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Infinity



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Question 1: ROCK CONCERT

For a rock concert a rectangular field of size 100 m by 50 m was reserved for the audience. The concert was completely sold out and the field was full with all the fans standing.

Which one of the following is likely to be the best estimate of the total number of people attending the concert?

- A 2 000
- B 5 000
- C 20 000
- D 50 000
- E 100 000

ROCK CONCERT SCORING 1

Full credit

Code 1: C: 20 000.

No credit

Code 0: Other responses.

Code 9: Missing.

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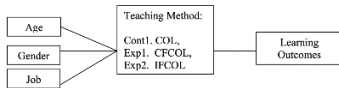
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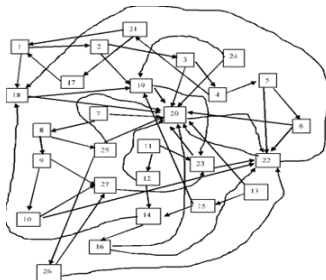
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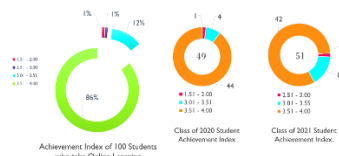
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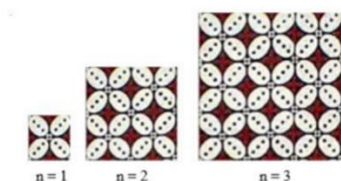
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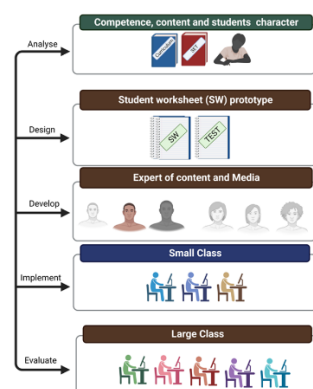
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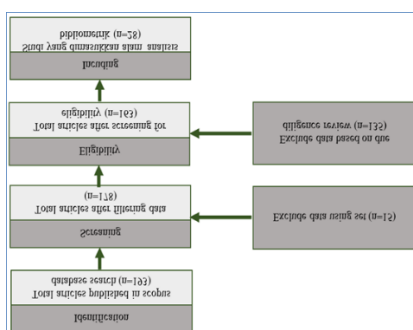
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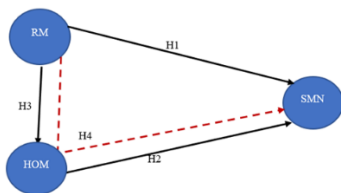
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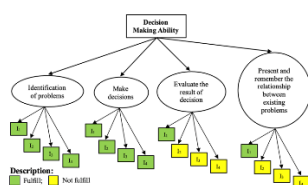
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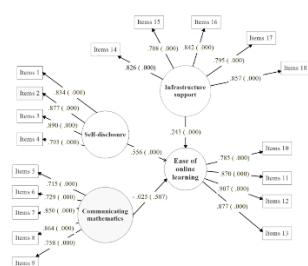
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QUESTION	GENDER	GL 10			GL 11			GL 12		
		F	C	M	F	C	M	F	C	M
Question 1	FEMALE	0	-	-	100%	-	100%	-	-	100%
	MALE	0	2	-	2	-	-	-	-	-
	N	10%	8%	-	80%	80%	-	2	10%	-
Question 2	FEMALE	0	-	-	10%	20%	20%	10%	10%	-
	MALE	0	2	-	1%	20%	20%	10%	10%	-
	N	-	100%	80%	20%	-	12%	12%	12%	-
Question 3	FEMALE	0	-	1	2	2	2	2	2	2
	MALE	0	0%	0%	100%	100%	100%	100%	100%	100%
	N	10%	10%	10%	10%	10%	10%	10%	10%	10%
Question 4	FEMALE	0	-	-	10%	20%	10%	10%	10%	-
	MALE	0	2	-	1%	20%	20%	10%	10%	-
	N	10%	8%	-	80%	80%	-	2	10%	-
Question 5	FEMALE	0	-	-	10%	20%	10%	10%	10%	-
	MALE	0	2	-	1%	20%	20%	10%	10%	-
	N	10%	8%	-	80%	80%	-	2	10%	-
Question 6	FEMALE	0	-	-	10%	20%	10%	10%	10%	-
	MALE	0	2	-	1%	20%	20%	10%	10%	-
	N	10%	8%	-	80%	80%	-	2	10%	-

MATHEMATICAL PROBABILITY: LEARNER'S MISCONCEPTION IN A SELECTED SOUTH AFRICAN SCHOOL

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

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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.

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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 in mathematics learning need to be further researched to find out students' decision-making abilities in solving open ended problems in mathematics learning.

The 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.

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.

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.

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. $2a + b = 3$ $3a + 4b = 7$
 $2a + b = 3$ $\times 4 \quad 8a + 4b = 12$
 $3a + 4b = 7$ $\times 1 \quad 3a + 4b = 7$
 \hline
 $-5a = 5$
 $a = 1$
 $2a + b = 3$
 $2 \cdot 1 + b = 3$
 $b = 1$
Jadi nilai a = 1 & b = 1

2. $3x - 4y = 16$ $\times 1 \quad 3x - 4y = 16$
 $x - 2y = 20$ $\times 3 \quad 3x - 6y = 60$
 \hline
 $2y = -44$
 $y = -22$
 $x - 2y = 20$
 $x - 2(-22) = 20$
 $x + 44 = 20$
 $x = 20 - 44$
 $x = -24$
Jadi nilai x = -24 & y = -22

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

$$\begin{array}{r} 2a + b = 3 \\ 3a + 4b = 7 \end{array} \quad \begin{array}{r} 6a + 3b = 9 \\ 6a + 8b = 14 \end{array}$$

$$\begin{array}{r} 6a + 3b = 9 \\ 6a + 8b = 14 \\ \hline -5b = -5 \\ b = 1 \end{array}$$

$$\begin{array}{l} * 2a + b = 3 \\ 2a + 1 = 3 \\ 2a = 2 \\ a = 1 \end{array}$$

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

$$\begin{array}{r} 3x - 4y = 16 \\ x - 2y = 20 \end{array} \quad \begin{array}{r} 3x - 4y = 16 \\ 3x - 6y = 60 \end{array}$$

$$\begin{array}{r} 3x - 4y = 16 \\ 3x - 6y = 60 \\ \hline 2y = 44 \\ y = 22 \end{array}$$

$$\begin{array}{l} * x - 2y = 20 \\ x - 44 = 20 \\ x = 64 \end{array}$$

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 I_2 writes $3x-4y=16$ as the first equation and $x-2y=20$ as the second equation. Then subject I_2 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 I_2 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 I_2 was less thorough in operating 16 minus 60 , which should be -22 . Through interviews, subject I_2 stated that "oh yes, I was not careful, ma'am, the results should have been negative".

Subject I_2 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 I_2 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 I_2 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_3

The following in Figure 3, results from subject I_3 's work in solving open ended problems. Subject I_3 finished with the wrong answer on problem number 1 and the correct answer on problem number 2.

11.
$$\begin{array}{rcl} 2a + b = 3 & \times 4 & 8a + 4b = 12 \\ 3a + 4b = 7 & \times 1 & 3a + 4b = 7 \\ \hline 5a = 5 & & \\ a = 1 & & \end{array}$$

$$\begin{array}{l} 2a + b = 3 \\ b = 3 - 2a \\ b = 3 - 2(1) \\ b = 1 \end{array}$$

21.
$$\begin{array}{rcl} 3x - 4y = 16 & \times 1 & 3x - 4y = 16 \\ x - 2y = 20 & \times 3 & 3x - 6y = 60 \\ \hline 2y = -44 & & \\ y = -22 & & \end{array}$$

$$\begin{array}{l} x = (-44) = 20 \\ x + 44 = 20 \\ x = -24 \end{array}$$

Figure 3. Subject test results from I_3

Based on indicators of decision-making ability in identifying the purpose of decision-making, subject I_3 knows what is known and asked in the problem so that subject I_3 can determine what method to use to solve the problem. The statement of subject I_3 supports this during the interview, "I use the method of elimination and substitution ma'am." Subject I_3 also wrote down the steps to solving the problem.

Subject I_3 used the elimination and substitution methods to solve problem number 1. Subject I_3 wrote $2a+b=3$ as the first equation and $3a+4b=7$ as the second equation. Then subject I_3 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 I_3 gets the result $a=5$. The results obtained by subject I_3 are wrong because the answer received should be $a=1$, so finding the value of variable b is also wrong. Subject I_3 was not careful in operating $5a=5$, namely 5 divided by 5, which should be $a=1$.

For number 2, subject I_3 uses the same method as number 1, namely the elimination and substitution method, to solve the problem. Subject I_3 writes $3x-4y=16$ as the first equation and $x-2y=20$ as the second. Then subject I_3 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.) $2a+b=3 \dots (1)$
 $3a+4b=7 \dots (2)$
 $\times 2a+b=3 \quad \times 4 \quad 8a+4b=12$
 $3a+4b=7 \quad \times 1 \quad 3a+4b=7$
 $\hline 5a=5$
 $a=5$
 $\times 2a+b=3$
 $2(5)+b=3$
 $b=3-10$
 $b=-7$
 Himp penyelesaian $\{-7, 5\}$

2.) $3x-4y=16 \dots (1)$
 $x-2y=20 \dots (2)$
 $\times 3x-4y=16 \quad \times 1 \quad 3x-4y=16$
 $x-2y=20 \quad \times 3 \quad 3x-6y=60$
 $\hline 2y=-44$
 $y=-22$
 $\times x-2y=20$
 $x-2(-22)=20$
 $x-44=20$
 $x=64$
 Himp. penyelesaian $\{-22, -24\}$

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 is 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 I_4 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 I_4 can make decisions by determining the method to be used, namely the method of elimination and substitution. Subject I_4 did not evaluate the results of the decision or make corrections before the subject collected the results of his work. Subject I_4 was careless in calculating to produce inaccurate solving results for both problems. Subject I_4 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 I_1 , I_2 , I_3 , and I_4 in each indicator of decision making, as shown in Figure 5.

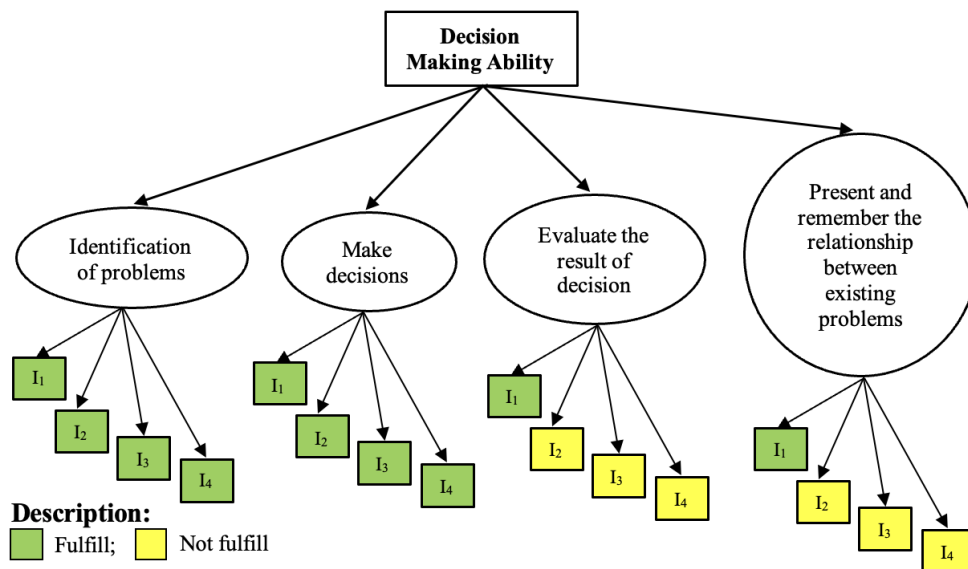


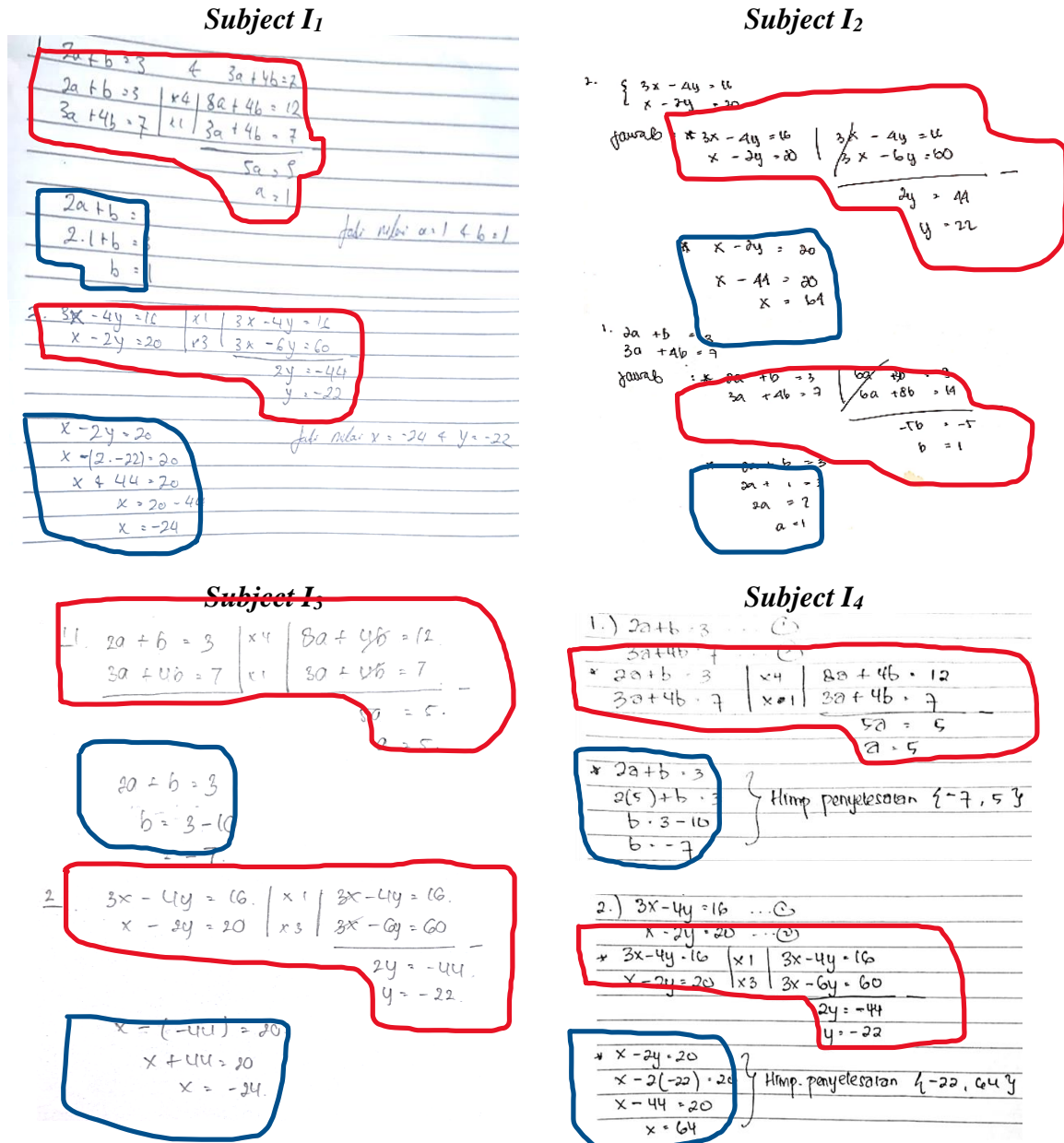
Figure 5. The subject's decision-making ability in each indicator

At the stage of identifying the purpose of making decisions from a given problem and matters relating to the situation, subjects I_1 , I_2 , I_3 , and I_4 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 subjects, 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, I_1 , "I did not write down what was known and asked because we usually wrote 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 understanding 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 I_1 , I_2 , I_3 , and I_4 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 I_1 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 I_2 , I_3 , and I_4 have almost the same reasons as submitted by subject I_3 "I use this method because it is as exemplified by the teacher". At this stage, only subject I_1 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 I_1 , I_2 , I_3 , and I_4 stated that they knew if other methods had been taught and could be used to solve the problem. Subject I_1 said, "in my opinion, this problem can be solved by using the method of elimination, substitution, and graphics". Subjects I_2 , I_3 , and I_4 have the same statement: Can this problem be solved using only the elimination method or substitution? Subject I_1 has better knowledge when compared to subjects I_2 , I_3 , and I_4 . Subject I_1 can mention if to solve the problem can also use the graphical method. Subject I_1 stated that he obtained information regarding visual methods from textbooks and the internet. Subjects I_2 , I_3 , and I_4 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 I_1 , 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 I_1 can consider correcting the answers to obtain the correct answers for numbers 1 and 2. Subjects I_2 and I_3 are less able to assess because they have one correct answer and one wrong. Subjects I_2 and I_3 were less thorough in performing integer division operations. Subject I_4 could not evaluate because he had incorrect answers in numbers 1 and 2. Subject I_4 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 I_2 , I_3 , and I_4 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 I_4 . In question number 2, subject I_4 was not cautious in operating the subtraction of negative integers. This is supported by the interview results where subject I_4 stated, "I am often confused when using numbers with a negative sign". The error in evaluating experienced by subject I_1 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 I_1 fulfills this. This is also supported by the results of an interview with I_1 , that I_1 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 I_2 , I_3 , and I_4 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 (I_1); 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 (I_2 and I_3), 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 (I_4), 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.

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