

III.B.3. Infinity

by Tim Turnitin

Submission date: 04-Aug-2023 03:14PM (UTC+0700)

Submission ID: 2141205564

File name: III.B.3._Infinity.pdf (781.89K)

Word count: 8238

Character count: 45225

HOW DO STUDENTS' DECISION-MAKING ABILITY IN SOLVING OPEN-ENDED PROBLEMS?

Wasilatul Murtafiah^{1*}, Nurcholif Diah Sri Lestari², Faridah Hanim Yahya³,
Davi Apriandi¹, Edy Suprpto¹

¹Universitas PGRI Madiun, Indonesia

²Universitas Jember, Indonesia

³Universitas Pendidikan Sultan Idris, Malaysia

Article Info

Article history:

Received Jan 13, 2023

Revised Feb 2, 2023

Accepted Feb 24, 2023

Keywords:

Decision Making,
Mathematical Problem,
Open-Ended,
Problem Solving

ABSTRACT

An open-ended problem in learning mathematics is a problem with more than one answer or method of solving. In solving open-ended problems in learning mathematics, one of the abilities students must use is decision-making ability. Each student has a variety of capacities, so this study aims to determine students' decision-making abilities in solving open-ended problems in learning mathematics. The type of research used is descriptive qualitative research. The subjects of this study were four students with different numbers of correct answers in working on open-ended problems. Data collection was carried out using tests and interviews. The results showed that (1) the decision-making ability of the subject who answers correctly for both problems is complete because they fulfill all indicators, the subject can identify goals, make decisions, evaluate the results of determination, and present and remember between problems with things known to the problem and related to decisions that have been taken correctly; (2) decision-making ability for subjects with wrong answers on one number or two numbers is incomplete because they only fulfilled two indicators, the subject can identify goals, make decisions, is less able to evaluate decision results and present and remember between problems with things known to the problem, and related to decisions that have been taken with correct. Mathematics teachers should often reinforce students to practice operating integers because it is a prerequisite for learning mathematics at the middle and high school levels.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Wasilatul Murtafiah,
Department of Mathematics Education,
Universitas PGRI Madiun
Jl. Setia Budi No.85, Madiun City, East Java 63118, Indonesia.
Email: wasila.mathedu@unipma.ac.id

How to Cite:

Murtafiah, W., Lestari, N. D. S., Yahya, F. H., Apriandi, D., & Suprpto, E. (2023). How do students' decision-making ability in solving open-ended problems? *Infinity*, 12(1), 133-150.

1. INTRODUCTION

In everyday life, mathematics has many benefits, especially for solving problems. Mathematics is a basic science that is essential in developing science and technology. For this reason, students must master mathematics early to improve human resources quality

(Hendriana et al., 2022; Hidayat et al., 2022). This follows the Regulation of the Minister of National Education of the Republic of Indonesia No. 64 of 2013 concerning content standards, which explains that learning mathematics has goals. Namely, students must have competencies such as a critical attitude, logical, analytical, responsible, creative, responsive, careful, thorough, and not easily give up on solving problems (Afdareza et al., 2020; Widodo et al., 2018). Thus the important thing that must be taught to students through mathematics is the ability to decide on problem-solving strategies (Septian et al., 2022; Verawati et al., 2022; Wijayanti et al., 2022).

Problem-solving in learning mathematics is the core of basic skills in the learning process (Widodo, 2017; Widodo et al., 2020). To hone students' skills in solving problems, teachers must be able to bring up students' creative ideas by using supporting facilities such as giving concerns about open-ended problems (Hidayat & Sariningsih, 2018). According to Becker and Shimada, an open ended problem is a problem that has many or several solutions and ways to get the correct answer (Fatah et al., 2016; Viseu & Oliveira, 2012). Therefore, giving problems regarding open-ended issues to students requires students to solve problems by looking for several alternative solutions (Puspaningtyas, 2019). An open-ended problem has great potential to accommodate concern-solving, and students must have problem-solving skills to support them in finding solutions to problems (Hernandez-Serrano & Jonassen, 2003; Özreçberoğlu & Çağanağa, 2018).

The benefits of solving open-ended problems are appreciating students' mathematical understanding, involving students' roles in the learning process by using their skills and knowledge to determine alternative solutions to issues, and allowing teachers and students to hold discussions to discuss some of the ways used to solve problems (Mariam et al., 2019). To solve this open-ended problem, students are also required to think creatively because problems can have more than one answer or solution strategy (Sa'dijah et al., 2017; Wijaya, 2018). This open-ended problem is a higher order thinking skills (HOTS) problem because it requires students' high-level thinking processes to solve it (Ibrahim & Widodo, 2020). Thus, the open-ended problem supports students' readiness for the Minimum Competency Assessment (Ernawati, 2016).

Facts show that students' minimum competency assessment results are still low. Students often experience difficulties formulating problems in everyday life into mathematical models, interpreting the context of real situations into mathematical models, and understanding the structure of mathematics, which consists of order, relationships, and problem patterns (Syawahid, 2019). In addition to difficulty modeling mathematics, students have difficulty interpreting and choosing which mathematical concepts can be used to solve problems. Students also experience difficulties determining or selecting the appropriate strategy to solve problems (Sinatra et al., 2015; Widodo et al., 2022), such as the ability to solve problems for the Minimum Competency Assessment problems, students must think at a high level, namely thinking creatively in determining solutions (Setianingsih et al., 2022).

Thinking creatively is part of a person's ability to make decisions. Students can determine several ways to solve problems by using decision-making abilities. Decision-making, commonly called decision-making, benefits students' thinking processes in solving problems (Winarso, 2014) with several alternative solutions and differences in students' ability to solve open-ended problems in learning mathematics. Therefore, students' decision-making abilities in solving open ended problems mathematics learning need to be further researched to find out students' decision-making abilities in solving open ended problems in mathematics learning.

Results of previous research indicate that there are several studies on decision-making in the field of mathematics education. Research related to the values underlying the decision-making process of Turkish and German mathematics teachers in group studies

(Dede, 2013). Research on perception, interpretation, and decision-making in developing novice teacher competencies (Santagata & Yeh, 2016). Decision-making research on student winners of student creativity programs in designing ICT-based learning media (Murtafiah et al., 2019). Research on junior and senior teacher decision-making in developing math problems (Murtafiah et al., 2020). An exploration of the decision-making of prospective teacher students in solving literacy problems shows differences in student decision-making abilities based on gender (Murtafiah et al., 2021). Research related to the decision-making of students winning microteaching competitions in designing plans and implementing mathematics learning (Murtafiah et al., 2022).

Some of these studies indicate that there is still no research on decision-making in school students. In addition, previous research on decision-making is still dominated by teachers and prospective mathematics teachers. Thus, it is necessary to research the analysis of students' decision-making abilities in solving open ended problems in learning mathematics. Through this research, teachers can discover students' decision-making abilities in solving open-ended problems to be used as a basis for improving mathematics learning. In addition, this research can provide opportunities for teachers to innovate learning to enhance students' decision-making skills in solving problems in learning mathematics.

10 2. METHOD

2.1. Research Design

The research used in this research is descriptive with a qualitative approach. Qualitative descriptive is a research method based on the philosophy of postpositivism, which is used to examine the condition of natural objects where the researcher is the critical instrument (Creswell, 2012; Creswell & Creswell, 2017). Qualitative descriptive research aims to describe, describe, explain, explain, and answer in more detail the problems to be studied by studying as much as possible an individual, a group, or an event (Johnson & Christensen, 2019; Lambert & Lambert, 2012). This study describes students' decision-making abilities in solving open ended problems. This research was carried out in stages in the even semester of the 2021/2022 academic year.

7 2.2. Participant

The subjects of this study were class VIII students of junior high schools in Madiun city. The selection of research subjects was based on truth in working on open ended problems, which were given to 36 students. The research subjects used four students in the grouping of research subjects: one student with two correct answers, one student with only one correct solution, one student with only two correct answers, and one student with all wrong answers. This is because researchers want to reveal how the decision-making abilities of each student's characteristics in solving open ended problems are based on the correctness of student answers. The selection of subjects in this study was also based on students' communication skills based on the considerations of the mathematics teacher.

2.3. Research Instrument

The test instrument used in this study is an open-ended problem. Open-ended problems have more than one correct answer or more than one correct solution method (Bragg & Nicol, 2008; Sa'dijah et al., 2017; Viseu & Oliveira, 2012). The open-ended problem the researcher designed was tested on three validators: two mathematics teachers and one mathematics education lecturer. Based on the expert validation test results, the open-

ended problem used in this study is a problem that has more than one way of solving according to the characteristics of the students at the junior high school where the study was conducted. The open-ended problem used is as follows.

1. The solution to the system of equations $2a + b = 3$ and $3a + 4b = 7$ is ...
2. The solution to the following system of equations is ...

$$\begin{cases} 3x - 4y = 16 \\ x - 2y = 20 \end{cases}$$

In addition to the test instrument in the form of an open-ended problem to uncover research data, it is also strengthened by interview data with the interview guide instrument in Table 1.

Table 1. Interview guidelines

Decision-Making Ability Indicators	Question
It identifies the purpose of deciding a given problem and matters relating to it.	a. Do you know what the problem is asking? b. What are the steps for the solution?
Able to make decisions	a. What solution method did you use? b. How many solutions do you know? c. Why did you use this solution method?
Evaluate the results of decisions	a. After you work on the problem, is it by what you learned at school? b. Is the method you used the most effective way to solve the problem?
Able to present and remember the relationship between existing problems and things that are known in the problem and related to decisions that have been taken correctly	a. After you decided to use the solution method, what materials/concepts did you use? b. Why do you decide to solve the existing problem with this solution method?

Interview guidelines in this study were designed based on decision-making indicators (Wang & Ruhe, 2007). As with the open-ended problem test instrument, two math teachers and one math lecturer validated the interview guide. The results of the validation show that the interview guide can be used because it can reveal decision-making abilities and is by student characteristics.

10

2.4. Data Collection and analysis

Data collection techniques in this study used tests and interviews, so the research instruments used were also of two types: difficulties in the form of open-ended problems and interview guidelines. There are three types of data analysis techniques in this study, including (1) the Reduction stage, where the researcher groups data and selects data according to the need to answer the problem formulation; (2) The data presentation stage, where the researcher presents the research results in the form of words adapted to indicators of decision-making ability; (3) The conclusion stage is by the research objectives (Bogdao & Biklen, 2003; Kirk & Miller, 1986; Miles et al., 2014). The following in Table 2 indicates the decision-making ability used to analyze research (Wang & Ruhe, 2007).

Table 2. Decision-making ability indicators

No	Decision Making Ability Indicator
1.	It identifies the purpose of deciding a given problem and matters relating to it.
2.	Able to make decisions.
3.	Evaluate the results of decisions
4.	Able to present and remember the relationship between existing problems and things that are known about the problem and related to decisions that have been taken correctly.

At this stage of data collection and analysis, a triangulation method was used to check the validity of the data (Carter et al., 2014; Guion et al., 2011; Natow, 2020; Renz et al., 2018). Triangulation of the technique in this study was carried out by comparing the data on the results of open-ended problem tests and interviews.

3. RESULT AND DISCUSSION

3.1. Results

Four groups were obtained based on the results of selecting research subjects. Namely, students with correct answers to 2 problems, students with accurate answers to only number 1, students with correct answers to only number 2, and students with wrong answers can all be presented in Table 3.

Table 3. Grouping research subjects

Answer Group	The number of students	Selected Subject Code
It's all true	19	I ₁
Number 1 is correct, and number 2 is wrong	7	I ₂
Number 1 is wrong, and number 2 is right	7	I ₃
Numbers 1 and 2 are wrong	3	I ₄

The following describes students' decision-making abilities in solving open ended problems.

Subject I₁

The following in Figure 1, results from subject I₁'s work in solving open ended problems. Subject I₁ can complete with correct answers on problem numbers 1 and 2.

1. $2a + b = 3$ $3a + 4b = 2$

$$\begin{array}{r|l} 2a + b = 3 & \times 4 \quad 8a + 4b = 12 \\ 3a + 4b = 2 & \times 1 \quad 3a + 4b = 2 \\ \hline & -5a = 10 \\ & a = -2 \end{array}$$

Substituting $a = -2$ into $2a + b = 3$:

$$2(-2) + b = 3 \Rightarrow -4 + b = 3 \Rightarrow b = 7$$

2. $3x - 4y = 16$ $x - 2y = 20$

$$\begin{array}{r|l} 3x - 4y = 16 & \times 1 \quad 3x - 4y = 16 \\ x - 2y = 20 & \times 3 \quad 3x - 6y = 60 \\ \hline & 2y = -44 \\ & y = -22 \end{array}$$

Substituting $y = -22$ into $x - 2y = 20$:

$$x - 2(-22) = 20 \Rightarrow x + 44 = 20 \Rightarrow x = 20 - 44 \Rightarrow x = -24$$

Figure 1. Subject test results from I₁

Based on the indicators of decision-making ability in identifying the purpose of decision-making, subject I₁ knows what is known and asked in the problem so that subject I₁ can determine what method to use to solve the problem. This was conveyed by subject I₁, "I use the elimination of one of the variables, then use substitution to obtain the other variable". Subject I₁ also wrote down the steps for solving the problem according to his chosen method.

Subject I₁ solves problems number 1 and 2 by eliminating one of the variables asked to determine the value of one of the variables. Then subject I₁ substitutes the variable's value found into one of the known equations to determine the value of the other variable. The work of subject I₁ is shown in Figure 1, where for numbers 1 and 2, the subject uses the same method. This is supported by the subject's statement during the interview, "In my opinion, questions 1 and 2 can be solved in the same way, namely using a mixed method".

Subject I₁ was decided by determining the method to be used, namely the elimination and substitution method. Subject I₁ then evaluates the results of his decision by making corrections before the subject collects the results of his work. For the results of solving number 1, the values obtained are $a=1$ and $b=1$, and for number 2, the values obtained are $x=-24$ and $y=-22$. Subject I₁ can present and remember the relationship between existing problems and things that are known about the problem and make decisions that are taken correctly.

Subject I₂

The following in Figure 2, results from subject I₂'s work in solving open ended problems. Subject I₂ can complete the correct answer on problem number 1 and the wrong answer on problem number 2.

1.
$$\begin{aligned} 2a + b &= 3 \\ 3a + 4b &= 7 \end{aligned}$$

$$\begin{aligned} \text{Jumlah} &: \times 2a + b = 3 \\ & \quad \times 3a + 4b = 7 \end{aligned}$$

$$\begin{aligned} 6a + 3b &= 6 \\ 6a + 8b &= 14 \end{aligned}$$

$$\begin{aligned} -5b &= -8 \\ b &= 1 \end{aligned}$$

$$\begin{aligned} 2a + b &= 3 \\ 2a + 1 &= 3 \\ 2a &= 2 \\ a &= 1 \end{aligned}$$

2.
$$\begin{cases} 3x - 4y = 16 \\ x - 2y = 20 \end{cases}$$

$$\begin{aligned} \text{Jumlah} &: \times 3x - 4y = 16 \\ & \quad \times -2y = 20 \end{aligned}$$

$$\begin{aligned} 3x - 4y &= 16 \\ 3x - 6y &= 60 \end{aligned}$$

$$\begin{aligned} 2y &= 44 \\ y &= 22 \end{aligned}$$

$$\begin{aligned} x - 2y &= 20 \\ x - 44 &= 20 \\ x &= 64 \end{aligned}$$

Figure 2. Subject test results from I₂

Based on indicators of decision-making ability in identifying the purpose of decision-making, subject I₂ knows what is known and asked in the problem so that subject I₂ can determine what method to use to solve the problem. This is supported by the interview results where subject I₂ stated, "I chose the combined method of elimination first, then substitution". Subject I₂ also wrote down steps to solve the problem.

Subject I₂ solves problems number 1 and 2 using elimination and substitution. Subject I₂ writes $2a+b=3$ as the first equation and $3a+4b=7$ as the second equation. Then subject I₂ eliminates one of the variables, variable a , by multiplying the first equation by 3 and the second by 2. So the first equation becomes $6a+3b=9$, and the second equation becomes $6a+8b=14$. So the subject gets the result $b=1$. After the subject receives the b value, the subject substitutes the b value into the first equation, namely $2a+b=3$, the result is $a=1$, and the answer the subject gets is correct.

The same applies to problem number 2, and subject I₂ writes $3x-4y=16$ as the first equation and $x-2y=20$ as the second equation. Then subject I₂ eliminates one of the variables, namely the variable, namely variable x , by multiplying the first equation by 1 and multiplying the second equation by 3. So that the first equation becomes $3x-4y=16$ and the second equation becomes $3x-6y=60$, then subject I₂ gets the result $y=22$. The results obtained by the subject are wrong because the answer received should be $y=-22$, so finding the value of the variable x is also wrong. Subject I₂ was less thorough in operating 16 minus 60, which should be -22 . Through interviews, subject I₂ stated that "oh yes, I was not careful, ma'am, the results should have been negative".

Subject I₂ can make decisions by determining the method used, namely the method of elimination and substitution, so that in evaluating the results of the decision, Subject I₂ corrects it first before the subject collects the results of his work. For solving number 1, the values $a=1$ and $b=1$ are obtained, but for problem number, the outcome of the solution is still not quite right. Subject I₂ is less able to present and remember the relationship between existing problems and things that are known about the problem and make decisions that are taken correctly.

Subject I₃

The following in Figure 3, results from subject I₃'s work in solving open ended problems. Subject I₃ finished with the wrong answer on problem number 1 and the correct answer on problem number 2.

$$\begin{array}{l} \text{1.} \quad \begin{array}{l} 2a + b = 3 \\ 3a + 4b = 7 \end{array} \quad \begin{array}{l} \times 4 \\ \times 1 \end{array} \quad \begin{array}{l} 8a + 4b = 12 \\ 3a + 4b = 7 \end{array} \quad - \\ \hline \quad \quad \quad 5a = 5 \\ \quad \quad \quad a = 1 \\ \hline 2a + b = 3 \\ b = 3 - 10 \\ b = -7 \end{array} \quad \begin{array}{l} \text{2.} \quad \begin{array}{l} 3x - 4y = 16 \\ x - 2y = 20 \end{array} \quad \begin{array}{l} \times 1 \\ \times 3 \end{array} \quad \begin{array}{l} 3x - 4y = 16 \\ 3x - 6y = 60 \end{array} \quad - \\ \hline \quad \quad \quad 2y = -44 \\ \quad \quad \quad y = -22 \\ \hline \quad \quad \quad x - (-44) = 20 \\ \quad \quad \quad x + 44 = 20 \\ \quad \quad \quad x = -24 \end{array} \end{array}$$

Figure 3. Subject test results from I₃

Based on indicators of decision-making ability in identifying the purpose of decision-making, subject I₃ knows what is known and asked in the problem so that subject I₃ can determine what method to use to solve the problem. The statement of subject I₃ supports this during the interview, "I use the method of elimination and substitution ma'am." Subject I₃ also wrote down the steps to solving the problem.

Subject I₃ used the elimination and substitution methods to solve problem number 1. Subject I₃ wrote $2a+b=3$ as the first equation and $3a+4b=7$ as the second equation. Then subject I₃ eliminates one of the variables, variable a , by multiplying the first equation by 4 and multiplying the second equation by 1. So that the first equation becomes $8a+4b=12$ and the second equation becomes $3a+4b=7$ then subject I₃ gets the result $a=5$. The results obtained by subject I₃ are wrong because the answer received should be $a=1$, so finding the value of variable b is also wrong. Subject I₃ was not careful in operating $5a=5$, namely 5 divided by 5, which should be $a=1$.

For number 2, subject I₃ uses the same method as number 1, namely the elimination and substitution method, to solve the problem. Subject I₃ writes $3x-4y=16$ as the first equation and $x-2y=20$ as the second. Then subject I₃ eliminates one of the variables, namely

the variable, namely variable x , by multiplying the first equation by 1 and multiplying the second equation by 3. So the first equation becomes $3x-4y=16$, and the second becomes $3x-6y=60$. Then subject I_3 obtains the result $y = -22$. After the subject brings the y value, the issue substitutes y into the second equation, the result $x = -24$, and the answers you get are correct.

Subject I_3 can make decisions by determining the method used, namely the method of elimination and substitution, to evaluate the decision results. Subject I_3 corrects it first before the subject collects the results of his work. For solution number 1, the values $a=5$ and $b=-7$ are wrong, but for problem number 2, the results are correct, namely $x = -24$ and $y = -22$. Subject I_3 is less able to present and remember the relationship between existing problems and things that are known about the problem and make decisions that are taken correctly.

Subject I_4

Figure 4 shows the result of subject I_4 's work in solving open ended problems. Subject I_4 finished with the wrong answer on problem number 1 and the correct answer on problem number 2.

1.) $2a + b = 3 \dots (1)$
 $3a + 4b = 7 \dots (2)$
 $\times 4 \quad 8a + 4b = 12$
 $\times 1 \quad 3a + 4b = 7$
 $\hline 5a = 5$
 $a = 1$
 $\times 2a + b = 3$
 $2(1) + b = 3$
 $b = 3 - 2$
 $b = 1$
 Himp. penyelesaian $\{1, 1\}$

2.) $3x - 4y = 16 \dots (1)$
 $x - 2y = 20 \dots (2)$
 $\times 3 \quad 3x - 4y = 16$
 $\times 3 \quad 3x - 6y = 60$
 $\hline 2y = -44$
 $y = -22$
 $\times x - 2y = 20$
 $x - 2(-22) = 20$
 $x - 44 = 20$
 $x = 64$
 Himp. penyelesaian $\{64, -22\}$

Figure 4. Subject test results from I_4

Based on indicators of decision-making ability in identifying the purpose of decision-making, subject I_4 knows what's known and asked in the problem so that subject I_4 can determine what method to use to solve the problem. This is supported by the results of an interview with subject I_4 "I chose elimination first, then substitution because it's easy". Subject I_4 also wrote down steps to solve the problem.

Subject I_4 used the elimination and substitution method to solve the problem for number 1. Subject I_4 wrote $2a+b=3$ as the first equation and $3a+4b=7$ as the second equation. Then subject I_4 eliminates one of the variables, variable a , by multiplying the first equation by 4 and multiplying the second equation by 1. So the first equation becomes $8a+4b=12$, and the second equation becomes $3a+4b=7$. Then subject I_4 obtained the result $a=5$. The results obtained by subject I_4 are wrong because the answer got should be $a=1$, so finding the value of variable b is also wrong. The results of the interviews show that the subject feels the answer is correct. This is by the statement of subject I_4 that "in my opinion, my answer is correct".

For number 2, subject I_4 uses the same method as number 1, namely the elimination and substitution method, to solve the existing problem. Subject I_4 writes $3x-4y=16$ as the first equation and $x-2y=20$ as the second. Then subject I_4 eliminates one of the variables, namely x , by multiplying the first equation by 1 and the second by 3. So the first equation becomes $3x-4y=16$, and the second becomes $3x-6y=60$. So subject I_4 gets the result $y = -22$. After the subject obtains the y value, the issue substitutes y into the second equation. The

result is $x=64$. Subject I₄ was careless in operating, so the wrong answer was obtained. The subject's acknowledgment supports this through interviews, "oh yes, ma'am, I made a mistake in counting, negative meets negative should be positive".

Subject I₄ can make decisions by determining the method to be used, namely the method of elimination and substitution. Subject I₄ did not evaluate the results of the decision or make corrections before the subject collected the results of his work. Subject I₄ was careless in calculating to produce inaccurate solving results for both problems. Subject I₄ is less able to present and remember the relationship between existing issues and things that are known in the problem and make decisions that are taken correctly.

3.2. Discussion

The results showed that each subject had different decision-making abilities. This difference can be seen in the skills of subjects I₁, I₂, I₃, and I₄ in each indicator of decision making, as shown in Figure 5.

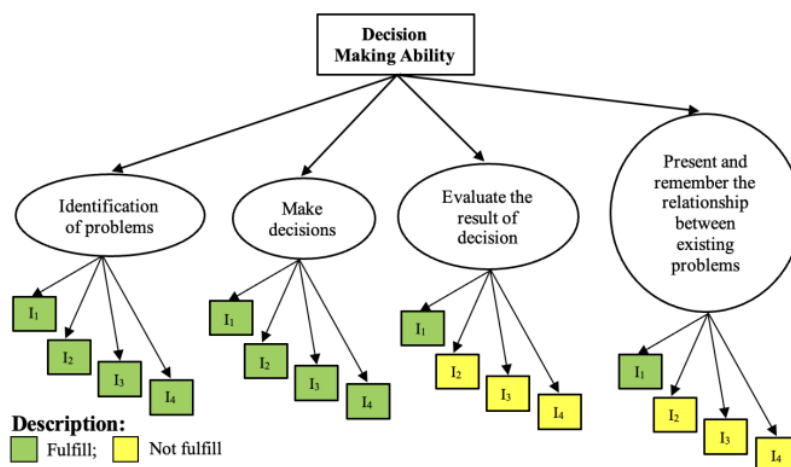


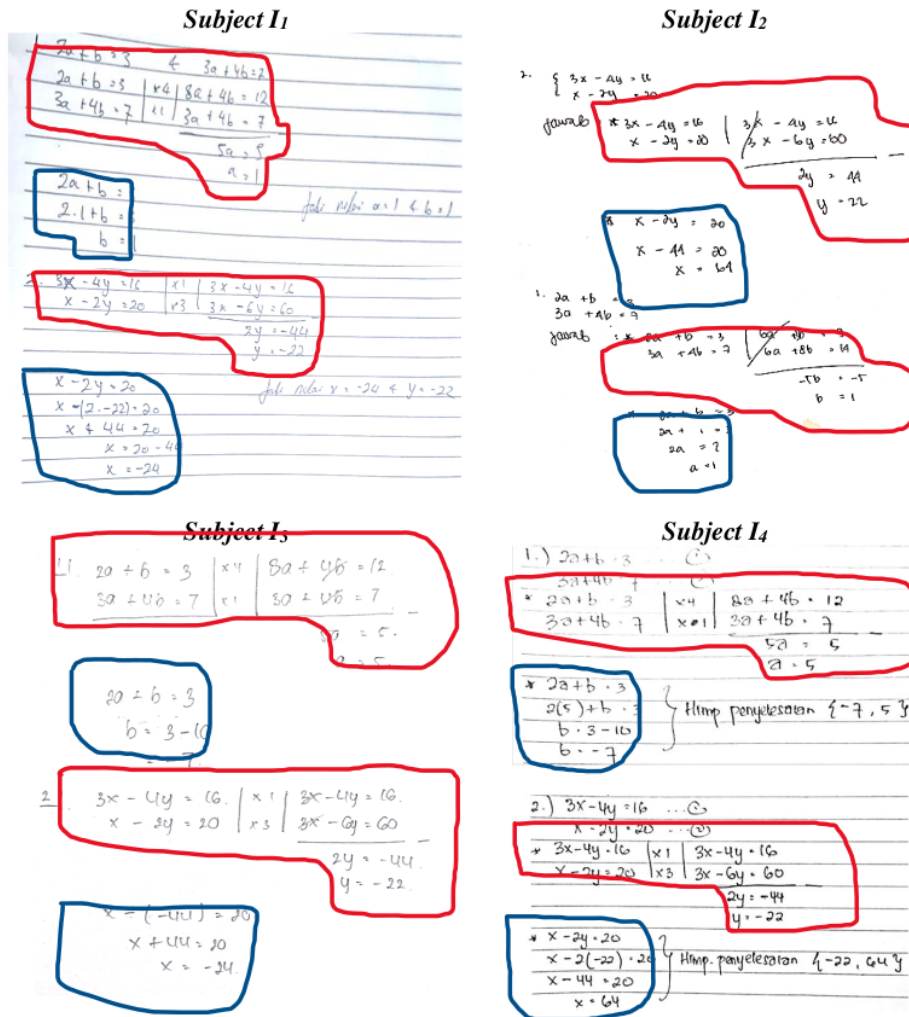
Figure 5. The subject's decision-making ability in each indicator

At the stage of identifying the purpose of making decision⁴ from a given problem and matters relating to the situation, subjects I₁, I₂, I₃, and I₄ were able to determine what was known and what was asked in the questions even though all subjects did not write explicitly on the answer sheets. From the interviews with the four subject¹ they said that they were used to working on a system of two-variable linear equations without writing down what was known and what was asked. As stated by one of the subjects, I₁, "I did not write down what was known and asked because we usually write this down in the form of story questions". Even though all subjects did not write down what was known and asked in the questions, based on the results of all interviews, all subjects could identify the purpose of decision making from the given problem.

This result is in line with research by Widodo, Istiqomah, et al. (2019), which also found that although the subject did not write down what was known and asked, the students could the process of solving the problem in the next stage. Problem identification is part of the student's understanding⁴ of the problem (Felmer et al., 2016). How to identify these students is different from the results of research conducted by Lee (2016), that at the stage of understanding the problem, students write down what is known and asked. In the

identification stage of this goal, all topics are looking for a set of solutions to a system of two-variable linear equations. At this stage, the subject can understand the problem even though students do not write down what is known and asked in their work. Identifying the purpose of deciding on this problem requires a person's ability to understand the situation, in this case, the issue (Dauer et al., 2017; Schoenfeld, 2015; Wang & Ruhe, 2007). Identifying this goal is marked by determining what is asked of the problem (Hutajulu et al., 2019; Widodo, Turmudi, et al., 2019).

At decision-making stage, all subjects I₁, I₂, I₃, and I₄ can choose a solution method. All subjects chose the same techniques, namely solving the problem using a mixed elimination and substitution method, as shown in Figure 6.



Description: - Elimination method; - Substitution method

Figure 6. All subjects chose the same method to solve the problem number 1 and 2

The results of interviews with the four subjects stated that subject I₁ said, "I chose this method because it was more concise and faster to solve this problem and as exemplified by the teacher in class". Subjects I₂, I₃, and I₄ have almost the same reasons as submitted by subject I₃ "I use this method because it is as exemplified by the teacher". At this stage, only subject I₁ had the right reason that choosing the combined elimination-substitution method would make the solution to a system of two-variable linear equations more concise and faster. The reason for choosing this method is in line with previous research if students choose the elimination-substitution combination method because it is more effective for solving a system of two-variable linear equations (Bariroh et al., 2023).

When asked if there was another way to use it, subjects I₁, I₂, I₃, and I₄ stated that they knew if other methods had been taught and could be used to solve the problem. Subject I₁ said, "in my opinion, this problem can be solved by using the method of elimination, substitution, and graphics". Subjects I₂, I₃, and I₄ have the same statement: Can this problem be solved using only the elimination method or substitution? Subject I₁ has better knowledge when compared to subjects I₂, I₃, and I₄. Subject I₁ can mention if to solve the problem can also use the graphical method. Subject I₁ stated that he obtained information regarding visual methods from textbooks and the internet. Subjects I₂, I₃, and I₄ do not mention graphical methods. When asked if there was another method to solve the problem, they gave the same answer: none. They said the teacher taught only the elimination, substitution, and combined elimination-substitution methods.

In this decision making stage, all subjects used one method, the combined elimination-substitution method. This result contradicts the theory that solving open questions differently should be used for questions 1 and 2 (Siswono, 2008). The subject should be able to use different ways and methods of solving (Baker et al., 2001). In addition to the reasons given by I₁, the technique chosen is concise; he uses one way for all subjects because they are fixated on the example given by the teacher. This shows that students are not used to using other methods or practices that vary besides those exemplified by the teacher. At this stage, students' creative thinking skills are needed to determine various solutions that can be used to solve the problem correctly. Students can use the use of other methods as a compare of the final answer from solving the problem. In making decisions, one must be creative in collecting various ways to solve problems (Murtafiah et al., 2021; Murtafiah et al., 2019).

When evaluating the decision results, subject I₁ can consider correcting the answers to obtain the correct answers for numbers 1 and 2. Subjects I₂ and I₃ are less able to assess because they have one correct answer and one wrong. Subjects I₂ and I₃ were less thorough in performing integer division operations. Subject I₄ could not evaluate because he had incorrect answers in numbers 1 and 2. Subject I₄ felt that the answer was correct in question number 1, even though he was not careful in operating the division of integers. Some 7th grade students in Malaysia also experienced subject errors in integer division operations, and they were weak in multiplication and division caused of poor basic knowledge of arithmetic operations (Khalid & Embong, 2019). The errors experienced by subjects I₂, I₃, and I₄ differ from high-ability grade 6 students in Indonesia who can correctly carry out the division operation (Nur et al., 2022).

In the evaluation of the result stage, there were other mistakes made by subject I₄. In question number 2, subject I₄ was not cautious in operating the subtraction of negative integers. This is supported by the interview results where subject I₄ stated, "I am often confused when using numbers with a negative sign". The error in evaluating experienced by subject I₁ is not surprising because understanding the concept of abstract negative numbers is an obstacle for students; 60.4% of the respondents had difficulty when they gave examples of contexts which are integers involving negative numbers (Fuadiah et al., 2017). In line

















with this, the results of previous research show that students with low abilities have difficulty operating negative integers. In contrast, students with high skills have no problem working with negative numbers (Utomo, 2020).

At the evaluation stage of the results of this decision, all subjects require fundamental knowledge, i.e., arithmetic operations. Arithmetic operations, which include addition, subtraction, multiplication, and division of integers, are prerequisite knowledge needed in advanced mathematics. In addition to basic skills related to arithmetic operations, critical thinking is also required. These critical thinking skills are necessary to evaluate and re-check work and answers to solving problems that have been resolved. Previous research also supports that critical thinking skills are needed to produce decisions with correct problem-solving (Murtafiah et al., 2020; Swartz et al., 1998).

At the stage of presenting and remembering the relationship between existing problems and things that are known in the problem and about decisions taken correctly, only subject I₁ fulfills this. This is also supported by the results of an interview with I₁, that I₁ presents a solution to a problem that has been rechecked for the suitability between what was asked and the answer to the problem-solving that has been done. Subjects I₂, I₃, and I₄ have not been able to present conclusions accurately because they have not used the concept of integer operations correctly. This shows that there is still a lack of students' understanding regarding the relationship between mathematical concepts to solve problems. Students need knowledge of the prerequisite material/concept in learning mathematics. This is in line with previous research that the subject's ability to relate mathematical concepts to problems, one of which is influenced by the basic skills possessed by students related to arithmetic operations (Khalid & Embong, 2019). Moreover, in solving open ended problems, knowledge and understanding of prerequisite materials and ideas are needed by students to be able to provide more than one solution method/strategy (Anggoro et al., 2021; Pramuditya et al., 2022).

Thus, the decision making by the subject answers correctly for both problems (I₁); the subject can do the problem precisely and fulfills all indicators of decision making ability. Decision-making for the subject by answering correctly only one problem (I₂ and I₃), namely, the subject can work on the situation well, with errors operating problem-solving. The issue can fulfill several indicators of decision-making where the subject is not sure about the decisions taken, but the subject can work on some of the problems well. Decision making for the subject by answering the two concerns incorrectly (I₄), namely, the subject can work on the issue to completion. Still, it cannot calculate correctly, and the subject fulfills several decision making indicators. The subject's decision-making abilities in solving the two-variable linear equation system problem can be presented in Table 4.

Table 4. Decision making ability

Subject	Indicators				Decision Making Ability
	Identification of problems	Make decisions	Evaluate the result of the decision	Present and remember the relationship between existing problems	
I ₁					Complete
I ₂					Incomplete
I ₃					Incomplete
I ₄					Incomplete

Description:

 Fulfill;  Not fulfill

The subject who answered correctly for both problems has complete decision-making abilities because they meet all the indicators that have been set. Subjects who responded to only one problem precisely had incomplete decision making abilities because they only fulfilled two indicators. Subjects who answered both questions incorrectly had incomplete decision making abilities because they only fulfilled two indicators. This shows that the basic skills of high school students need to be taken seriously. The results showed that the weak essential ability of students in performing integer operations had a significant influence on other students' skills, as in this case, it affected students' decision making abilities. This finding is an unanswered question, as many high school students still experience errors in operating integers (Fuadiah et al., 2017; Khalid & Embong, 2019; Utomo, 2020). Is there anything wrong with learning mathematics in elementary school? This requires teachers to seriously innovate in teaching students essential skills such as integer operations. Mathematics teachers should often reinforce students to practice operating integers because it is a prerequisite for learning mathematics at the middle and high school levels. In addition, this also provides an opportunity for future researchers to overcome student errors in performing integer operations.

4. CONCLUSION

This study concluded that based on decision-making the subject answers correctly for both problems. The subject can identify goals, make decisions, evaluate the results of determination, and present and remember between problems with things known to the problem and related to decisions that have been taken correctly. Subjects who answered correctly for both questions have complete decision-making abilities because they meet all indicators. While decision-making for subjects with wrong answers on one number or two numbers, namely the subject can identify goals, make decisions, is less able to evaluate decision results and present and remember between problems with things known to the problem, and related to decisions that have been taken with correct. Subjects who answered correctly only one problem or answered incorrectly for both problems had incomplete knowledge abilities because they only fulfilled two indicators. Furthermore, mathematics teachers should often reinforce students to practice operating integers because it is a prerequisite for learning mathematics at the middle and high school levels.

ACKNOWLEDGEMENTS

The authors would like to thank the Universitas PGRI Madiun, Universitas Jember, SMPN 7 Madiun, and DRTPM DITJEN DIKTI, who have facilitated and provided funds for this research.

REFERENCES

- Afdareza, M. Y., Yuanita, P., & Maimunah, M. (2020). Development of learning device based on 21st century skill with implementation of problem based learning to increase critical thinking skill of students on polyhedron for grade 8th junior high school. *Journal of Educational Sciences*, 4(2), 273-284. <https://doi.org/10.31258/jes.4.2.p.273-284>
- Anggoro, B. S., Puspita, N., Pratiwi, D. D., Agustina, S., Komala, R., Widyastuti, R., & Widyawati, S. (2021). Mathematical-analytical thinking skills: The impacts and interactions of open-ended learning method & self-awareness (Its application on

- bilingual Test instruments). *Al-Jabar: Jurnal Pendidikan Matematika*, 12(1), 89-107. <https://doi.org/10.24042/ajpm.v12i1.8516>
- Baker, D., Bridges, D., Hunter, R., Johnson, G., Krupa, J., Murphy, J., & Sorenson, K. (2001). *Guidebook to decision-making methods* (Vol. 45). Westinghouse Savannah River Company Aiken, SC, USA.
- Bariroh, N. M., Triyanto, T., & Fitriana, L. (2023). Critical thinking ability of students at SMPN 2 Kudus with impulsive cognitive style on two variables linear equation system material. *AIP Conference Proceedings*, 2540(1), 070012. <https://doi.org/10.1063/5.0105903>
- Bogdao, R. C., & Biklen, S. K. (2003). *Qualitative research for education*. New York: Pearson.
- Bragg, L., & Nicol, C. (2008). Designing open-ended problems to challenge preservice teachers' views on mathematics and pedagogy. *Proceedings of PME 32 and PME-NA 30*, 2, 201-208.
- Carter, N., Bryant-Lukosius, D., DiCenso, A., Blythe, J., & Neville, A. J. (2014). The use of triangulation in qualitative research. *Oncology Nursing Forum*, 41(5), 545-547. <https://doi.org/10.1188/14.ONF.545-547>
- Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. USA: Pearson.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.
- Dauer, J. M., Lute, M. L., & Straka, O. (2017). Indicators of informal and formal decision-making about a socioscientific issue. *International Journal of Education in Mathematics, Science and Technology*, 5(2), 124-138.
- Dede, Y. (2013). Examining the underlying values of Turkish and German mathematics teachers' decision making processes in group studies. *Educational Sciences: Theory and Practice*, 13(1), 690-706.
- Ernawati, E. (2016). Pengembangan perangkat pembelajaran matematika berbasis open-ended approach untuk mengembangkan HOTS siswa SMA [Development of mathematics learning tools based on an open-ended approach to develop HOTS for high school students]. *Jurnal Riset Pendidikan Matematika*, 3(2), 209-220. <https://doi.org/10.21831/jrpm.v3i2.10632>
- Fatah, A., Suryadi, D., Sabandar, J., & Turmudi, T. (2016). Open-ended approach: An effort in cultivating students' mathematical creative thinking ability and self-esteem in mathematics. *Journal on Mathematics Education*, 7(1), 11-20. <https://doi.org/10.22342/jme.7.1.2813.9-18>
- Felmer, P. L., Pehkonen, E., & Kilpatrick, J. (2016). *Posing and solving mathematical problems*. Springer. <https://doi.org/10.1007/978-3-319-28023-3>
- Fuadiah, N. F., Suryadi, D., & Turmudi, T. (2017). Some difficulties in understanding negative numbers faced by students: A qualitative study applied at secondary schools in Indonesia. *International Education Studies*, 10(1), 24-38. <https://doi.org/10.5539/ies.v10n1p24>

- Guion, L. A., Diehl, D. C., & McDonald, D. (2011). Triangulation: establishing the validity of qualitative studies. *Edis*, 2011(8), FCS6014.
- Hendriana, H., Prahmana, R. C. I., Ristiana, M. G., Rohaeti, E. E., & Hidayat, W. (2022). The theoretical framework on humanist ethno-metaphorical mathematics learning model: An impactful insight in learning mathematics. *Frontiers in Education*, 7, 773. <https://doi.org/10.3389/feduc.2022.1030471>
- Hernandez-Serrano, J., & Jonassen, D. H. (2003). The effects of case libraries on problem solving. *Journal of Computer Assisted Learning*, 19(1), 103-114. <https://doi.org/10.1046/j.0266-4909.2002.00010.x>
- Hidayat, W., Rohaeti, E. E., Ginanjar, A., & Putri, R. I. I. (2022). An ePub learning module and students' mathematical reasoning ability: A development study. *Journal on Mathematics Education*, 13(1), 103-118. <https://doi.org/10.22342/jme.v13i1.pp103-118>
- Hidayat, W., & Sariningsih, R. (2018). Kemampuan pemecahan masalah matematis dan adversity quotient siswa SMP melalui pembelajaran open ended [Mathematical problem-solving abilities and adversity quotient of junior high school students through open-ended learning]. *JNPM (Jurnal Nasional Pendidikan Matematika)*, 2(1), 109-118. <https://doi.org/10.33603/jnpm.v2i1.1027>
- Hutajulu, M., Wijaya, T. T., & Hidayat, W. (2019). The effect of mathematical disposition and learning motivation on problem solving: an analysis. *Infinity Journal*, 8(2), 229-238. <https://doi.org/10.22460/infinity.v8i2.p229-238>
- Ibrahim, I., & Widodo, S. A. (2020). Advocacy approach with open-ended problems to mathematical creative thinking ability. *Infinity Journal*, 9(1), 93-102. <https://doi.org/10.22460/infinity.v9i1.p93-102>
- Johnson, R. B., & Christensen, L. (2019). *Educational research: Quantitative, qualitative, and mixed approaches*. Sage publications.
- Khalid, M., & Embong, Z. (2019). Sources and possible causes of errors and misconceptions in operations of integers. *International Electronic Journal of Mathematics Education*, 15(2), em0568. <https://doi.org/10.29333/iejme/6265>
- Kirk, J., & Miller, M. L. (1986). *Reliability and validity in qualitative research*. Sage.
- Lambert, V. A., & Lambert, C. E. (2012). Qualitative descriptive research: An acceptable design. *Pacific Rim International Journal of Nursing Research*, 16(4), 255-256.
- Lee, C. I. (2016). An appropriate prompts system based on the Polya method for mathematical problem-solving. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(3), 893-910. <https://doi.org/10.12973/eurasia.2017.00649a>
- Mariam, S., Nurmala, N., Nurdianti, D., Rustyani, N., Desi, A., & Hidayat, W. (2019). Analisis kemampuan pemecahan masalah matematis siswa mtsn dengan menggunakan metode open ended di Bandung Barat [Analysis of the mathematical problem-solving abilities of MTSN students using the open-ended method in West Bandung]. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 3(1), 178-186. <https://doi.org/10.31004/cendekia.v3i1.94>
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative Data Analysis. A Methods Sourcebook*. SAGE Publications.

- Murtafiah, W., Lukitasari, M., & Lestari, N. D. S. (2021). Exploring the decision-making process of pre-service teachers in solving mathematics literacy problems. *Jurnal Pendidikan Matematika*, 15(2), 145-160. <https://doi.org/10.22342/jpm.15.2.13908.145-160>
- Murtafiah, W., Lukitasari, M., Lestari, N. D. S., Zayyadi, M., & Widodo, S. A. (2022). Decision making students winning microteaching contest in design lesson plan and its implementation in mathematics learning. *Cypriot Journal of Educational Sciences*, 17(3), 2045-2060. <https://doi.org/10.18844/cjes.v17i6.7497>
- Murtafiah, W., Sa'dijah, C., Chandra, T. D., & Susiswo, S. (2019). Decision making of the winner of the national student creativity program in designing ICT-based learning media. *TEM Journal*, 8(3), 1039-1045. <https://doi.org/10.18421/TEM83-49>
- Murtafiah, W., Sa'dijah, C., Chandra, T. D., Susiswo, S., & Zayyadi, M. (2020). Novice and experienced mathematics teachers' decision making process in designing math problem. *Journal of Physics: Conference Series*, 1464(1), 012030. <https://doi.org/10.1088/1742-6596/1464/1/012030>
- Natow, R. S. (2020). The use of triangulation in qualitative studies employing elite interviews. *Qualitative Research*, 20(2), 160-173. <https://doi.org/10.1177/1468794119830077>
- Nur, A. S., Kartono, K., Zaenuri, Z., & Rochmad, R. (2022). The learning trajectory construction of elementary school students in solving integer word problems. *Participatory Educational Research*, 9(1), 404-424. <https://doi.org/10.17275/per.22.22.9.1>
- Özreçberoğlu, N., & Çağanağa, Ç. K. (2018). Making it count: Strategies for improving problem-solving skills in mathematics for students and teachers' classroom management. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(4), 1253-1261. <https://doi.org/10.29333/ejmste/82536>
- Pramuditya, S. A., Noto, M. S., & Azzumar, F. (2022). Characteristics of students' mathematical problem solving abilities in open-ended-based virtual reality game learning. *Infinity Journal*, 11(2), 255-272. <https://doi.org/10.22460/infinity.v11i2.p255-272>
- Puspaningtyas, N. D. (2019). Proses berpikir lateral siswa SD dalam menyelesaikan masalah matematika open-ended ditinjau dari perbedaan gaya belajar [Elementary students' lateral thinking processes in solving open-ended math problems in terms of differences in learning styles]. *MAJAMATH: Jurnal Matematika Dan Pendidikan Matematika*, 2(2), 80-86. <https://doi.org/10.36815/majamath.v2i2.373>
- Renz, S. M., Carrington, J. M., & Badger, T. A. (2018). Two strategies for qualitative content analysis: An intramethod approach to triangulation. *Qualitative Health Research*, 28(5), 824-831. <https://doi.org/10.1177/1049732317753586>
- Sa'dijah, C., Rafiah, H., Gipayana, M., Qohar, A., & Anwar, L. (2017). Asesmen pemecahan masalah open-ended untuk mengukur profil berpikir kreatif matematis siswa berdasar gender [An open-ended problem-solving assessment to measure the profile of students' mathematical creative thinking based on gender]. *Sekolah Dasar: Kajian Teori dan Praktik Pendidikan*, 25(2), 147-159. <https://doi.org/10.17977/um009v25i22016p147>

- Santagata, R., & Yeh, C. (2016). The role of perception, interpretation, and decision making in the development of beginning teachers' competence. *Zdm*, 48(1), 153-165. <https://doi.org/10.1007/s11858-015-0737-9>
- Schoenfeld, A. H. (2015). How we think: A theory of human decision-making, with a focus on teaching. In *The Proceedings of the 12th International Congress on Mathematical Education: Intellectual and Attitudinal Challenges*. <https://doi.org/10.1007/978-3-319-12688-3>
- Septian, A., Widodo, S. A., Afifah, I. N., Nisa, D. Z., Putri, N. P. K., Tyas, M. D., Nisa, R. H., & Andriani, A. (2022). Mathematical problem solving ability in Indonesia. *Journal of Instructional Mathematics*, 3(1), 16-25. <https://doi.org/10.37640/jim.v3i1.1223>
- Setianingsih, W. L., Ekayanti, A., & Jumadi, J. (2022). Analisis kemampuan numerasi siswa smp dalam menyelesaikan soal tipe asesmen kompetensi minimum (AKM) [Analysis of the numeracy skills of junior high school students in solving minimum competency assessment type questions (AKM)]. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(4), 3262-3273. <https://doi.org/10.24127/ajpm.v11i4.5915>
- Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science. *Educational Psychologist*, 50(1), 1-13. <https://doi.org/10.1080/00461520.2014.1002924>
- Siswono, T. Y. E. (2008). Promoting creativity in learning mathematics using open-ended problems. In *The 3 International Conference on Mathematics and Statistics (ICOMS-3)* Institut Pertanian Bogor, Indonesia.
- Swartz, R. J., Fischer, S. D., & Parks, S. (1998). *Infusing the teaching of critical and creative thinking into secondary science: A lesson design handbook*. Critical Thinking Books and Software.
- Syawahid, M. (2019). Mathematical literacy in algebra reasoning. *International Journal of Insight for Mathematics Teaching*, 2(1), 33-46.
- Utomo, D. P. (2020). The pattern of a relational understanding of fifth-grade students on integer operations. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, 5(2), 119-129. <https://doi.org/10.23917/jramathedu.v5i2.9545>
- Verawati, A., Agustito, D., Pusporini, W., Utami, W. B., & Widodo, S. A. (2022). Designing android learning media to improve problem-solving skills of ratio. *Advances in Mobile Learning Educational Research*, 2(1), 216-224. <https://doi.org/10.25082/AMLER.2022.01.005>
- Viseu, F., & Oliveira, I. B. (2012). Open-ended tasks in the promotion of classroom communication in mathematics. *International Electronic Journal of Elementary Education*, 4(2), 287-300.
- Wang, Y., & Ruhe, G. (2007). The cognitive process of decision making. *International Journal of Cognitive Informatics and Natural Intelligence (IJCINI)*, 1(2), 73-85. <https://doi.org/10.4018/jcini.2007040105>
- Widodo, S. A. (2017). Development of teaching materials algebraic equation to improve problem solving. *Infinity Journal*, 6(1), 59-68. <https://doi.org/10.22460/infinity.v6i1.p59-68>

- Widodo, S. A., Darhim, D., & Ikhwanudin, T. (2018). Improving mathematical problem solving skills through visual media. *Journal of Physics: Conference Series*, 948(1), 012004. <https://doi.org/10.1088/1742-6596/948/1/012004>
- Widodo, S. A., Irfan, M., Trisniawati, T., Hidayat, W., Perbowo, K. S., Noto, M. S., & Prahmana, R. C. I. (2020). Process of algebra problem-solving in formal student. *Journal of Physics: Conference Series*, 1657(1), 012092. <https://doi.org/10.1088/1742-6596/1657/1/012092>
- Widodo, S. A., Istiqomah, I., Leonard, L., Nayazik, A., & Prahmana, R. C. I. (2019). Formal student thinking in mathematical problem-solving. *Journal of Physics: Conference Series*, 1188(1), 012087. <https://doi.org/10.1088/1742-6596/1188/1/012087>
- Widodo, S. A., Sari, D. D., Maarif, S., Setiana, D. S., & Perbowo, K. S. (2022). Learning achievement of extroverted students in algebraic operations by tutorial learning: A single subject research. *International Journal of Evaluation and Research in Education*, 11(1), 99-107. <https://doi.org/10.11591/ijere.v11i1.21747>
- Widodo, S. A., Turmudi, T., & Dahlan, J. A. (2019). An error students in mathematical problems solves based on cognitive development. *International Journal Of Scientific & Technology Research*, 8(07), 433-439.
- Wijaya, A. (2018). How do open-ended problems promote mathematical creativity? A reflection of bare mathematics problem and contextual problem. *Journal of Physics: Conference Series*, 983(1), 012114. <https://doi.org/10.1088/1742-6596/983/1/012114>
- Wijayanti, A., Widodo, S. A., Pusporini, W., Wijayanti, N., Irfan, M., & Trisniawati, T. (2022). Optimization of Mathematics Learning with Problem Based Learning and 3N (Niteni, Nirokke, Nambahi) to improve mathematical problem solving skills. *IndoMath: Indonesia Mathematics Education*, 5(2), 123-134.
- Winarso, W. (2014). Problem solving, creativity dan decision making dalam pembelajaran matematika [Problem solving, creativity and decision making in learning mathematics]. *Eduma: Mathematics Education Learning and Teaching*, 3(1), 1-16.

III.B.3. Infinity

ORIGINALITY REPORT

8%

SIMILARITY INDEX

7%

INTERNET SOURCES

7%

PUBLICATIONS

1%

STUDENT PAPERS

PRIMARY SOURCES

- | | | |
|---|--|----|
| <div style="background-color: red; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">1</div> | <p>S A Widodo, Istiqomah, Leonard, A Nayazik, R C I Prahmana. "Formal student thinking in mathematical problem-solving", Journal of Physics: Conference Series, 2019</p> <p>Publication</p> | 1% |
| <hr/> | | |
| <div style="background-color: purple; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">2</div> | <p>doaj.org</p> <p>Internet Source</p> | 1% |
| <hr/> | | |
| <div style="background-color: purple; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">3</div> | <p>icle.stkippacitan.ac.id</p> <p>Internet Source</p> | 1% |
| <hr/> | | |
| <div style="background-color: teal; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">4</div> | <p>online-journal.unja.ac.id</p> <p>Internet Source</p> | 1% |
| <hr/> | | |
| <div style="background-color: green; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">5</div> | <p>repository.unib.ac.id</p> <p>Internet Source</p> | 1% |
| <hr/> | | |
| <div style="background-color: brown; color: white; width: 40px; height: 40px; display: flex; align-items: center; justify-content: center; margin: 5px;">6</div> | <p>Jovitha Indah Gisbtarani, Veronika Fitri Rianasari. "Analysis of Creative Thinking Abilities of Prospective Mathematics Teachers in Solving and Posing Quadrilateral Open-ended Problems", IndoMath: Indonesia Mathematics Education, 2021</p> <p>Publication</p> | 1% |
-

7	Dahlia Fisher, Jarnawi Afgani Dahlan, Beni Yusepa Ginanjar Putra. "MATHEMATICAL SELF-ESTEEM ABILITY OF JUNIOR HIGH SCHOOL STUDENTS IN PROJECT-BASED LEARNING", Infinity Journal, 2022 Publication	1 %
8	Prida N. L. Taneo, Yaya S Kusumah. "Analysis of Students' Mathematical Problem-Solving Ability Based on Category Levels Through Polya Steps", (JIML) JOURNAL OF INNOVATIVE MATHEMATICS LEARNING, 2021 Publication	<1 %
9	journal2.um.ac.id Internet Source	<1 %
10	Utin Desy Susiaty, Nurul Fitria, Marhadi Saputro. "Morndumath Application Against HOTS in Building Materials for Middle School Students", Absis: Mathematics Education Journal, 2022 Publication	<1 %
11	Submitted to Universitas Muhammadiyah Purwokerto Student Paper	<1 %
12	eprints.umm.ac.id Internet Source	<1 %
13	Erisca Lusy Rusdianti, Hendro Permadi, Sisworo Sisworo. "CREATIVE THINKING	<1 %

ABILITIES OF PROSPECTIVE MATHEMATICS
TEACHERS IN SOLVING OPEN-ENDED
TRIGONOMETRY PROBLEM", AKSIOMA: Jurnal
Program Studi Pendidikan Matematika, 2023

Publication

14

I P A A Payadnya. "Investigation of students' mathematical reasoning ability in solving open-ended problems", Journal of Physics: Conference Series, 2019

Publication

<1 %

15

"Values and Valuing in Mathematics Education", Springer Science and Business Media LLC, 2019

Publication

<1 %

Exclude quotes On

Exclude matches

< 15 words

Exclude bibliography On