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Analysis of Metacognition Levels Ability in Solving Problem in Science Learning Based on Gender Differences

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ABSTRACT

Metacognition has a role in regulating and monitoring one's cognitive processes in thinking and learning. Students can solve problems well when applying metacognition strategies. Each student has different abilities in understanding learning material. Where male and female students have different ways of thinking, as well as solving a problem. This study aims to describe the level of metacognitive abilities of male and female students in solving problem-based questions in science learning. This type of research is descriptive qualitative research. This research was conducted at MTs Al-Islam by taking three male and three female subjects. The selection of subjects is based on the value of student learning outcomes which are limited by a certain standard deviation. This study used written tests and interviews as instruments for data collection. The results are 1) Male students in the high category are at the strategic use level, male students in the medium category are at the aware use level and male students in the low category are at the tacit use level. 2) Female students in the high category are at the level of reflective use, female students in the middle category are at the level of strategic use and female students in the low category are at the level of aware use.

Keywords: Metacognition Ability, Problem-Based Questions, Science, Gender

INTRODUCTION

Science learning focuses on the process. Lestari stated that in science learning the metacognition ability is very necessary. Considering that in the science learning process students are required to be able to plan, monitor and evaluate their learning process, so that students can find and relate the concepts they have been looking for through their metacognitive abilities. (Septiyani et al., 2019). Curriculum renewal requires teachers to be able to change learning activities that were originally teacher-centered into learning activities for students, where teachers are facilitators in cultivating students' abilities and equipping students with skills so that students live as independent individuals. So, choosing a learning strategy is very important because it is to improve the quality of learning.

Improving the quality of learning is done by empowering students' metacognitive skills. Students are required to be familiar with knowing the reasons and purposes for doing something. Metacognitive ability is the ability of students to understand their strengths and weaknesses so that they can think of several things that need to be done in the future (Dewi et al., 2016). In line with the opinion of Gul and Shehzad, Jaafar, and Job who stated that metacognitive knowledge is related to cognition ideas such as knowledge about good abilities and strategies in student activities to enhance learning and has great potential in increasing student learning understanding in class. (Siagian et al., 2019). The indicators of metacognitive abilities according to Jacob are identification of problem characteristics, construction of relationships between previous knowledge and new knowledge, planning problem-solving activities, elaboration, solving problems, using and selecting appropriate settlement procedures in solving problems, summarizing information that has been done in solving problems, and student reflection (Zulyanty et al., 2017).

One approach that can be applied to learning is the problem-solving approach. Solving a problem is an effort made to get a solution to the problem at hand. This approach is applied so that students have sufficient provisions in solving various forms of problems in learning science. In addition, the problem-solving approach will also be useful for students to form ways of thinking in solving an existing problem. Ibrahim and Nur explained that one of the learning approaches used so that students can think at a higher level which leads to problems in real life is to apply problem-based learning (Oktaviani & Tari, 2018). Metacognition ability is related to the examining of cognitive elements that enable students to understand a problem that is being faced and then tries to find information and carry out investigations to find solutions to the problem (Dewi et al., 2016).

Metacognition has an important role in regulating and controlling individual mindsets to solve a problem (Huda et al., 2021). Ormrod and Özcan stated that students who have good metacognitive abilities in solving problems will also have good learning processes and achievements. In line with the opinion of Iswahyudi and Kamid who stated that students who have high metacognitive abilities are better at solving mathematical problems than students who have low metacognitive abilities (Mayasari et al., 2019). This shows that metacognition has an important role in solving a problem.

Each student has different abilities in understanding learning material. Where male and female students have different ways of thinking, as well as solving a problem. The results of Zhu's research concluded that male and female students have different ways of solving math problems. The methods used by female and male students determine the metacognitive strategies used when they solve a problem (Sudia, 2015). Swartz and Perkins suggested the level of students' metacognitive abilities in solving problems, including the following:

a. *Tacit use* is the process of using the mind without awareness. When making a decision, it is done without thinking about the decision. In this case, students use strategies without special awareness or just try and answer when solving problems.
b. *Aware use* is the process of using the mind with awareness. This type of thinking is related to awareness of what and why to do the thinking. In this case, students are aware of the steps that will

be used in solving the problem by providing an explanation of the reasons for choosing the implementation of these steps.

c. *Strategic use* is the process of using a strategic mind. This type of thinking is related to how a person consciously manages his thinking process and uses specific strategies that can increase the accuracy of his thinking. In this case students have awareness and can choose the right strategy for solving problems.
d. *Reflective use* is a process of using the mind that is reflexive. This type of thinking is related to a person's reflection on the thought process before and after even during the process by reviewing the continuity and improvement of the results of his thinking. In this case, the students are aware of and will correct the wrong steps taken when solving the problem (Swamp, 2020)

Seeing from the results of the interviews conducted in the field, the researcher is interested in researching students' metacognition abilities in solving problem-based questions because there are several potentials in the science learning process, one of which is the learning media used by teachers has varied, namely using media pictures and visual aids. . In the process of learning science in schools, teachers have implemented problem-based learning where problem-based learning is carried out individually or in groups. The division of groups is carried out by the teacher so that students can work together in completing assignments. Metacognition has a role in regulating and monitoring one's cognitive processes in thinking and learning (Wahyuningtyas et al., 2020). Metacognition ability can be used as a basis for measuring students' abilities in solving a problem. From this background, the researcher took the research title "Profile level of metacognition ability in solving problem-based questions in science learning based on gender differences."

PURPOSE

The purpose of this research are as follows:

1. To determine the level of metacognitive abilities of male students in solving problem-based questions in science learning.
2. To determine the level of metacognitive abilities of female students in solving problem-based questions in science learning.

RESEARCH QUESTION

The questions in research this are as follows:

1. What is the level of metacognitive abilities of male students in solving problem-based questions in science learning?
2. What is the level of metacognitive abilities of female students in solving problem-based questions in science learning?

METHOD

The type of research to be conducted is descriptive qualitative research using a naturalistic or natural design. Descriptive research is focused on describing a situation or phenomenon as it is. The design of this study is to select several samples that have different levels of ability to know and analyze the level of metacognition ability in solving problem-based questions in terms of gender differences in students. The role of researchers in research with a qualitative approach is very important in the process of selecting research subjects, conducting data collection, and data analysis. Researchers also play a role in the success of a study and

as a benchmark for the suitability of research objectives

The subjects of this study were students of class VIII. The selection of subjects is based on the learning outcomes of students which will be grouped into three categories, namely students with high, medium, and low learning outcomes. This grouping is limited by a certain standard deviation. After obtaining the learning outcomes of the students, the average value and standard deviation (SD) of the learning outcomes value data are then determined, then the limits for each group are determined. Researchers took samples in each category based on the suggestions and recommendations given by science subject teachers where these students had good communication skills

To obtain data about the level of metacognition ability in solving problems in science learning based on gender differences, in this study, the data collection technique used was a written test in the form of problem-based questions on substance stress material, interviews with students about how the students chose in solving problem-based questions that have been given, as well as documentation in the form of answer sheets for students' problem-based test questions about substance stress, interview transcripts and also pictures so that research is more accurate. While the data analysis technique used is using the Miles and Huberman model where the steps of this technique include data reduction, data presentation, and conclusion.

RESULT AND DISCUSSION

The research data was obtained based on the results of solving problem-solving test questions and the results of interviews with research subjects who had been selected with the categories of high, medium, and low learning outcomes. From the results of the subject's job analysis in completing the problem-solving sheets given in this study, there were several different metacognition activities for each subject. The high, low, and medium categories of male and female subject metacognition activities can be described as follows.

The level of metacognitive ability of male students in solving problem-based questions in science learning

a. High category subject

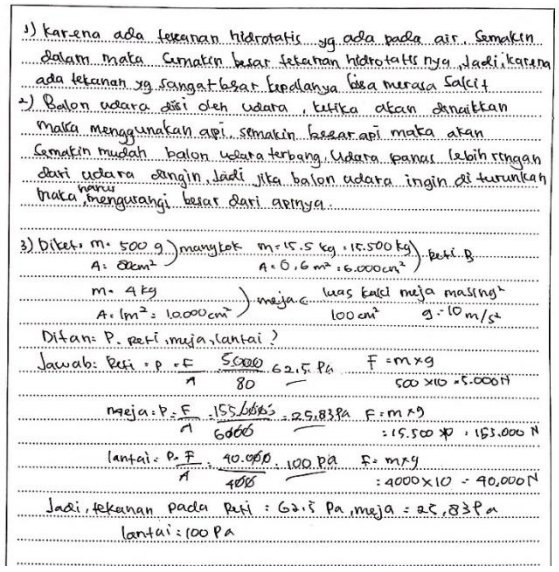


Figure 1. Answers to Problem-Solving Subjects LT

The answers written by the LT subject showed that the LT was able to answer questions 1 and 2 correctly. LT subjects were able to relate concepts in answering questions and concluding answer number 1 but did not conclude answer number 2. Based on Figure 1 it can be seen that the LT subject's first step in solving problem number 3 was to write down the mass and surface area of the bowl, and the mass and surface area of the table. , the mass and surface area of the crate, as well as the area of each table base, but the units that should

be changed are not correct. Subject LT changed the surface area of the table to 10,000 cm^2, changed the mass of the crate to 15,500 grams, and changed the surface area of the crate to 6,000 cm^2. Then write down the questions asked in the form of pressure on the table, crate, and floor. Answer the questions by writing down the formula first. The formula used by subject LT to solve problem number 3 is P = F / A where before calculating the pressure on the crate, table and floor subject LT1 first calculates the compressive force with the formula F = m x g. The LT subject also wrote down the conclusions of the calculations performed. The conclusion written by the subject LT is that the pressure on the crate = 62.5 Pa, the pressure on the table = 25.83 Pa, and the pressure on the floor = 100 Pa.

Paying attention to the results of the written answers in Figure 1, an interview was then conducted to clarify the process of solving the LT subject test questions. The results of the interviews showed that the LT subject was able to understand the problem and explain what he wrote but felt confused when changing units of mass and surface area. The LT subject was able to explain the concept and was able to explain the formula that would be used to solve question number 3. The LT subject was able to apply the formula to be used in the calculations but there was confusion when working on it so the answer was wrong and only realized there was an error in the calculation during the interview. Subject LT already did a re-examination of the answer but was only limited to reading it. LT subjects were also able to draw some conclusions from their answers.

b. Medium category subject

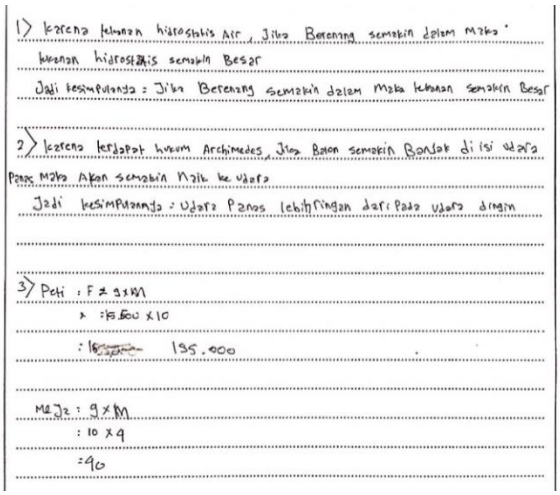


Figure 2. Answers to LS Subject Problem Solving Questions

The answers written by the LS subject indicated that the LS was able to answer question number 1 but the answer to question number 2 did not match the question given. The LS subject wrote a conclusion at the end of his answer. It can be seen from figure 2 that the steps taken by subject LS1 in solving question number 3 were to write down the answers immediately. The LS subject did not write down what was known and was asked first and immediately answered the questions using the formula F = m x g. The LS subject did not write down the conclusions from the calculations that had been carried out and did not write down the final unit of the answer.

Paying attention to the results of the written answers in Figure 2, an interview was then conducted to clarify the process of solving the LS subject test questions. The results of the interviews showed that the LS subject could understand the problem but only explained part of what he wrote. The LS subject was able to explain the concept but had not been able to explain the formula that would be used to solve question number

3. The LS1 subject could apply the formula that would be used to perform calculations but could not continue with what was to be done. Subject LS1 already deidre-checked the answer but only re-reading the answer. The LS1 subject was also able to conclude the answer.

c. Low category subject

The answer written by subject LR in question number 1 corresponds to the question given, LR is able to answer the question correctly but is not quite right in writing the answer to question number 2. Based on figure 3 it can be seen that subject LR completed question number 3 by writing the formula W = m x g then immediately doing the calculations with the formula. The LR subject did not write down what was known and was asked beforehand and also did not write down the conclusions from the calculations that had been carried out.

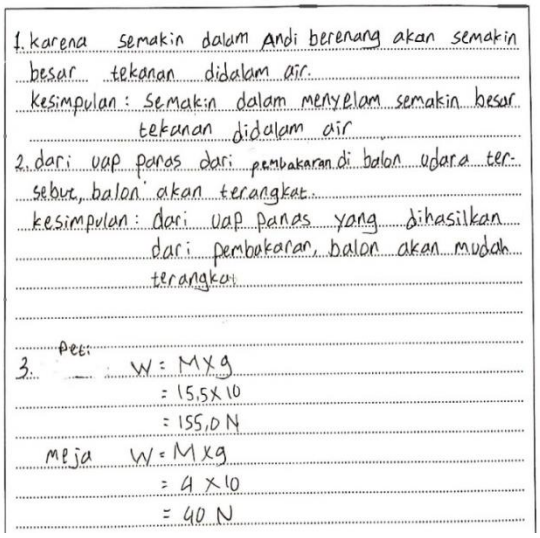

1. karena semakin dalam Andi berenang akan semakin besar tekanan didalam air.
Kesimpulan : Semakin dalam menyelam semakin besar tekanan didalam air
2. dari uap panas dari pembakaran di balon udara ter: sebut, balon akan terangkat.
kesimpulan : dari uap panas yang dihasilkan dari pembakaran, balon akan mudah terangkat
Pet:
3. W = M x g
= 15,5 x 10
= 155,0 N
meja W = M x g
= 4 x 10
= 40 N

Figure 3. Answers to LR Subject Problem Solving Questions

Paying attention to the results of the written answers in Figure 3, an interview was then conducted to clarify the process of solving the LR subject test questions. The results of the interviews showed that the LR subject knew the problems presented but was unable to explain the problems clearly. The LR subject was only able to name the formula that would be used to solve question number 3 but had not been able to solve the problem correctly. Subject LR1 did not perform a re-examination of the answer and also has not been able to conclude the answer.

Based on the description and analysis of male subjects, it is known that the level of metacognitive ability in solving problem-based questions has differences between students in the high, medium, and low categories. It can be seen from the above data exposure, students with high categories are at a level of Strategic Use In solving problem-based questions in science learning. Where male students in the high category met almost all of the metacognition indicators, it's just that on the indicators they checked the results again, and the subjects only checked their answers in only a few steps.

Students in the moderate category are at the Aware Use level in solving problem-based questions in science learning. From the metacognition indicators it can be seen that students can understand the problem but only explain part of what they wrote at the stage of understanding the problem, can explain the concept but have not been able to explain the formula that will be used to solve the problem at the planning stage of solving the problem, can apply the formula that will be used to perform calculations but cannot continue what will be done at the stage of carrying out problem-solving and at the re-examination stage students have re-examined their answers but only reread the answers.

Meanwhile, students in the low category are at the Tacit Use level in solving

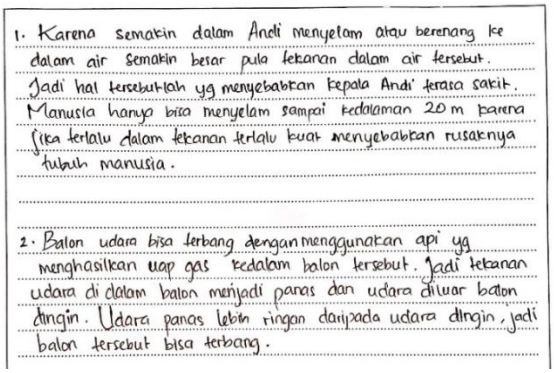
problem-based questions in science learning. This can be seen from the metacognition indicators which show that students only know the problems presented but are unable to explain the problem clearly at the stage of understanding the problem, are only able to mention the formula that will be used to solve the problem at the planning stage of problem-solving, have not been able to solve the problem correctly at the stage of carrying out problem-solving and at the stage of re-examining the results obtained students do not re-examine their answers and are also not able to conclude the answers.

In the research conducted by Kamid, it was found that in preparing the steps for solving problems, male students did well, and male students were also aware of the correct method used to solve the problem. Male students do not forget to check every step of problem-solving that is done (Kamid, 2013). The results of this study were different from what the researchers did where the results showed that the male subjects examined their answers, only read them, and did not check all the steps, some did not re-examine because they only answered questions. This means that students do not have sufficient knowledge to solve these problems. According to E. Ibrahim Zakaria and Siti Mistima Maat, a student's mistake in solving a problem occurs in a misunderstanding, a transformation error, and an error in the settlement process. The reason is that students are less careful in solving problems (Zakaria & Maat, 2010).

Level of the metacognitive ability of female students in solving problem-based questions in science learning

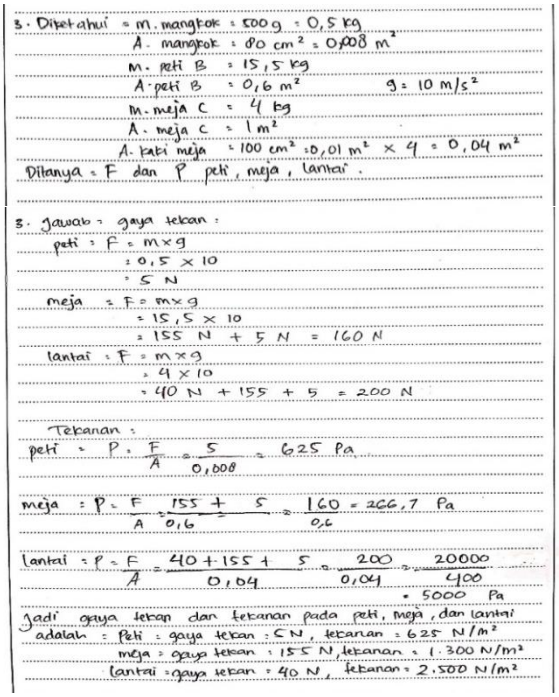
a. High category subject

The answers written by the PT subject indicated that the PT was able to answer question number 1 by the concept and was able to conclude the answer. Subject PT1 also answered question number 2 correctly and was able to conclude her answers.


1. Karena semakin dalam Andi menyelam atau berenang ke dalam air semakin besar pula tekanan dalam air tersebut. Jadi hal tersebutlah yg menyebabkan kepala Andi terasa sakit. Manusia hanya bisa menyelam sampai kedalaman 20 m karena jika terlalu dalam tekanan terlalu kuat menyebabkan rusaknya tubuh manusia.

2. Balon udara bisa terbang dengan menggunakan api yg menghasilkan uap gas kedalam balon tersebut. Jadi tekanan udara di dalam balon menjadi panas dan udara diluar balon dingin. Udara panas lebih ringan daripada udara dingin, jadi balon tersebut bisa terbang.

Figure 4. Answers to PT Subject Problem-Solving Questions Number 1 and 2


3. Diketahui = m. mangkok = 500 g = 0,5 kg
A. mangkok = 80 cm² = 0,008 m²
M. peti B = 15,5 kg
A. peti B = 0,6 m² g = 10 m/s²
M. meja C = 4 kg
A. meja C = 1 m²
A. kaki meja = 100 cm² = 0,01 m² × 4 = 0,04 m²
Ditanya = F dan P peti, meja, lantai.

3. jawab = gaya tekan :
peti = F = m × g
= 0,5 × 10
= 5 N
meja = F = m × g
= 15,5 × 10
= 155 N + 5 N = 160 N
lantai = F = m × g
= 4 × 10
= 40 N + 155 + 5 = 200 N

Tekanan :
peti = P = F/A = 5/0,008 = 625 Pa
meja = P = F/A = 155 + 5/0,6 = 160/0,6 = 266,7 Pa
lantai = P = F/A = 40 + 155 + 5/0,04 = 200/0,04 = 20000/400 = 5000 Pa
Jadi gaya tekan dan tekanan pada peti, meja, dan lantai adalah : Peti : gaya tekan : 5 N, tekanan : 625 N/m²
meja : gaya tekan : 155 N, tekanan : 1.300 N/m²
lantai : gaya tekan : 40 N, tekanan : 2.500 N/m²

Figure 5. Answers to PT Subject Problem-Solving Questions Number 1 and 2

Based on Figures 4 and 5, it can be seen that the first step of the PT subject in solving problem number 3 was to write down the known mass of the 500-gram bowl which was changed to 0.5 kg, the surface area of 80 cm box which was changed to 0.008 m^2, the mass of the crate 15.5 kg, the surface area of the crate is 0.6 m^2, the mass of the table is 4 kg, the surface area of the table is 1 m2 and the area of each table leg is 100 cm2 which is converted to 0.01 m^2. The second step taken by the PT subject was to write down the questions in the form of compressive forces and pressure on tables, crates, and floors. The PT subject looked for the value of F on the crate table and floor first with the formula F = m x g. After that, calculate the P value of crates, tables, and floors with the formula P = F / A. The PT subject also wrote down the conclusions from the calculations that had been done. The conclusion written by the PT subject is that the crate compressive force = 5 N, the table compressive force = 160 N.

Paying attention to the results of the written answers in Figures 4 and 5, interviews were then conducted to clarify the process of completing the PT subject test questions. The results of the interviews showed that PT subjects were able to understand the problem and explain what they wrote. PT subjects were able to explain concepts and how to solve problems. PT subjects can apply the formula to be used in calculations and can conclude their answers. PT subject has done-examine the answer and can justify the mistake.

b. Medium category subject

The answers written by subject PS1 show that PS can answer question number 1 correctly and follow the concept. The PS subject also answered question number 2 correctly and by the questions given and was able to conclude his answers. Based on Figure 6, it can be seen that in solving question number 3, the PS subject immediately wrote down the formula to perform the calculation. The formula used is P = m x g / A. Subject PS did not write down what was known and was asked first. The PS subject also did not write down the conclusions from the calculations that had been made.

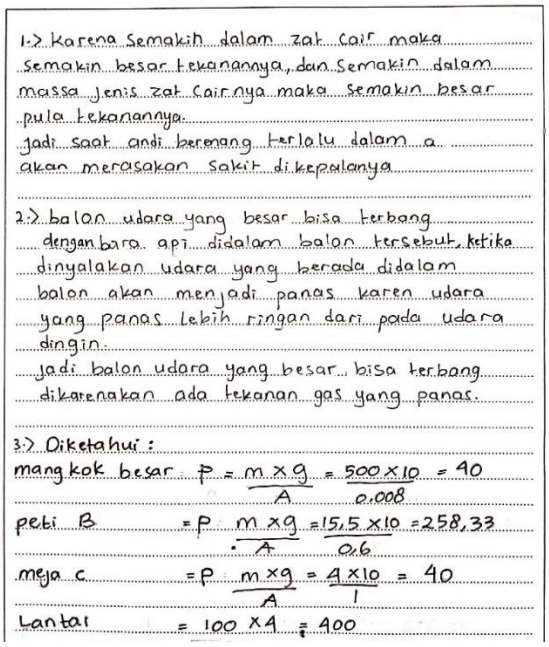


Figure 6. Answers to Problem-Solving Subject PS

Taking into account the results of the written answers in Figure 6, interviews were then conducted to clarify the process of completing the PS subject test questions. The results of the interviews showed that the PS subject was able to understand the problem and explain what he had written. PS subjects can explain concepts and how to solve problems. PS subjects can apply the formula to be used in calculations and can conclude their answers. PS subject already deidre-checking the answer but not at every step taken.

c. Low category subject

As seen in figure 7, the first step for the homework subject in solving problem number 3 is to write down the known mass of the bowl 500 grams, the surface area of the crate 80 cm^2, the mass of the crate 15.5 kg, the surface area of the crate 0.6 m^2, the mass of the table 4 kg, the area of each - each table leg is 100 cm^2 and the acceleration due to gravity is 10 m/s^2. The second step taken by the PR1 subject was to write down what was asked in the form of pressure on the table, crate, and floor. Subject PR1 first looked for the value of F on the crate table and floor with the formula F = m x g. After that, calculate the P value of the crate table with the formula P = F / A. The homework subject does not write down the conclusions from the calculations that have been done.

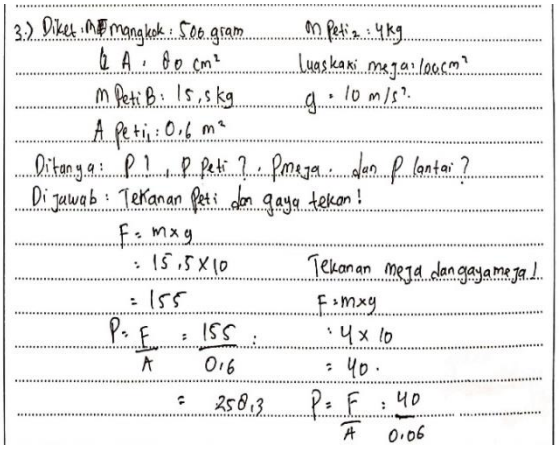


Figure 7. Answers to PR Subject Problem Solving Questions

Paying attention to the results of the written answers in Figure 6, interviews were then conducted to clarify the process of solving the PR subject test questions. The results of the interviews showed that PR subjects were able to understand the problem and explain what they wrote. PR1 subject was able to mention the concept and mention the formula to be used in the calculations. PR1 subject can apply the formula to be used in calculations and is only able to conclude part of the answer. PR1 subject has done-checked the answer but was not sure of the results he got.

Based on the description and analysis of female subjects, it is known that there are differences in the level of metacognition ability in solving problem-based questions between students in the high, medium, and low categories. It can be seen from the above data presentation, students with high categories are at the Reflective Use leveling solving problem-based questions in science learning. Female students in the high category can fulfill all metacognition indicators in solving problem-based questions. Swartz and Perkins suggest that students who reach the Reflective Use level in the process of thinking before and after even while the process is running by reviewing the continuity and improvement of the results of their thinking.

Students in the moderate category are at the level of Strategic Use In solving problem-based questions in science learning. Where female students in the medium category almost fulfilled all the metacognition indicators, it's just that on the indicators of re-checking the results, students have re-examined their answers, but not at every step taken.

While students in the low category are at the level Aware Use In solving problem-based questions in science learning. From the metacognition indicators it can be seen that students can understand the problem but only explain part of what they wrote at the stage of understanding the problem, can explain the concept but have not been able to explain the formula that will be used to solve the problem at the planning stage of solving the problem, can apply the formula

that will be used to perform calculations but cannot continue what will be done at the stage of carrying out problem-solving and at the re-checking stage students have re-examined their answers but only re-read the answers.

In the research conducted by Muhammad Sudia, it was shown that female students had a good metacognition profile in terms of monitoring when re-examining the results of problem-solving (Sudia, 2015) This is to the research conducted where female students were able to check their answers even though some were only limited to reading them. Female students always pay attention to their way of working from the start, understand the problem to carry out the plan and convince themselves that the checks carried out are correct. In line with the metacognitive strategy put forward by Livingstone, in which female subjects can connect existing information in the problem with previous knowledge, choose strategies to think carefully and can plan, monitor, and evaluate their thinking processes well, this shows that subjects who involve their metacognition in each step of problem-solving will be able to choose a formula, and a suitable way of solving it, (Kamid, 2013) According to Ormrod, the more students know the process of thinking and learning, the greater their metacognitive awareness, the better the learning process and achievements they might achieve (Herman et al., 2018).

CONCLUSION

Profile of the metacognitive ability level of male students in solving problem-based questions in science learning for male students in the high category at the strategic use level, while male students in the medium category are at the aware use level, and for male students with a low category is at the level of tacit use. Meanwhile, the metacognitive ability level profile of female students in solving problem-based questions in science learning for female students in the high category is at the level of reflective use, while female students in the middle category are at the level of strategic use and for female students in the low category, they are at the level of aware use.

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