis was carried out on mathematical problem-solving skills based on the results of observations, question item tests, and interviews.

## Results and Discussion

The research has been carried out by collecting data through observation methods, the use of problem-solving item tests, and interviews. The item test for problem-solving skills uses 3 questions. The table below presents the results of the study in the form of the percentage of each student's mathematical problem-solving indicator of the overall problem.

**Table 2.** Results of Mathematical Problem Solving Ability

| No | Indicator | Total Score | Percentage | Category |
|---|---|---|---|---|
| 1 | Understanding problem | 280 | 66,7% | Middle |
| 2 | Devising a plan | 350 | 83,3% | Middle |
| 3 | Carrying out the plan | 245 | 58,3% | Middle |
| 4 | Looking back | 210 | 50% | Low |
| | Total | 1.085 | 64,5% | Middle |

The results of the analysis showed that overall, the percentage of students' mathematical problem-solving skills was in the medium category, with a score of 64.5%.

This shows that the majority of students have a fairly adequate level of mathematical problem-solving ability. However, the indicator with the lowest value is recheck which only reaches 50%. This number is included in the low category, indicating that students are less able to recheck the answer results. Here are the correct answers in each indicator of mathematical problem-solving ability in each given question:

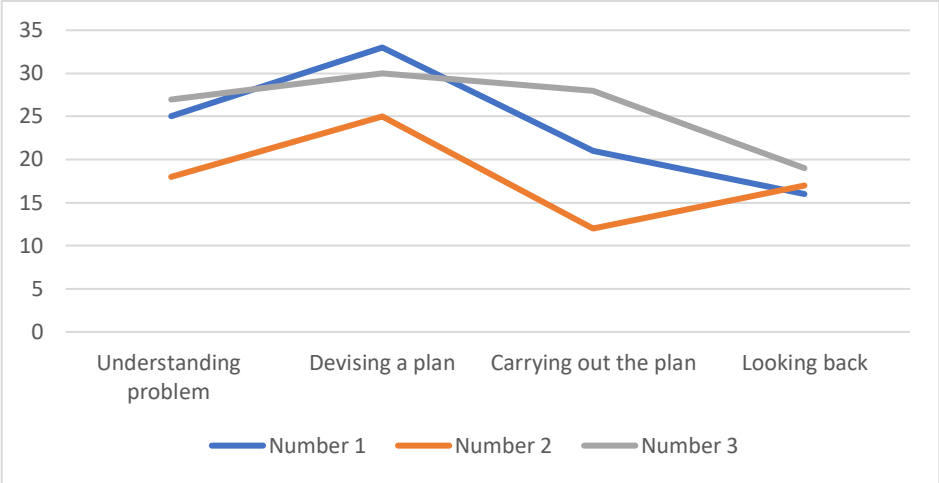


**Figure 1.** Frequency Distribution Chart Capability Indicator Mathematical Problem Solving for Each Problem

Data on pedagogic competence were obtained through observation of the learning process and interviews with teachers and students. The following are the results of the analysis of teachers' pedagogic competencies in mathematics learning based on the following observation results:

Pedagogic curricular knowledge (PCrK) is evaluated through observation during the mathematics learning process. The teacher's PCrK covers aspects of teaching materials, the use of technology, and teaching resources. In terms of teaching materials, teachers and students use package books provided by schools as learning support. However, the use of technology by teachers in the learning process is relatively minimal. In addition, the teaching resources used by teachers are not clearly visible in the learning process.

Knowledge of pedagogic content (PCnK) is related to the ability to present mathematical concepts and procedures. A teacher with good knowledge of pedagogic content must be able to relate students' pre-knowledge to the material to be taught. Based on the results of observation, the teacher provides initial knowledge to students before starting new material. In addition, teachers also review previous material that is still related to the mathematics topic to be taught to ensure the continuity of student understanding.

Pedagogic instructional knowledge (PIK) refers to the teacher's ability to use learning strategies and organize the classroom. This strategy includes teaching methods, models, techniques, and skills. Based on the results of observation of mathematics learning, teachers use a teacher-centered method, where all explanations are delivered by the teacher, and students act as passive recipients. In this process, students rely heavily on the teacher as their sole source of learning and tend to neglect other sources such as printed books or their own notes. Student dependence is seen when the teacher gives a problem, where students only start working after seeing a friend who has finished or waiting for an answer from the teacher, without any initiative to try on their own. Teacher control is less than optimal when teachers focus too much on one student, so that other students become less focused on the lesson. When the teacher gives an explanation of the answer, there are various reactions from students, ranging from those who pay attention to those who do not care. This shows that the teaching methods used by teachers affect the atmosphere of mathematics learning, including in supporting students' independence in solving problems.

The following are the results of interviews regarding teachers' pedagogic competencies related to mathematical problem-solving skills involving teachers and students:

Interviews with teachers regarding his pedagogical knowledge revealed several things. In the aspect of pedagogic curricular knowledge (PCrK), teachers said that the teaching materials used were school package books and did not use LKS. However, for some materials, teachers use LKPD and teaching tools that are prepared by themselves. The use of technology in learning by teachers is still limited, generally only used for administration and exams through Google Form. In terms of pedagogic content knowledge (PCnK), teachers explain that the learning concept is prepared based on previous teaching experience. The teacher also reflects on the students' knowledge to relate it to the material that will be taught at the meeting. Meanwhile, in the aspect of pedagogic instructional knowledge (PIK), the teacher stated that the material was delivered according to the schedule that had been prepared, without the involvement of students in the delivery process. Students are given problems to solve, but there are still many who have difficulty solving them independently. Learning strategies involving parents are not carried out, so there is no communication between teachers and parents regarding learning at home.

Interviews with students revealed that the learning strategy at home was not carried out because there was no encouragement from teachers or parents to prepare materials before the learning process at school. As a result, students do not implement learning strategies at

home. Regarding learning resources, students tend to only rely on package books or ask teachers. In addition, students feel less confident to express the answers that have been worked on. They only work on the problems assigned by the teacher without the motivation to practice math problems independently. During the learning process, students stated that they only listened to the explanation from the teacher.

From this explanation, it can be seen that problem solving is an aspect that affects students' success in learning mathematics. The findings illustrate that the level of mathematical problem-solving ability of students in one of the junior high schools in the city of Bandung is in the medium category. This is in line with the results of research conducted on the ability to solve mathematical problems (Boero & Dapueto, 2007).

Analysis of students' answers on the indicator re-examined based on the test of question items showed. that overall students do not know and implement these indicators in solving math problems. This is confirmed based on the results of interviews that state that students study outside of school only twice a week, namely when the next day there is a math lesson. In addition, the results of interviews with teachers stated that there was no monitoring from teachers on learning carried out at home. That way, students do not have a strategy to learn and are confused to study independently. Because they are not used to it and there is no monitoring from teachers to learn mathematics. This opinion is strengthened by the argument that there is no monitoring by teachers of student performance during the learning process at home (Salazar, 2022).

In the pedagogical aspect, the teacher's competence showed compatibility with the results of students' mathematical problem-solving abilities which were in the medium category. Based on the results of observations and interviews, teachers' pedagogic knowledge in mathematics learning has included several relevant aspects of pedagogic knowledge. In pedagogic curricular knowledge (PCrK), the use of technology by teachers is still lacking, even though technology can support the understanding of mathematical concepts that are difficult to explain manually. Meanwhile, in pedagogic content knowledge (PCnK), teachers have been able to compile mathematical learning concepts well. However, in pedagogic instructional knowledge (PIK), teachers' methods in organizing learning need to be improved to better involve students through a student-centered approach. In addition, the use of technology as a strategy to monitor student performance at home is important so that students can prepare an independent learning strategy at home. Therefore, the pedagogic

knowledge possessed by teachers is very important in supporting the mathematics learning process and helping to shape students' mathematical problem-solving skills.

Based on the results of observations and interviews regarding pedagogic knowledge related to students' mathematical problem-solving skills, the aspects of pedagogic curricular knowledge (PCrK) and pedagogic instructional knowledge (PIK) play a very important role. This knowledge includes teaching materials, technology, teaching resources, and learning methods applied by teachers. This is in line with the opinion that modifying teaching methods is an important step in improving students' mathematical problem-solving skills (Jihanifa et al., 2023). In addition, the motivation factor also plays a big role in encouraging students to solve problems and generate high intentions to learn independently. Learning methods, which are part of pedagogic instructional knowledge (PIK) in mathematical pedagogy, assist teachers in choosing appropriate methods for mathematics learning. The selection of the right method is essential to support success in reducing low indicators of mathematical problem-solving. According to Ritonga & Napitupulu (2024), effective learning methods are not only able to increase students' motivation, but also provide them with opportunities to develop critical thinking skills, creativity, and productive fighting power in facing mathematical challenges. Thus, a planned and directed learning approach can be key in helping students achieve better competence, especially in solving mathematical problems independently and confidently.

In the problem of factors that cause low indicators of mathematical problem-solving ability and related to learning methods, as a solution, it is necessary to choose a method that meets the following criteria: (1) Learning is carried out with a student center so that students can express their opinions and make students more confident, (2) Learning uses technology to monitor student learning at home so that students can learn and form learning strategies, That way it can reduce students' dependence on teachers. In addition, technology helps in understanding mathematics, (3) Using problems in the learning process and using problem-solving steps that are useful in getting students used to evaluating the problems that have been done (Looking back). A learning approach that meets these criteria not only helps students improve their mathematical problem-solving skills, but also encourages the creation of learning that is more active, collaborative, and relevant to the needs of the times. By integrating student-centered learning, the use of technology, and a focus on problem-solving strategies, students can develop independent learning skills as well as sustainable critical thinking skills. In addition, these steps also support the formation of reflective habits, which

are very important to help students understand their learning process and improve their ability to deal with various mathematical challenges systematically (Prima Riyani & Muhamad Sofian Hadi, 2023).

The Problem-Based Learning method can be used to overcome the low indicators of mathematical problem-solving ability based on the pedagogic aspect of teachers. The selection of this method is supported by various studies that state that PBL is a student-centered learning approach in the learning process (Kurniyawati et al., 2019). PBL syntax can support student independence through several phases, including (Kurniyawati et al., 2019) are (1) The phase of guiding individual or group investigation and the phase of assisting investigation, in which students actively conduct investigations and apply methods to solve problems, which in turn assists students in choosing and establishing learning strategies. (2) The analysis and evaluation phase, where students check their performance and learning outcomes. (3) The student-oriented phase on the problem, in which students construct knowledge and autonomously explore the concept of knowledge from a given problem, which can increase their confidence because they understand the problem at hand. These phases can help solve the factors that cause low indicators of mathematical problem-solving ability.

In addition, PBL is in accordance with the concept of 21st century learning which is very important to integrate. The use of technology is also relevant to answer problems related to student performance monitoring, as an effort to improve students' ability to choose and set learning strategies. This is related to the blended learning method, which allows monitoring of student learning performance at home. The use of technology in learning is very important to monitor students so that they can carry out learning effectively at home. Based on this, the problem of low indicators of mathematical problem-solving ability in this study is related to learning methods and technology. Therefore, this problem can be overcome by applying the PBL method combined with blended learning. The PBL method provides an effective solution to improve students' mathematical problem-solving abilities by encouraging them to actively explore, analyze, and solve problems that are relevant to real life. This approach also allows students to develop critical thinking skills, creativity, and independence in learning. By utilizing technology as a support tool, teachers can monitor students' progress and help them design appropriate learning strategies. Through the application of PBL integrated with technology, the problem of low indicators of mathematical problem-solving ability can be overcome more optimally, giving students the

opportunity to be more confident and independent in understanding mathematics (Aprina et al., 2024; Br Sinaga et al., 2024; Ningrum et al., 2024; Ramadhani et al., 2024).

## Conclusion and Suggestion

Based on the findings of the study, it can be concluded that the level of mathematical problem-solving ability of junior high school students in Bandung is in the medium category. The lowest indicator in this study is the ability of students to choose and set learning strategies. Students' mathematical problem-solving ability in mathematics learning is influenced by teachers' pedagogic knowledge, especially pedagogic curricular knowledge (PCrK) and pedagogic instructional knowledge (PIK), both of which play an important role in supporting students' mathematical problem-solving skills. This pedagogic knowledge affects the selection of learning methods and technologies used by teachers. Therefore, learning methods and technology have a very important role in improving students' mathematical mathematical problem-solving skills. For further research, it is recommended to discuss more in-depth pedagogic analysis in developing students' cognitive abilities in mathematics learning.

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