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Metacognitive Ability of Junior High School Special Intelligent Students in Solving Mathematical Problems

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Abstrak

Metakognisi adalah suatu tingkatan dalam proses berpikir yang dapat digunakan siswa untuk memecahkan masalah, memiliki kesadaran terhadap proses berpikirnya dan mengontrol cara berpikirnya. Pada pembelajaran matematika di sekolah kita sering menemukan banyak siswa yang mengalami kesulitan dalam memecahkan masalah disebabkan kurangnya kesadaran dan control dalam diri mereka. Kesulitan ini pun terjadi pada siswa kategori cerdas istimewa yang memiliki IQ di atas 130. Pada penelitian ini, peneliti ingin melihat bagaimana kemampuan yang dimiliki oleh siswa cerdas istimewa dalam memecahkan masalah matematika. Penelitian ini menggunakan metode kualitatif deskriptif. Penelitian ini dilakukan di sebuah SMP di kota Bandung dengan sample sebanyak 13 orang siswa cerdas istimewa. Untuk mengukur kemampuan metakognisi, siswa diberikan soal pemecahan masalah beserta angket metakognisi. Dari hasil penilaian pemecahan masalah, siswa cerdas istimewa memperoleh nilai rata – rata sebesar 59. Secara rinci, kemampuan metakognisi siswa cerdas istimewa berdasarkan angket yang mereka isi berada pada kriteria cukup baik untuk tahap planning, monitoring dan evaluating yaitu berada di kisaran 41% - 60%, dengan presentase berturut – turut 58,46%, 52,56% 53, 64%. turut 58,46%, 52, 56% 53, 64%.

Kata kunci: Metakognisi, Pemecahan Masalah, Cerdas Istimewa

Abstract

Metacognition is a level in the thinking process that students can use to solve problems, have awareness of their thinking processes, and control the way they think. In learning mathematics in schools, we often find many students who have difficulty solving problems due to a lack of awareness and control within themselves. This difficulty also occurs in the special intelligent category students who have an IQ above 130. In this study, the researcher wanted to see how the abilities possessed by special intelligent students in solving mathematical problems. This research is a descriptive qualitative method. This research was conducted in a junior high school in Bandung with a sample of 13 special intelligent students. To measure metacognitive ability, students are given problem-solving questions along with a metacognition questionnaire. From the results of the problem-solving assessment, the special intelligent students got an average score of 59. In detail, the metacognitive abilities of the special intelligent students based on the questionnaires they filled were in the good criteria for the planning, monitoring, and evaluating stages, which were in the range of 41% - 60 %, with a successive percentage of 58.46%, 52.56% 53,4%.

Keywords: *Metacognition, Metacognitive Ability, Mathematical Problem, Special Intelligent*

1. INTRODUCTION

Mathematics is one of the subjects that has a big enough role in preparing students. Mathematics can also be referred to as a means of communication about patterns that are useful in practicing logical, critical, creative, and innovative thinking skills. Mathematics as an educational vehicle can not only be used to achieve educational goals but can also shape the personality of students in developing certain skills (Nugrahaningsih, 2012).

The process of learning mathematics will occur smoothly if the learning itself is carried out continuously. Learning mathematics provides opportunities for students to develop their potential and improve their ability to construct knowledge. Schoenfeld (in Yulianti, 2014: 1) states that the mathematics learning process at the classroom level focuses on four ability standards, namely, problem-solving, reasoning, communication, and connections. One of the four abilities can be developed by enriching experience through problem-solving problems.

Problem-solving as the highest mental activity process in learning mathematics can help students learn concepts and intellectual skills. Problem-solving is the highest activity process in learning mathematics that can help students learn concepts and intellectual skills. Problem-solving is one of the cognitive strategies needed in everyday life, including students in learning activities. Regarding problem-solving as a process of mental activity in learning mathematics, the mathematical problem-solving ability is one of the focuses taught in schools. Omron (in Yulianti, 2014: 2) states that students work on problem-solving if the teacher has done what should be done. Students view mathematical problem solving as a quick effort that does not require thinking. This is in line with the phenomenon that occurs in students at the junior high school (SMP) level. Based on the giving of math problem-solving questions to 13 8th grade junior high school students, one of them (7.7%) wrote down what was known on the problem, did not write down what was asked, and did the completion steps and the answer was correct, seven people (53.8 %) answered by directly working on the completion steps and their answer was correct, three people (23.07%) immediately wrote the correct answer without any steps, and two people (15.38%) wrote the answer directly but it was wrong.

This shows that many students ignore the early stages of the problem-solving step, which is not writing down what is known and what is being asked. In the problem-solving aspect, writing down what is known and asked is included in the problem understanding stage, while in the metacognitive aspect writing what is known and asked is included in the aspect of declarative knowledge and planning skills, so based on these results it can be said that most students still do not understand. fully understand the content of the problem-solving problem. This can be seen in the process of working on problem-solving problems, they ask each other into their friends, and some directly copy their friends' work without understanding the problem first.

Based on the results of the 2012 PISA study (Hutabarat, 2020) Indonesia occupies the ranked 64th out of 65 participating countries. Or in other words, ranked the second bottom of all surveyed PISA participating countries. The average score of ability Indonesian students in mathematics is 375, the score below the average score international is 494. One of the factors that cause low student achievement in Indonesia in PISA is the weakness of problem-solving ability of non-routine questions or high level. The questions tested in PISA consist of 6 levels (level 1 is the lowest and the highest level is 6) and the questions tested are contextual, the problem is taken from the real world. Meanwhile, students in Indonesia are only used to the routine questions at level 1 and level 2. Therefore, it can be concluded that the ability of Indonesian students' mathematics problems solving is low.

According to Garofalo & Lester (Kuzle, n.d.), low problem-solving performance is not due to insufficient content of knowledge and facts, but is more associated with the inability of students to

analyze problems, understand, assess the adequacy of the information provided, organize their knowledge and facts properly. The purpose of preparing a plan, evaluating the feasibility of implementing the plan that was prepared previously, and evaluating the reasonableness of the results.

In developing the skills to understand the problem, students are required to have an awareness of their thinking process. This awareness is known as metacognition. Metacognition is a person's knowledge of their thought processes (Surya, 2015: 42). Schoenfield (Widadah et al., 2013) defines metacognition as follows: " *Metacognition is thinking about our thinking and chunking the following three important aspects: knowledge about our thought, process, control or self-regulation, and belief and intuition"*. This means metacognition is thinking about thinking

2. METHOD

This research uses a qualitative descriptive design. This study analyzes students' metacognitive skills which consist of planning, monitoring, and reflection in solving problem-solving problems. The description and categorization of students' metacognitive skill levels became the main target of this study. The students were given problem-solving questions along with a metacognition questionnaire. The research subjects were 7th-grade junior high school students with special intelligence.

There were two instruments used in this research. The first instrument was mathematical problem solving and the second instrument is a metacognitive questionnaire, here the researcher uses the Metacognition Awareness Inventory (MAI) (Lapele, 2020). In this study, to support the measurement of students' metacognitive ability in solving mathematical problems, students were asked to fill out a metacognition questionnaire containing 14 statements about what they did while working on the problem.

3. RESULT AND DISCUSSION

To answer the formulation of the first problem, which is about how the metacognitive abilities of special intelligent junior high school students in solving mathematical problems, it is done by analyzing the results of the mathematical problem-solving ability test given to 13 students in the special intelligent class:

Table 1. Problem Solving Ability Test Score

SMI	X_{max}	X_{min}	$\bar{x}$
100	96	20	59

First, after being given math problem-solving questions, students are grouped into several groups based on the results obtained from the problem-solving scores they are working on to analyze the results of the answers.

The recapitulation of the quality of the problem-solving ability test results for special intelligent students is presented in the table below:

Table 2. Criteria for Mathematical Problem-Solving Ability

Criteria for Mathematical Problem-Solving Ability	**Total students**	**Percentage of students**	**Assessment Criteria**
90≤A≤100	2	15%	Very high
75≤ **B** <90	1	8%	High
55≤ **C** < **75**	3	23%	Enough
40≤ **D** < **5**5	6	46%	Low
0≤ **E** <40	1	8%	Very Low

Based on Table 2., we get data that 15% of students, namely two students have very high-quality problem-solving abilities, 8% of students, namely one student has high-quality problem-solving abilities, 23% of students, namely three students have the quality of ability is quite high, 46% of students, namely as many as six students have low-quality problem-solving abilities, and 8% of students or as many as one students have very low-quality abilities.

Visually, the above data can be seen in the form of a graph as shown in the following figure:

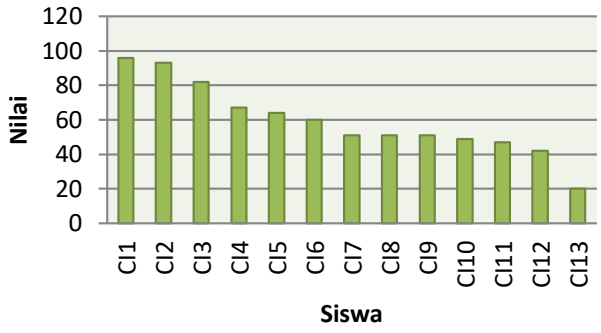

Figure 1. Graph of Students' Problem Solving Ability

Furthermore, it will be discussed on the students' metacognitive abilities in solving mathematical problems obtained from questionnaires and the results of students' answers in doing math problem-solving tests consisting of upper group students, middle group students, and low group students. The following will explain the results of the students' metacognition questionnaire analysis in solving mathematical problems.

Metacognition Questionnaire Analysis of Special Intelligent Students in Solving Mathematical Problems

The questionnaire is filled out by each student who finishes working on one question so that there are three metacognitive questionnaires, namely the questionnaire for question number 1, up to question number 3. The measurements in this questionnaire are divided into three parts according to the stages in the students' metacognition process, namely the monitoring, planning, and evaluation. Previously, it will be explained in advance that the results of this metacognition questionnaire analysis, at each stage have a percentage of more than 50%, meaning that students have fairly good metacognitive abilities. The results of the metacognition questionnaire analysis will be explained in the table below:

Table 3. Results Of The Metacognition Questionnaire Analysis

Metacognitions' Stages	Question 1	Question 2	Question 3
Planning	58,46 %	58,46 %	61,54 %
Monitoring	52,56%	58,97 %	55,13 %
Evaluating	53,64 %	51,28%	61,54 %

From the Table 3., we can see that for question number 1 58.46% of students have good metacognitive abilities in the Planning stage. 52.56% of students have good abilities for the monitoring stage, and in the evaluating stage, only 53.64% of students have metacognitive abilities. For question number 2, 58.46% of students have good abilities in the Planning stage, 58.97% of students have good abilities in the monitoring stage, and only 51.28% of students have good metacognitive abilities in the evaluating stage. Furthermore, for question number 3, there are 61.54% of students whose have good metacognitive abilities in the Planning stage, 55.13% of students have

good abilities in the monitoring stage, and 61.54% of students have good abilities in the evaluating stage.

For more details, the following is a graphic image that represents the table above.

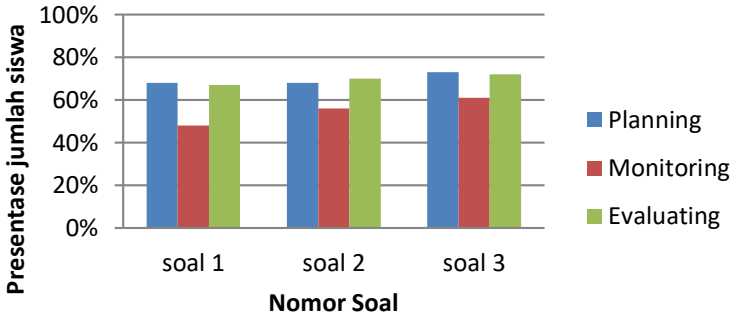

Figure 2. Graph of Students' Metacognitive Ability

Analysis of Student Answer Results:

Question number 1:
A wood craftsman will make a lampshade with a shape like the following picture, if the cost of making the lampshade is IDR 100,000.00/m2, how much will it cost, if the wood craftsman wants to make 50 lampshades?

1) Analysis of the results of the answers to question number 1 by students in the upper group

a) In Understanding the Problem
Based on Figure 3., we can see that students write what they know in the problem by assuming the sides of a prism with variables a, b, and t where a and b are sides of a trapezoid with lengths of 6 cm and 16 cm, respectively. The next information written by students is the cost of making a lampshade of Rp. 100,000/m2, this information is also following per under the information contained in the problem. Next, students write down what they are asked about, namely the cost of making 50 lampshades.

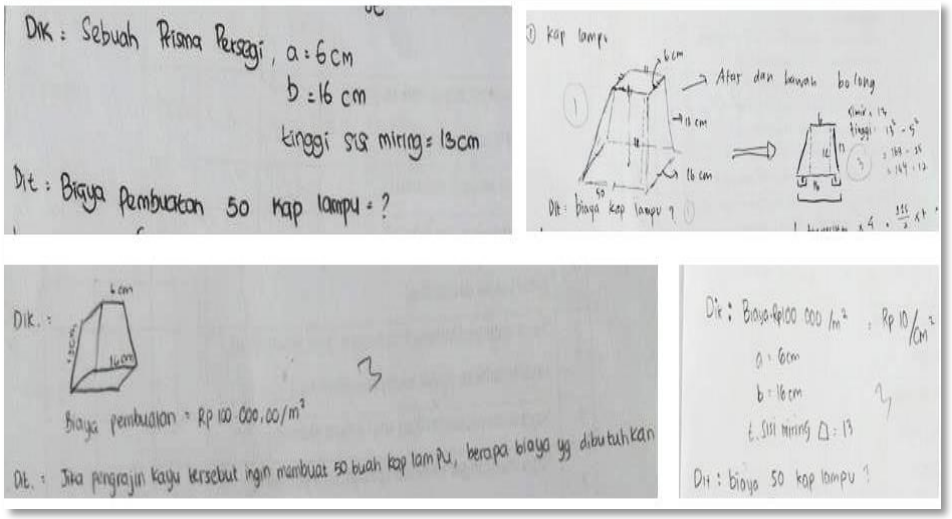

Figure 3. Answer Sheet Number 1

Based on the results of these student answers, it can be stated that the students understand the questions well.

Metacognitive knowledge refers to knowledge (*memory)*, understanding, and learning processes that can be expressed in words. Flavel (Lai, n.d.) classifies metacognitive knowledge into three parts, namely: individual variables, task or goal variables, and action or strategy variables. Individual variables refer to a person's awareness of the abilities he has, a child who has individual variables will realize that he is able or not to solve the problems presented in front of him. At this stage, we see students can answer or complete the given task and know the steps that must be taken so that it shows that students have individual variables in the form of good awareness of their abilities.

Task variables include knowledge of the commands of different tasks. Flavel argues that the task variable refers to a person's cognitive effort (Louca, 2019). We can see this variable from the knowledge that students have which is the basis for them in solving problems. Meanwhile, the action or strategy variable is knowledge about what strategies are most useful to use. This variable refers to what specific thoughts or actions will be used to achieve a goal. Task variables and action variables will be seen at the stage of making plans in problem-solving.

Judging from the information written by students, it shows that students have good *planning* skills, namely thinking about what information is known, being asked, and thinking about expressing problems in their sentences. This is in line with Schraw's opinion (Irham, 2015) that one of the components of metacognition is the regulation of cognition which includes; *planning, monitoring,* and *evaluating,* where *planning* ability refers to choosing the right strategy and providing resources that influence the strategy.

b) In Planning

Based on Figure 4., we can see that the students wrote the completion plan. This is indicated by writing the formula that will be used for calculations. Students write the formula for the surface area of the prism according to the picture given in the problem. A student writes that the surface area of a prism is JSS or the number of parallel sides times four.

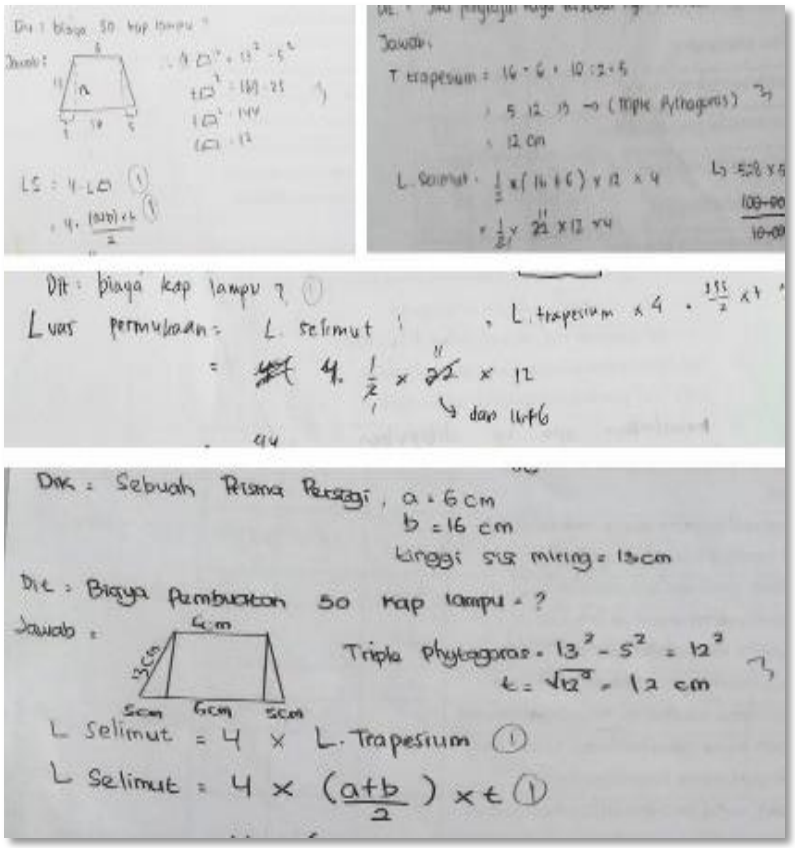

Figure 4. Student Answer Sheet Number 1 (Planning Stage)

Another student wrote down that the surface area of the prism that corresponds to the picture listed in the problem is $\frac{(a+b)}{2} \times t$. The two types of answers from the special intelligent students in the upper group are correct because to find out the costs involved in making the lampshade, we first need to know the surface area of the lampshade.

Two people from the upper group, wrote the formula for the surface area of the prism, because the question asked about the cost of 50 lampshades, so they had to find the surface area of the lampshade first. This shows that they think about the calculation path first. In addition, as discussed in the understanding stage of the problem, all of these students made pictures to find the height of the trapezoid, and all of them used the Pythagorean triple pattern comparison. From this, we can see that the four students thought of the easiest way to get the height of the trapezoid.

Furthermore, at the planning stage, students also have good abilities where they write their plans by writing down the formulas that will be used in the calculation of problem-solving shown in the picture. Students realize that there is incomplete information in the problem and that information can be obtained by doing calculations first. The incomplete or unknown information is the height of the trapezium. Students find the height of the trapezoid using the Pythagorean theorem. This shows that students have good *procedural knowledge*.

c) In Solving Problems
In the stage of solving the problem or in the calculation, three out of four students have not consistently written down the unit of measure from the beginning of the calculation. They list the units after completing the calculations. The rest of the four upper group students did not experience difficulties in mathematical calculations. In addition, the four students in the upper group also wrote conclusions from the results of their calculations according to the request in the question.

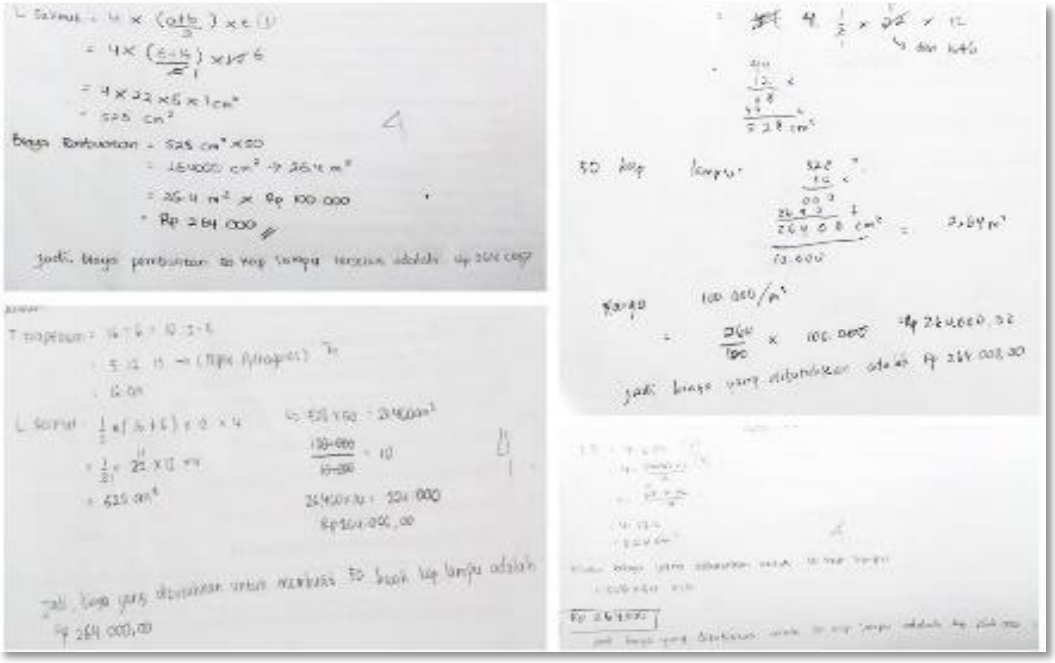

Figure 5. Answer Sheet Number 1 Student Problem Solving Stage)

d) In Checking Back.
When they finished working on question number 1, the researchers made sure whether they had checked the answers again, they said they had been checked by doing calculations from behind. However, if you look at the answer sheet, some students missed this stage. When there are still mistakes made by students, it could be because they are not aware that there is incomplete

information, or it could be because they do not understand the importance of the information they missed in this unit of measure.

2) Analysis of the results of students' answers in the medium group

a) In Understanding the Problem

At this stage, two out of five students wrote down the information that was known and asked completely, two other students only wrote down what was known and one other person did not include the information that was known and asked.

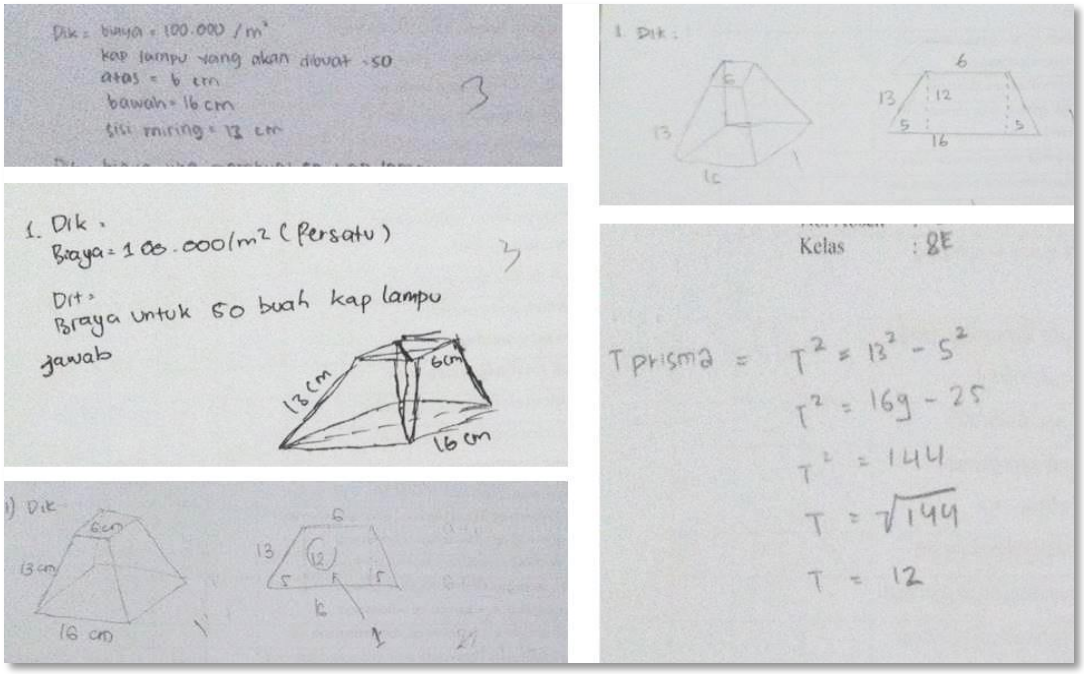

Figure 6. Answer Sheet Number 1 Middle Group Students (Problem Understanding Stage)

b) In Planning

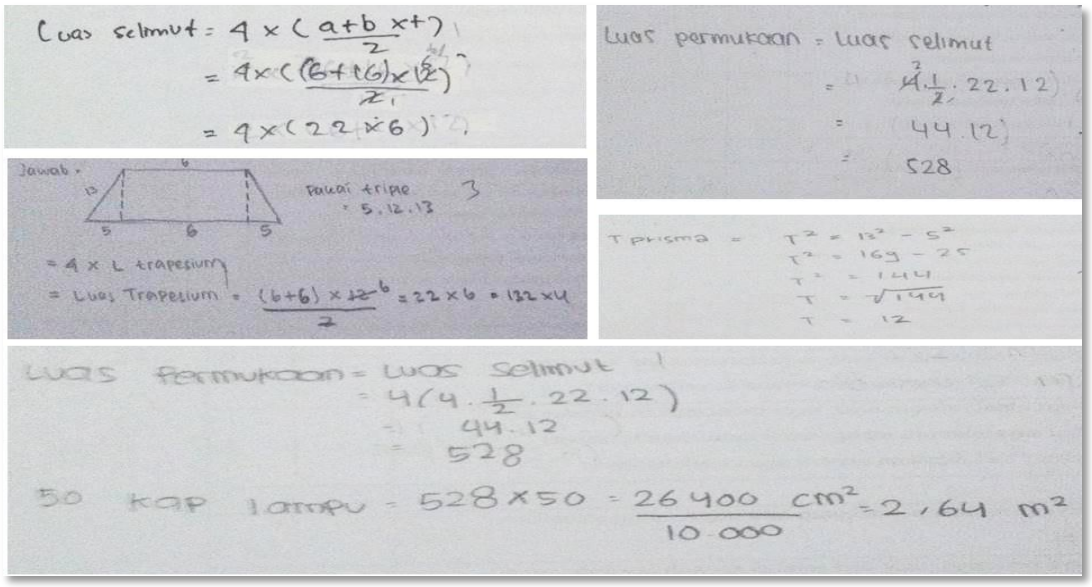

Figure 7. Answer Sheet of Medium Group Students (Planning Stage)

At this stage there is one student who does not write down what formula is used; the student only writes down the information that is not contained in the question. The other four students wrote down that they would use the surface area of a prism, then immediately performed calculations after previously finding information that was not yet known by using certain strategies.

c) In Solving Problems

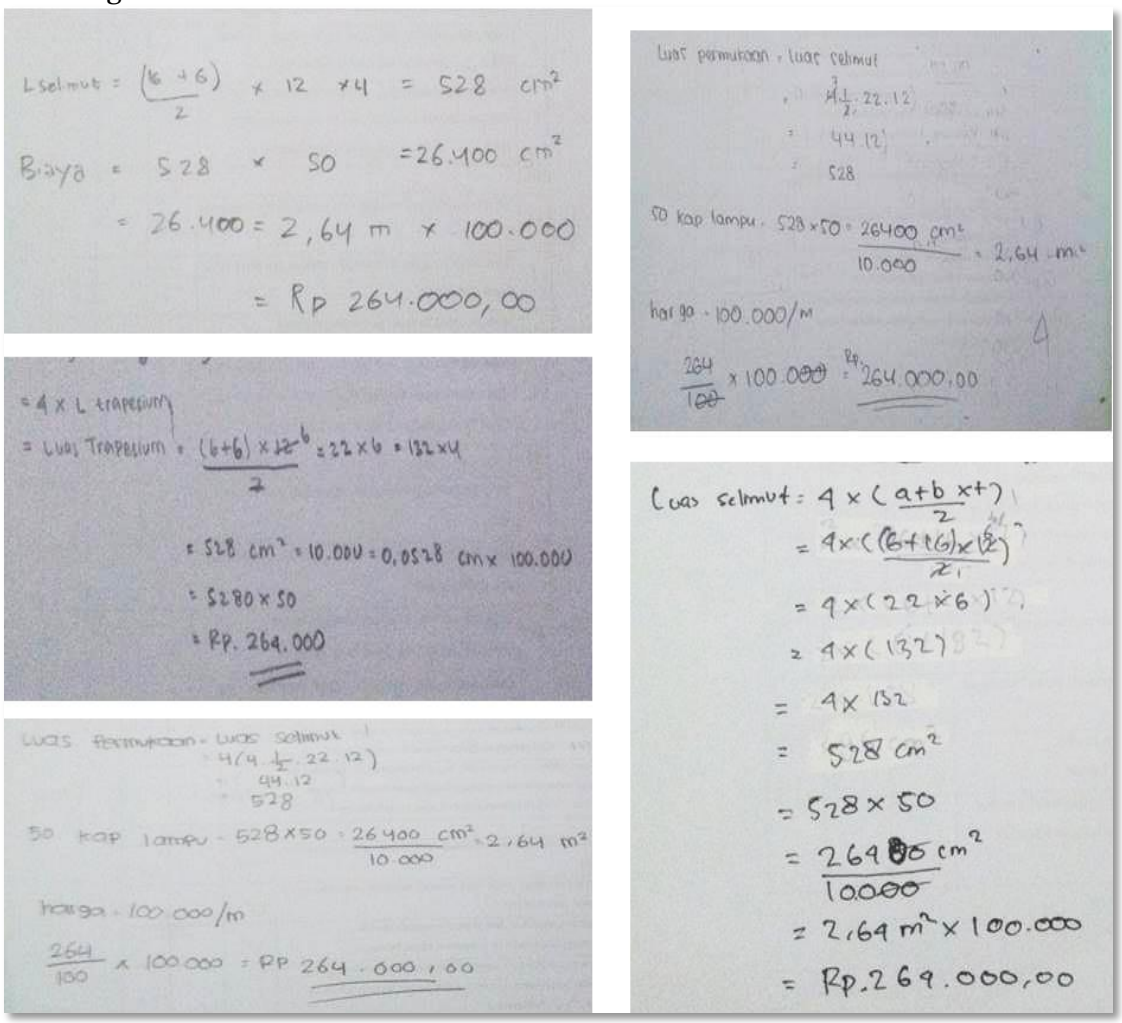

Figure 8. Answer Sheet of Medium Group Students

At this stage, all students did the calculations correctly. But just like the students in the upper group, the middle group students also had not consistently write units and the five students did not write down the conclusions from their calculations.

d) In Checking Back.
In the re-examination stage, there is one student who corrects the answer. Initially, the student made a calculation error but then he was able to correct his answer to become the right answer. This shows that students have an awareness that they made mistakes and try to correct them.

3) Analysis of the Results of Lower Group Students' Answers

a) In Understanding the Problem
At this stage, two students write down the known and asked information, the other two students immediately do the calculations.

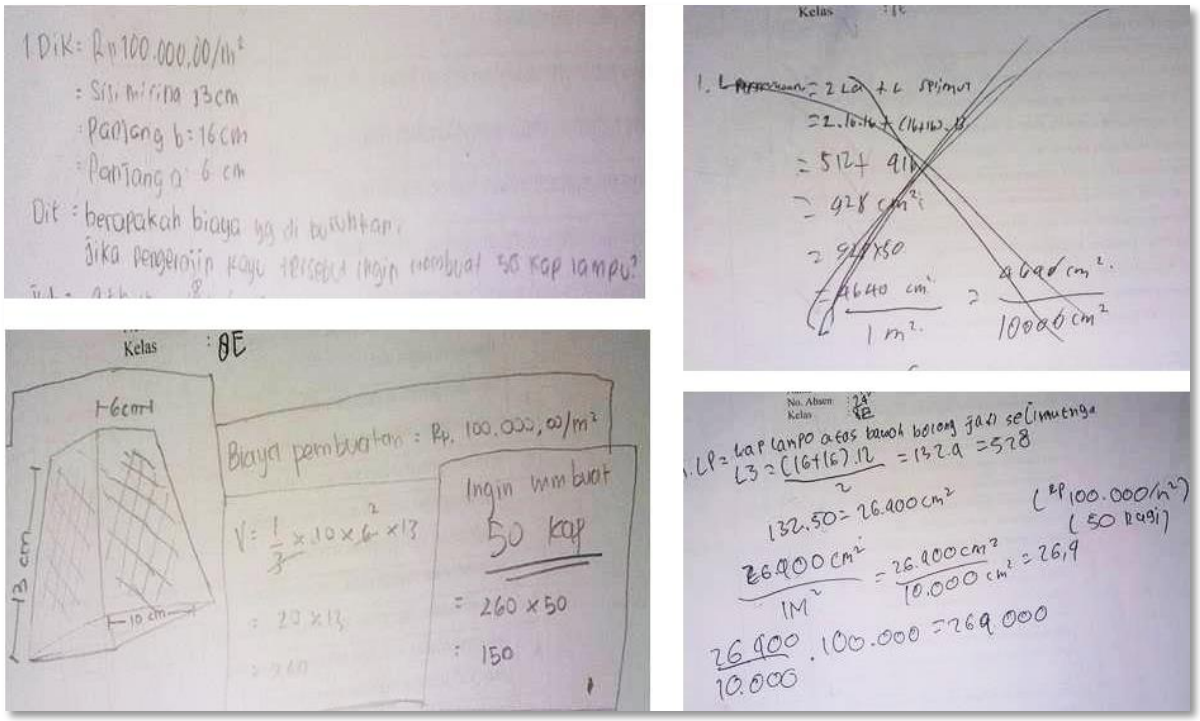

Figure 9. Answer Sheet Number 1 Student Lower Group

b) In Planning

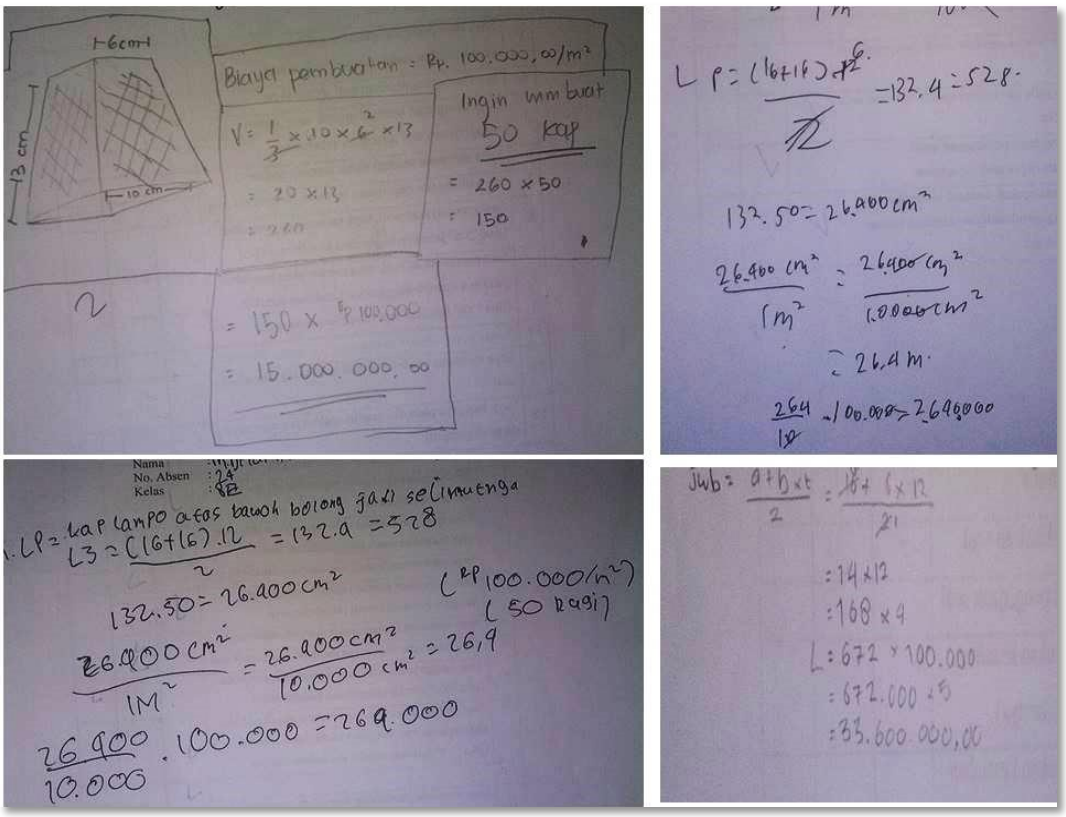

Figure 10. Answer Sheet Number 1 Regular Student Lower Group

At the planning stage, only one student makes a plan, namely by writing down the formula that will be used. The concept they use to figure out the cost of making 50 lampshades is to first calculate the surface area.

c) In Solving Problems

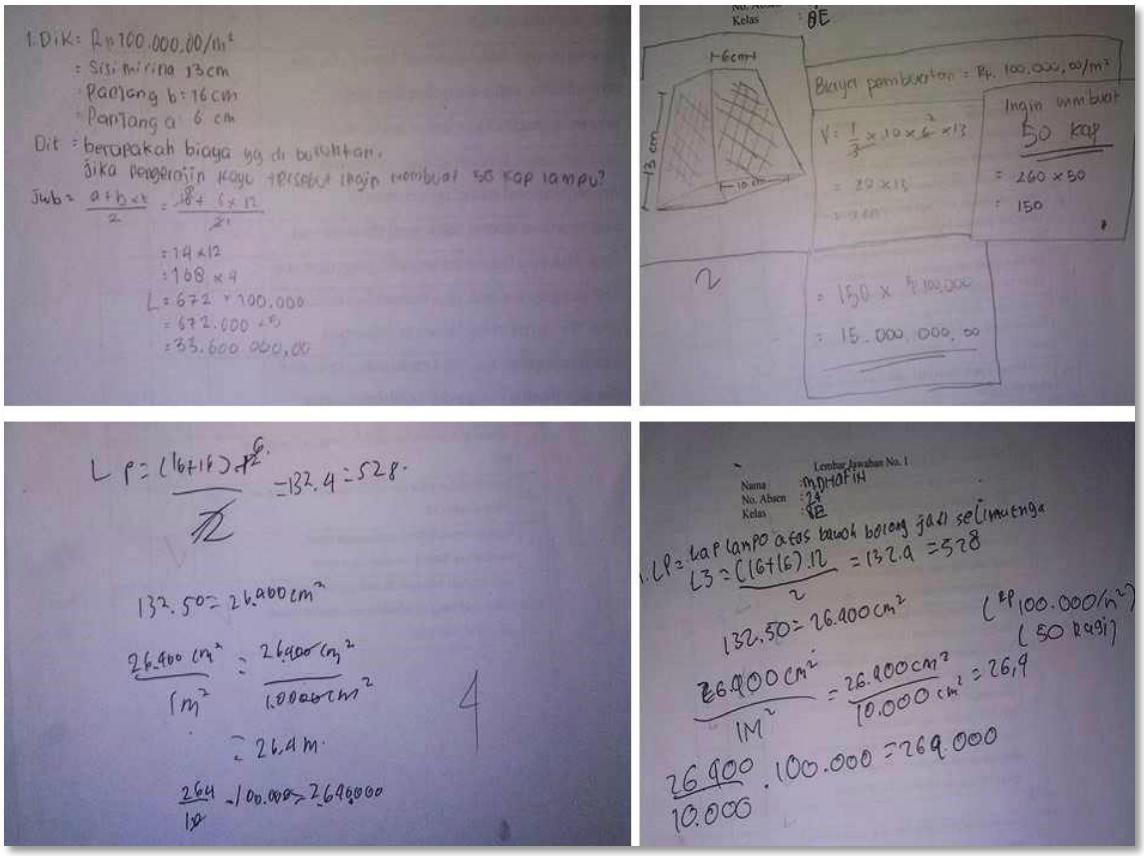

Figure 10 Student Answer Sheets for the lower group

At this stage, two students make an error. Two other students did calculations with the right steps but still couldn't be consistent in listing units. This shows that in solving problems, students are still less thorough. This situation is supported by the results of a metacognition questionnaire which shows that students have low *monitoring* abilities. This low *monitoring* ability causes students to need to be guided to be consistent in paying attention to every step in working on questions and monitoring properly whether the answers they present are correct and complete or not.

d) In Checking Back.

At this stage, students do not seem to have re-examined the calculation process carried out. This can be seen from the calculation errors made by two students in the lower group. After being checked on the questionnaire given, they admitted that they did not re-examine their work.

In solving mathematical problems, initial knowledge or basic knowledge is needed. Gagne (Strategy & Riyadi, 2017) argues that a topic can be studied if the hierarchy of prerequisites has been studied. A topic at a certain level can be supported by one or more of the topics at the previous level. In this study, the subject solves a mathematical problem with the topic of discussing the surface area and volume of a prism. Therefore, in solving the given problem, students need to master the prerequisite material in the spatial structure material first. The prerequisite materials include the area and perimeter of plane figures, the Pythagorean theorem, and the conversion of area units. Students will

be able to solve mathematical problems related to surface area and volume of flat shapes if they have mastered the materials mentioned above.

In this study, each research class was divided into three groups, namely the upper group, the middle group, and the lower group. Upper group students seem to have good metacognitive abilities. This can be seen from the way they solve problems very regularly. They write in full the stages of solving mathematical problems, and from their way, we can see the metacognitive abilities they have. Students write down what they know, what is being asked and state the problem in their language in the early stages of problem-solving, meaning that they are already thinking to be able to find out the information needed, thinking about knowing what is being asked, and thinking how to state the problem is the problem in language. alone. In addition to thinking about knowing what they know, what to ask, and how to state the problem in their language, they also ask themselves and then check or make sure that they have written down or know in full the information contained in the problems they solve.

In the next stage, namely the stage of making a problem-solving plan, the upper group students already have good metacognitive abilities, they write a settlement plan by first writing down the formula they will use. This shows that students in the upper group think and look for relationships between known information and what is being asked, they also think to find some formulas that might be used and think they will choose what prior knowledge can help them in solving mathematical problems. After they think, and determine the formula they will use, then they make sure that the relationship between the two data, namely the information that is known and the information asked is correct.

The next stage in solving mathematical problems after planning is solving mathematical problems according to the plan made. At this stage, the upper group students already have good metacognitive abilities which are indicated by the suitability between the plan and the implementation of problem-solving. That is, when they carry out problem-solving, they have thought about the steps that must be taken. Then they think about whether the steps for solving the problem are correct and then re-checking whether there are errors in each step. If there are errors, they will be corrected immediately until they are sure that the steps, they are doing are correct

After students solve the problem, the next step is to re-examine the results of their work as a whole. This stage is not visible on the student answer sheet, because the re-examination stage is carried out by students after completing the problem-solving steps, and for checking the results of calculations, students write them down on cross-sectional paper, not on answer sheets.

Next, the middle group students had the same patterns in solving mathematical problems. Namely, they did not write down what was known and what was asked in full. This shows that at the stage of understanding the problem, they have thought about what information is known but did not confirm whether the information they received was correct or not.

At the planning stage, students can relate the information that is known to what is being asked, and they decide to use a concept to solve a math problem, but they don't include the plan, but instead do the calculations directly. understand the problem but because students follow other students' ways of working, or just because they guess.

And for students in the lower group, students are still trying to understand and solve problems. Students in the lower group do not yet have good metacognition skills, at the stage of understanding the problem they do not write completely what is known in the problem and how is the relationship between the information known and what is known. asked. Students also have not been able to think about what concepts and steps to use to solve problems, this is due to the lack of prerequisite skills possessed by students. So that there are students who experience errors both in the steps of problem-

solving, as well as in the calculations they do. In addition to the lack of prerequisite skills possessed by students, another cause of the lack of metacognitive abilities is the lack of students' abilities in terms of monitoring the solution, namely students feel that what they are doing is correct even though there are still mistakes.

4. CONCLUSION

From the results of research and discussion on the metacognitive abilities of special intelligent students, it can be concluded that the overall metacognitive abilities of special intelligent students can be categorized as quite good. This is indicated by the average value of the ability to solve math problems reaching a good criterion, namely 59. In detail, the metacognitive abilities of special intelligent students based on the questionnaire they filled out were good enough criteria for the planning, monitoring, and evaluating stages, which was in the range of 41%-60%, with a successive percentage of 58.46%, 52, 56% 53, 64%.

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