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METACOGNITIVE ANALYSIS OF STUDENTS IN SOLVING MATHEMATICS PROBLEM

Sri Adi Defi[1*], Yulia Haryono[1], Lucky Heryanti Jufri [1]

[1] Departement of Mathematics Education, Universitas PGRI Sumatra Barat

*email: sri5121defi@gmail.com

Abstrak

Penelitian ini dilatarbelakangi oleh kurangnya pemahaman siswa terhadap kemampuan berfikirnya dan siswa tidak dapat menentukan strategi yang tepat umtuk mengatasi masalah yang dihadapi dalam pemecahan masalah matematika. Tujuan penelitian ini adalah untuk mengetahui bagaimana level metakognitif siswa dalam menyelesaikan soal pemecahan masalah matematika pada siswa kelas IX.1 SMPN 26 Padang. Jenis penelitian ini adalah deskriptif kuantitatif. Subjek penelitian ini adalah kelas IX.1 SMP Negeri 26 Padang. Instrument yang digunakan yaitu tes dan wawancara. Tes digunakan untuk mengetahui level metakognitif siswa dalam menyelesaikan soal pemecahan masalah. Wawancara digunkan untuk mengetahui lebih lanjut level metakognitif dari segi pemahaman siswa. Hasil penelitian menunjukan bahwa sebanyak 35,71% siswa berada pada level metakognitif *Tacit Use*, sebanyak 35,71% siswa memiliki level metakognitif *Aware Use*, dan sebanyak 28,58% siswa memiliki level metakognitif *Strategic use*. Siswa yang memiliki skor kemampuan metakognitif kelompok tinggi di dalam kelas berada pada level metakognitif *Strategic Use*. Siswa yang memiliki skor kemampuan metakognitif kelompok sedang di dalam kelas berada pada level metakognitif *Aware Use*. dan siswa yang memiliki skor kemampuan metakognitif kelompok rendah dalam kelas berada pada level metakognitif *Tacit Use*.

Kata kunci: Kemampuan berfikir, Pemecahan Masalah, Level Metakonitif

Abstract

This research is motivated by the lack of students' understanding of their thinking skills and students cannot determine the right strategy to overcome the problems encountered in solving mathematical problems. The purpose of this study was to find out how the metacognitive level of students in solving math problem solving problems in class IX.1 students of SMPN 26 Padang. This type of research is descriptive quantitative. The subject of this research is class IX.1 SMP Negeri 26 Padang. The instruments used are tests and interviews. The test is used to determine the metacognitive level of students in solving problem solving problems. Interviews were used to find out more about the metacognitive level in terms of students' understanding. The results showed that as many as 35.71% of students were at the metacognitive level of Tacit Use, as many as 35.71% of students had the metacognitive level of Aware Use, and as many as 28.58% of students had the metacognitive level of Strategic use. Students who have a high group metacognitive ability score in the classroom are at the Strategic Use metacognitive level. Students who have a moderate group metacognitive ability score in the class are at the Aware Use metacognitive level. and students who have a low group metacognitive ability score in the class are at the metacognitive level of Tacit Use.

***Keywords**: Thinking Skills, Problem Solving, Metaconative Level*

INTRODUCTION

Mathematics is a basic science that is always related to human daily life so it needs to be studied at every level of education. (Sholihah & Mahmudi, 2015) said that mathematics is a subject given at all levels to equip students with the ability to think logically, analytically, systematically, critically and creatively. According to(Revelation Hidayat, 2018)in learning mathematics problem solving is the core of learning and as a basic ability in the learning process. From the opinion above, it can be concluded that learning mathematics cannot be separated from problem solving.

According to Suratmi (Mariam et al., 2019) in problem solving students must have good problem solving abilities that will help them in the learning process. (Yildrim & Ersozlu, 2013) Problem-solving skills are an important aspect of mathematics education because knowledge and thinking skills must be applied together in everyday life. Risnanosanti (Bulu & Slamet, 2015) states that there are five aspects of ability that must be mastered by students in order to be able to solve a problem, namely the ability about mathematical concepts, the ability about mathematical algorithm skills, the ability to process mathematics, the ability to be positive about mathematics and the ability to metacognition.

Brown(Hatip, 2016)argues that metacognition is the process of someone thinking about their own thinking in order to build strategies to solve a problem. Metacognition has an important role in solving mathematical problems such as regulating and controlling one's cognitive processes in learning and thinking, so that one's learning and thinking becomes more effective and meaningful.(Jalali & Ikram, 2018). Nur in(Hatip, 2016)argues that metacognition relates to students' thinking about their own thinking and their ability to use certain learning strategies appropriately.

According to Scharaw and Denniso, there are 2 components of metacognition, namely cognitive knowledge and cognitive regulation. According to (Rinaldi, 2017) knowledge of cognition refers to what individuals know about their own cognitive abilities or about what is cognitive in general, while cognitive regulation is a series of activities that help students control their learning process. From the description above, it can be concluded that controlling students' own thinking abilities such as understanding the thought process, determining the decisions to be taken, commitment to goals in order to be able to regulate their own learning activities so as to increase learning effectiveness.

Based on observations made during the after covid-19 at moment new normal, in class IX of SMP Negeri 26 Padang, information was obtained that learning was carried out face-to-face and online. Where in one week students study face to face and one week learn online at home. During online learning the teacher sends learning materials via WhatsApp. Meanwhile, during face-to-face learning the teacher reinforces the material that was previously sent online.

When face-to-face learning takes place when the teacher explains the learning material, many students do not pay attention to the teacher in front of the class, students are engrossed in chatting with friends, drawing in books, and playing mobile phones. When the teacher gives a question, it can be seen that the students are just silent and stare at each other. When the teacher appoints one of the students to answer the teacher's question, the student does not answer the teacher's question. From the description above, it can be seen that students are not aware of their level of ability and cognitive limitations and how strategies are used to overcome these limitations. The ability to be aware of cognitive limitations is part of metacognitive (Handel et al., 2013).

Based on the results of the students' math exercises, it was seen that the students had not been able to answer the questions given by the teacher correctly. The question given by the teacher is "A piece of wire has a length of 1m, the wire is formed into a rectangle with lengths x cm and y cm. The area of a rectangle is expressed as L(cm^2) The mathematical model for the area of a rectangle is ". The questions given by the teacher are questions of objective form, but the teacher asks students to write down answers complete with their solutions. The answers obtained from the student practice sheet are, students describe the length and width of the rectangle as 25cm, meaning that each side has a length of 25cm, obtained from the length of the wire 1m divided by four, then the students write down $f(x) = -x^2 + 25x$ obtion A. Metacognitive plays an important role in communication, reading, comprehension, language acquisition, social cognition, attention, self-control, self-instruction,writing, problem solving and personality development (Chauhan & Singh, 2014).

Students should illustrate the length of the wire as the perimeter of the rectangle, which $K = 2(p + l)$is $1m = 2(p + l)$simplified to $50 = p + l$. Then do the example p= x and l= y to $y = 50 - x$. Then the mathematical model for the area of a rectangle is$L = p \times l$ be $L = x * (50 - x)$ and get results $f(x) = -x^2 + 50x$. From this explanation, we can conclude that students did not plan and monitor their answers properly so that the answers

they got were wrong. (Akturk & Sahin, 2011) Good metacognitive allows students to plan, monitor, and evaluate their thinking processes during learning.

Based on the description above, in general we can conclude that the problem solving ability of students is still relatively low. And students do not understand how their own cognitive abilities and strategies to overcome these deficiencies. The ability to understand and cope with cognitive abilities is closely related to metacognition. Therefore, the author will conduct research on "Metacognitive Analysis of Students in Solving Mathematics Problems".

RESEARCH METHODS

The research method used in this research is descriptive quantitative method. The choice of quantitative descriptive method is based on the research objective which is to describe how students' metacognitive skills in solving math problems.

The subjects of this study were 14 students of class IX.1 of SMP Negeri 26 Padang. The selection of subjects by purposive sampling was chosen based on the consideration of the students' midterm exam minimum completeness criteria.

The instruments used are tests and interviews. The test is used to determine the metacognitive level of students in solving problem solving problems. The test was analyzed based on observations in terms of the problem solving process at each stage of problem solving. Interviews were used to find out more about the metacognitive level in terms of students' understanding. The results of the test with the results of the interviews were concluded based on the analysis using the students' metacognitive level indicators. The metacognitive level criteria (Hatip, 2016) are as follows:

Table 1. Metacognitive Level Criteria

Problem solving stage	Indicator	Level	Score
Planning	Students cannot explain the information contained in the questions Students do not understand the problem	*Tacit use*	1
	Students do not understand the problem Students have difficulty thinking about the concept to be used	*Aware use*	2
	Students can understand the problem Students have doubts about the concept (method) that will be used	*Semi-strategic use*	3

	Students can understand the problem Students can explain most of what they wrote	*strategic use*	4
	Students are able to realize the diversity of ways that can be used in problem solving	*Semi-reflective use*	5
	Students can be aware of the diversity of ways in solving problems and are able to explain them appropriately	*Reflective use*	6
Monitoring	Students are not aware of errors in the concepts and results obtained	*Tacit use*	1
	Students cannot continue what they are doing Students realize mistakes but can't fix them	*Aware use*	2
	Students realize mistakes but can't fix them Students are aware of appropriate strategies, but need help to convince	*Semi-strategic use*	3
	Students are aware of their mistakes and are able to give reasons that support their thinking	*strategic use*	4
	Students are aware of other strategies and are able to apply them to the same problem	*Semi-reflective use*	5
	Students are aware of other strategies and are able to apply them to the same problem and other problems	*Reflective use*	6
Evaluation	Students do not evaluate at all	*Tacit use*	1
	Students doubt the results obtained	*Aware use*	2
	Students look confused with the results obtained	*Semi-strategic use*	3
	Students do not evaluate	*strategic use*	4
	Students evaluate only on certain steps	*Semi-reflective use*	5
	Students evaluate each step and are sure of the results obtained	*Reflective use*	6

In order to find out more, the researcher presented the data from the metacognitive level analysis of each group. Groups were made based on students' metacognitive scores from tests and interviews in solving problem solving. There are three categories of groups,

namely high, medium and low groups. The classification of the score categories uses the method of determining the student's position using the standard deviation.

RESULTS AND DISCUSSION

Result

The data used for analysis is the results of student tests and student interviews in solving problems that have been given, regarding the material congruence and similarity. The data were identified based on the students' metacognitive level based on predetermined indicators. Congruence and similarity problem solving test questions are given to students after students study the material. In the following, data regarding the acquisition of test results and student interviews are presented which are analyzed based on indicators of metacognitive level in problem solving.

Table 2. Results of Metacognitive Analysis of Class IX 1 Students of SMPN 26 Padang

Metacognitive Level	**Total students**	**Percentage (%)**
Tacit Use	5	35.71%
Aware Use	5	35.71%
Semi-Strategic Use	0	0
Strategic Use	4	28.58%
Semi Reflective Use	0	0
Reflective Use	0	0
Amount	14	100%

Based on Table.2 it can be seen that as many as 5 or 35.71% of students are at the *Tacit Use metacognitive level* , as many as 5 or 35.71% of students have the *Aware Use metacognitive level, and as many as 4 or 28.58% of students have the Strategic use* metacognitive level.

Discussion

1. High group students

Table 3. Problem Solving Results of High Group Students

Student's name	Problem 1	Problem 2	Problem 3	Conclusion Metacognitive Level
S-1	*Strategic Use*	*Tacit Use*	*Strategic Use*	*Strategic Use*
S-2	*Tacit Use*	*StrategicUse*	*Strategic Use*	*Strategic Use*
S-3	*Aware Use*	*Strategic Use*	*Strategic Use*	*Strategic Use*
S-7	*Aware Use*	*Strategic Use*	*Strategic Use*	*Strategic Use*

Based on Table 3, students who have high abilities (high group students) are at the metacognitive level of strategic use. The indicators that are met by students at the strategic use level in problem solving are at the planning stage students understand the problem and can express it clearly, students do not experience doubts about concepts or calculations and students are able to explain what they have written. For the monitoring stage students are aware of suitable strategies and concepts so that they can solve problems, if there are errors, students can realize mistakes and are able to provide reasons that support their thinking. And for the evaluation stage, students do not evaluate less.

The following are the results of the written test of representatives of high category students (Subject-7) in solving congruence and similarity problems in solving math problems in question no. 3 with the question: "A student with a height of 150 cm faces the flagpole on a sunny morning. The length of the shadow of the student is 2.5 m and the length of the shadow of the flagpole is 6 m. Determine the height of the flagpole!" In this question, students in the high category (subject-7) are at the metacognitive level of strategic use.

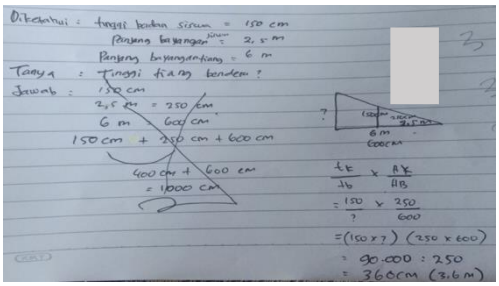

Figure 1. S-7 work

Based on Figure 1 it can be seen that the writing is known and asked. S-7 wrote down data that was known completely and was asked in full, namely the student's height was 150 cm, the student's shadow length was 2.5 m, and the pole's shadow length was 6 m. This indicates that students are able to identify information in the problem and students are able to construct questions in the form of images clearly. So S-7 has written down the known data and was asked to plan a solution to the problem, namely finding the height of the flagpole.

Based on the description above, it can be concluded that students in the high category understand the problem because they can clearly write down the information contained in the problem. In addition, high category students can explain the problems contained in the questions and can explain the method to be used in the questions. This was shown when the researcher conducted interviews with high category students about the information contained in the problem in the problem. The student answered "From the questions that I read, sir, in the problem that is known the student's height is 150 cm, then the student's shadow is 2.5 m long, then the pole's shadow is 6 m long". Then the researcher asked about the material related to the problem in the problem, the students answered "The material is about congruence and congruence, right? In congruence, the formula is not the ratio of small and large wakes.

Based on the analysis of the tests and interviews, it can be concluded that students in the high category do the planning properly because they can understand and be aware of the information contained in the questions. High category students in problem solving activities meet metacognitive indicators at the *Strategic use level* .

In Figure 1 it can be seen that there is an answer written, which means answered. In this section S-7 has written a picture construction about the problem and how to solve the problem. Based on the results of completing the S-7 it can be seen that students were confused and made mistakes when carrying out the completion, but students were aware and then justified it with the right and correct steps. This indicates that students carry out the monitoring process when solving problem solving.

Based on the description above, it can be concluded that students in the high category can realize misconceptions about concepts and how to calculate and can realize suitable strategies and use them directly to solve problems. Students with a high category can also explain solutions coherently. This was shown when the researcher conducted interviews with

high category students about how the steps were taken by students in solving problem solving, the students answered "After describing it, it turns out that the picture is in the form of small and big triangles, right? So, the formula I use is the ratio of the height of the small and large triangles to the ratio of the base lengths of the small and large triangles. Let me compare the height of the small triangle for the student, right, and for the big triangle for the flagpole, miss." From the students' explanations, it can be seen that students are able to solve problems, and students are able to provide reasons that support their thinking. This is supported by student statements about what obstacles were encountered during the completion process as follows "at first I was confused, OK, I tried to change the units, OK, then I added them up, the result was too big, I thought it was impossible for the flagpole to be very high, OK? After that, I'll try to describe it, Sis."

Based on the description above, at the monitoring stage students are in the high category. The activities carried out by students in the high category in solving mathematical problems meet the metacognitive indicators at the *strategic use level* .

From the results of the student's completion in Figure 1 it can be seen that S-7 did not write down the conclusions from the results of the solution. However, S-7 students sometimes check the results of their completion. This was shown when the researcher conducted interviews with high category students regarding whether students checked the stages of completion, students answered "sometimes not". This proves that students do less evaluation. The activities carried out by students in the high category in solving mathematical problems at the evaluation stage meet the metacognitive indicators at the *strategic use level* .

Based on written data and interviews, it was found that Subject-7 could understand the problem correctly, plan steps to solve the problem correctly, carry out monitoring activities and sometimes carry out evaluation activities. Based on the results of the analysis and suitability with the indicators in Table 1, subject-7 is at the *Strategic Use metacognitive level* . Because students are able to find suitable strategies and are able to provide reasons that support their thinking in solving problems. This is in line with research conducted (Laurens, 2010), subjects at the *strategic use level* are able to realize strategies and directly use these strategies, and the use of these strategies can raise awareness of what is thought.

2. Medium Group Students

Table 4. Problem Solving Results of High Group Students

Student's name	Problem 1	Problem 2	Problem 3	Conclusion Metacognitive Level
S-4	*Aware Use*	*Aware Use*	*Strategic Use*	*Aware Use*
S-5	*Tacit Use*	*Tacit Use*	*Strategic Use*	*Tacit Use*
S-6	*Aware Use*	*Tacit Se*	*Strategic Use*	*Aware Use*
S-8	*Aware Use*	*Aware Use*	*Strategic Use*	*Aware Use*
S-9	*Aware Use*	*Aware Use*	*Strategic Use*	*Aware Use*
S-10	*Aware Use*	*Aware Use*	*Strategic Use*	*Aware Use*

Based on Table 4, students who have moderate ability (medium group students) are at the metacognitive level of aware use. The indicators that are met in problem solving are that at the planning stage students do not understand the problem and are only able to explain part of what they have written. At the monitoring stage, students are unable to realize or correct the conceptual and arithmetic errors that they do. At the evaluation stage, students did not carry out the evaluation stage and doubted the results obtained.

The following are the results of the students' written test in the medium category (Subject-8) in solving the mathematical problem solving problem of congruence and congruence material on question no. 2 with the question "Vienna has a convection business. To find out the fabric material needed. Before producing in large quantities, he made a small sample of clothes with a scale of 1:4 to the actual size. It turns out that for one sample requires a cloth of 0.25 . How much cloth will he need if he gets an order to produce 1,000 shirts?"m^2

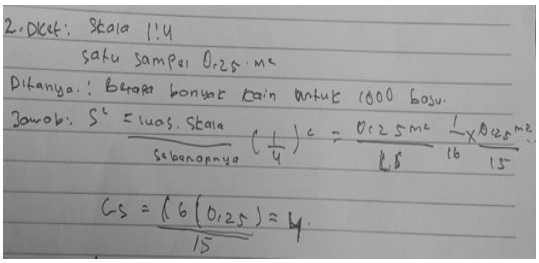

Figure 2. S-8 Work

Figure 2 at the planning stage it can be seen that S-8 was able to understand the problem correctly. S-8 wrote down the known data and was asked from the questions to solve the problem, that is, it was known that the scale was 1:4 and for one sample it was 0.25 . For those asked, S-8 wrote that the person being asked how much cloth is for 1,000 clothes. S-8 can also explain the information contained in the problem, this is evidenced by the results of interviews with S-8 "it is known that the scale is 1:4, then to make one sample requires cloth of 0.25 mbuk . Then the question is how much cloth is needed to make 1000 clothes.

Results of the S-8 tests and interviews, it meets the metacognitive indicators, namely students understand the problem because they can express it clearly and students can explain most of what they write. The activities of students in the moderate category (Subject-8) meet the metacognitive indicators at the *Strategic Use level* .

In Figure 2 at the S-8 monitoring stage you can also see the answer written which means the student is solving the problem. At this stage it can be seen that students use the scale formula to find the actual area. The formula used by S-8 is correct , but S-8 does not complete the problem solving. Students did not answer what was asked by the question, namely finding the cloth needed to make 1000 clothes.

Based on the analysis above, S-8 does not carry out monitoring activities in metacognitive activities which include not being able to solve the problem completely or not being able to continue what was being done. This conclusion is reinforced by the results of the researcher's interview with S-8 regarding the steps taken to solve the questions. And the students answered "I used the volume scale formula to find the actual area, the result was 4 volumes". From the answers students have not found an answer that is in accordance with what is asked by the question. Then the researcher asked questions about what was asked. The student answered that what was asked was the cloth needed to make 1000 clothes. From this statement it can be seen that students experience confusion and cannot continue their completion.

Test and interview data it was found that the S-8 in the problem solving monitoring phase of the students experienced confusion and was unable to continue working, realized a conceptual or calculation error but was unable to fix it. S-8 activity fulfills the metacognitive indicator activity at the *Aware Use level* .

Based on Figure 2 it can be seen that students did not write down the conclusions from the solutions made. This shows that students do not carry out the evaluation process. This opinion was reinforced by the results of the researcher's interview with the S-8 about whether the S-8 checked each work, the students answered that they forgot to check it.

The results of tests and interviews with student representatives in the medium category (Subject-8) above show that at several stages they are at the strategic use level and at the aware use level. Because the dominant metacognitive level in the medium category is aware use, the metacognitive level in the medium category is *aware use* . because students in the middle category cannot continue what they are doing and cannot correct mistakes in problem solving even though they are aware of it. This is in line with the research conducted by (Nurjanah, 2017), based on the results of the analysis and suitability with the metacognitive level criteria indicators of group students being at the *aware use level* . Because group students are not able to solve the problem until it is complete

3. Low Group Students

Table 5. Problem Solving Results of Low Group Students

Student's name	Problem 1	Problem 2	Problem 3	Conclusion Metacognitive Level
S-11	*Tacit Use*	*Tacit Use*	*Tacit Use*	*Tacit Use*
S-12	*Tacit Use*	*Tacit Use*	*Tacit Use*	*Tacit Use*
S-13	*Tacit Use*	*Tacit Use*	*Aware Use*	*Tacit Use*
S-14	*Semi-Strategic Use*	*Tacit Use*	*Tacit Use*	*Tacit Use*

Table 5. students have low abilities (low group students) the results of the analysis of the completion of questions 1,2, and questions 3 are at the tacit use level. The indicators that are met by students at the tacit use level in problem solving are that at the planning stage students cannot explain the problem clearly. At the monitoring stage students do not show any awareness of what is being monitored, students are not aware of conceptual errors and

the results obtained. At the evaluation stage, students do not carry out the evaluation process at all.

The following are the results of the written test of S-11 students in solving mathematical problem solving problems with congruence and congruence material:

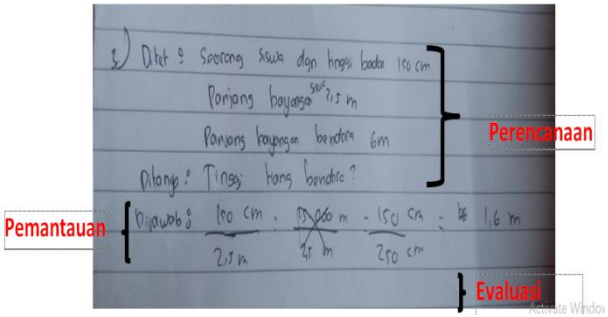

Figure 3. S-11 Work

Figure 3 it can be seen that students write down by writing "a student with a height of 150 cm, the length of the student's shadow is 2.5m, and the length of the flag's shadow is 6m" and asked the height of the flagpole. S-11 has written down known data to plan problem solving, namely writing down what is known and asked correctly and correctly. However, it looks like they are not using their own language but copying what is in the problem.

Based on the description above, it can be concluded that students in the low category understand the problem because they can clearly write down the information contained in the problem. However, this is not in line with the results of the low category student interviews because when asked what material is related to the question the students answered "I don't know about related material, for the formula I don't use the formula." From student statements we can conclude that students do not understand the problem.

Based on the results of the interview S-11 can state what is known and asked correctly. However, students do not know the concept (formula) and the method that will be used to solve the problem solving. Student activity in problem solving at the planning stage fulfills metacognitive indicators at the *semi-strategic use level* .

In Figure 3, the low category student test results at the monitoring stage show that students do not understand the problem. It can be seen that S-11 writes 150cm divided by 2.5 m and gets the result 1.6. From the answer, the settlement made by S-11 was not correct because the concept used was not clear and the calculations were also wrong. This statement is in line with the results of the researcher's interview with S-11 regarding the steps taken by

students to solve problem solving. Then the researcher asked whether the steps used were correct, the students answered "No, because I was just trying to answer it, sir". From the student statements it can be seen that the students did not show any awareness to monitor their progress.

Based on the results of the S-11 interviews, information was obtained that students did not know the correct concepts and calculations to solve problems, and students were not sure about the results of their solutions. Student activity in problem solving in the monitoring phase fulfills the metacognitive indicators at the *tacit use level* .

In Figure 3 the results of the S-11 completion test at the evaluation stage can be seen that, students in the low category do not conclude the results of their completion, this means that the S-11 does not carry out the evaluation process. This statement was reinforced by the results of the researcher's interview with S-11 who asked whether students were doing student evaluations . From this statement it can be seen that students do not evaluate their answers because students do not understand what they are doing.

From the test and interview results, it can be concluded that students in the low category in problem solving at the evaluation stage are at the tacit use level, because students do not evaluate.

The results of tests and interviews with representatives of low category students (Subject-11) above show that in several stages they are at the level *of semi-strategic use* and are at the level of tacit use. Because the dominant metacognitive level in the low category is *tacit use* , the low category metacognitive level is *tacit use* . Because low category students do not show awareness of what is being monitored, are not aware of misconceptions and results and do not carry out the evaluation process. This is in line with research conducted by (Rambe et al., 2015), students who have low abilities are at the *tacit use metacognition ability level* . (Wahyuningsih & Waluya, 2017) Tacit use students, students who only answer carelessly, are less able to organize strategies in solving problems so they have low scores in the aspects of *planning* , *monitoring* , and *evaluation.*

CONCLUSION

Based on the results of research and discussion, this study obtained the following conclusions:

1. As many as 35.71 % of students are at the *Tacit Use* metacognitive level , as many as 35.71% of students have the *Aware Use metacognitive level, and as many as 28.58% of students have the Strategic use* metacognitive level .
2. Students who have a high group metacognitive ability score in the class are at the *Strategic Use metacognitive level* . Students who have moderate group metacognitive ability scores in the class are at the *Aware Use metacognitive level* . and students who have low group metacognitive scores in the class are at the *Tacit Use metacognitive level*

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