Students' Difficulties in Solving Mathematical Literacy Problem Level 3, Level 4 and Level 5

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Abstract: This study aims at describing students' difficulties in solving mathematical literacy problem level 3, level 4 and level 5. Qualitative research was used in this study. Participants of the research were 10 tenth-grade students randomly selected from a senior high school. The research was conducted at Senior High School 1 North Bengkulu. Data collected through mathematical literacy skill test, questionnaire, and interview. Data analysis revealed that in level 3 student had difficulties in calculating the arithmetic operation and interpreting the problem which make them solve the problem without understanding the question well. In level 4 students have difficulties in interpreting the problem, calculating the arithmetic operation, making mathematical models, communicating explanation and arguments, solving the problem due to forget the prior knowledge and not knowing how to apply the formula. In level 5 students also have difficulties in interpreting the problem, calculating the arithmetic operation, devising the strategy to solve the problem, making mathematical models, and using the formula. In this level students also have difficulty in communicating their interpretation and reasoning and have difficulty in using well-developed thinking and reasoning skills.

Keywords: Mathematical Literacy, Solving Mathematical Problem, Students Difficulties

Introduction

Mathematics becomes one of the subjects that usually gets avoided by students at school. İn reality, each student views mathematics differently depending on their knowledge towards mathematics. Mathematical knowledge of each person will be diverse from one another since a person's cognitive structure influence someone's activity in learning mathematics (Umbara & Suryadi, 2019). Students' action toward mathematics somehow also affects their learning outcomes at school. Students' mathematical ability could be seen from the PISA (Programme for

International Student Assessment) result in 2018. It was stated students' mathematics scores in PISA were ranked 72 out of 78 countries with an average score of 379 (OECD, 2019). This lower score affected by some factors such as difficulty in communicating questions' information, creating mathematical form based on real problem, representing answers, designing strategies in solving problems, deciding arithmetic operations to be executed in solving problems, students also had struggle in reasoning and conveying arguments (Prahmana, 2022). Those datas and explanations showed that Indonesian students still had lower mathematics ability compare to the other students from another country.

One of the factors affecting students' mathematics ability is Mathematical literacy. The focus in mathematical literacy situated in the way indivisual uses conceptual mathematical knowledge and abilities in a variety of social contexts (Umbara & Suryadi, 2019). It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena (OECD, 2017). Mathematical literacy is seen as mastering the use of reasoning, concepts, facts and mathematical tools in solving everyday problems (Suciati et al., 2020). Mathematical literacy involves more than executing procedures, the competence and the self-reliance in applying the base knowledge are required in the practical world which means mathematical literacy is not only about executing procedures (Ojose, 2011).

The use of real-life data is needed in modeling mathematical literacy problems (Kula et al., 2018) where each problem in mathematical literacy has a different proficiency to be accomplished. There are 6 levels of Proficiency in mathematical literacy according to PISA (OECD, 2019). These proficiencies distinguish students in each level of mathematical literacy. The use of informations in the students' resource system that contributes to connect mathematical knowledge with real life situation can distinguish the mathematical literacy levels of two students with huge mathematics accomplishment (Ada et al., 2021). Each proficiency should be mastered by students to be able solving mathematical problem correctly, but from the PISA results it can be said students rarely reach the ability of higher level of mathematical literacy.

Most of the students find some difficulties in solving higher level of mathematical literacy, 65.3% and 73.68% of students made error in solving mathematical literacy level 3 and level 4 respectively (Setiawan et al., 2020) and students are in a low category of mathematical literacy (Sari & Wijaya, 2017; Wijaya, 2016). İt happens because students do not have good literacy skills (Hayati & Kamid, 2019). The factor contributing on students' low mathematical literacy is their ability in solving the problems. From the prior research, it was found that students struggle to formulate situations mathematically and evaluate the reasonableness of a mathematical solution in the context of a practical issue (Ratnasari & Abadi, 2018; Edo et al., 2013).

Students were able to interpret the problem correctly and knew the right formula but they were unable to apply the formula to solve the problem and made mistakes in reasoning the questions (Masfufah& Afriansyah, 2021). The procedures carried out by students were fully incorrect so that the final conclusions obtained were incorrect and students didn't not carry out the completion process and strategy (Ratnasari & Abadi, 2018; Lukman & Zanthy, 2019). İn addition, students are unable to select and integrate different representations (Nurhanurawati

et al., 2022). Besides that, the most frequently observed while solving the problem is students' error in doing arithmetic (Setiawati, 2017) whereas this ability is important as a high level of mathematical literacy may be influenced by the high level of skills in the four mathematical operations (Y1lmazer & Masal, 2014). Those attitudes become the reason why they fail to solve the problem correctly and fail to gain a better mathematical experience.

It is important to explain the students' problems with tackling literacy problems in depth so that they can follow up and come up with solutions. (Retnawati & Wulandari, 2019). Besided, the information about students' difficulties supports teachers to select suitable teaching strategies and organize the learning material (Lestari & Juniati, 2019). In addition, Haara et al. (2017) claimed that to teach mathematical literacy teacher can not stick out to the traditional mathematics teaching, teacher needs something more than that.

To encourage students' knowledge of problems and solution-finding, teachers should consider students' backgrounds and select problems that are connected to their backgrounds. (Sumirattana et al., 2017). Because of that reason, teacher need to know which part in each level of mathematical literacy proficiency that makes students have the struggle to solving the mathematical literacy problem. By doing this, teacher can manage to develop students' mathematical literacy ability by giving the suitable contextual problem.

Based on the data described above, it is an important issue to find out the students' error in solving mathematical literacy problem. This issue needs more concern due to a purpose of knowing the deeper reason why students experience poor mathematical literacy so the teachers can overcome this matter by applying relevant strategy and approach. The problem level 3, level 4, and level 5 will be given to the students in higher school as students in Indonesia got a lower mathematical literacy score in those level and they rarely get those problems at school. Therefore, the research of this study will focus on the students' difficulties in solving mathematical literacy problem level 3, level 4 and level 5.

Method

This type of research was descriptive qualitative research. The subjects of this study were 10 students in X IPA 2 of senior high school 1 in North Bengkulu which were selected randomly. To collect data research, data collection techniques were carried out as follows:

1. Individual written test which consists of 3 questions about the linear equation. The instrument was designed based on the proficiency of mathematical literacy level 3, level 4, and level 5.
2. Questionnaire were given to the students to analysis their difficulties in solving mathematical literacy problem.
3. Interviews were conducted to the students to strengthen the analysis of students' difficulties in solving mathematical literacy problem which has been known from written test and questionnaire.

Results

The first question given to the students was "When you go to a mall in Bengkulu, you bring Rp. 500,000.00 with you. One of your friends bought 2 audio cassettes and 3 video cassettes for IDR 425,000.00. Your other friend bought 3 audio cassettes and 2 video cassettes for IDR 350,000.00. If you are also interested in buying cassettes, do you have enough money to buy 4 audio cassettes and 3 video cassettes? Explain and make its mathematical modeling". Three out of ten students made mistakes in calculation that led them to the incorrect answer. Five out of ten students solved the problem without answering the question "does he have enough money to buy 4 audio cassettes and 3 video cassettes?" and two out of ten students answer the question correctly.

The second question given to the students was "Thomas has IDR 6,000,000.00 invested between a checking account, a savings account, and a bond account. The checking account has 2% annual interest, savings account has 5% annual interest, and bond has 7% annual interest. Thomas earns a total of Rp355,000.00 in annual interest. If has Rp2,300,000,00 less invested in his savings account than his bond account, how much does he invest in each account?". Nine out of ten student only write what was known and one student answered using mathematical model but she made miscalculation.

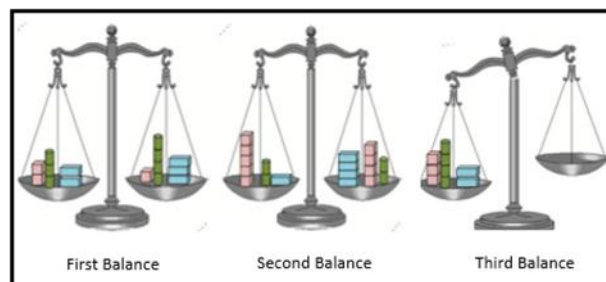The third question given to the students was:

Figure 1. Balance for Problem Number Three

If Cuboids has 3 kg in weight. How many cubes, cuboids, cylinders that may be added at the right side of third balance such that the weights are in balance? (Edo et. al, 2013). Seven out of ten students left the answer blank, one student answered the question using her logic falsely and two students answered correctly but made mistakes in mathematical prosedure.
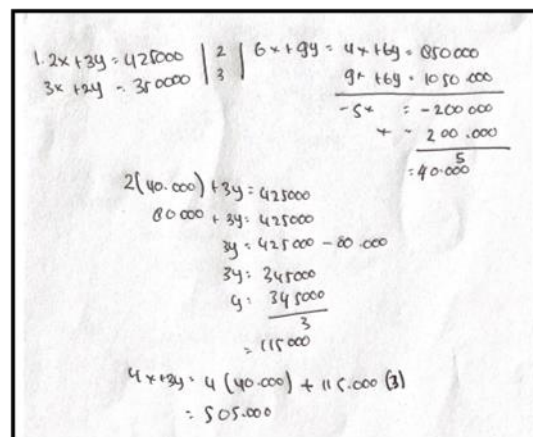
Discussion

Analyzing the first question

Question number one is the question that contains mathematical proficiency level 3 including using

representations based on different information sources and reason directly from them, showing some ability to handle percentages, fractions and decimal numbers, and working with proportional relationships (OECD, 2019). From students' answer, it can be said that most of them still don't understand the question in number 1. Five out of ten students solved the problem without answering the question "does he have enough money to buy 4 audio cassettes and 3 video cassettes?". Instead, they giving answer how much money they need to pay for buying 4 audio cassettes and 3 video cassettes. Student A's answer for number one can be seen in Figure 1 below.

From the Figure 1 it can be seen that student A correctly made the mathematical models and could find the value of x and y correctly. What made student A incomplete in solving problem number one was she neither gave the answer the question "is the money enough to buy cassettes" nor gave explanations to answer the question. From the questionnaire, it can be seen that student A confidently said she could solve the problem correctly without any difficulties. To clarify their answer, the interview was conducted to student A to talk about her strategies, difficulties, and undertanding in mathematics. Here is the result of the conversation in the interview process.

Figure 2. Student Misinterpreting the First Question

R: Do you understand this problem well?

A: Yes

R: Do you think your answer was correct.

A: I think yes

R: Look at the question, what was the question again?

A: Is his money enough to buy 4 audio cassettes and 3 video cassettes?
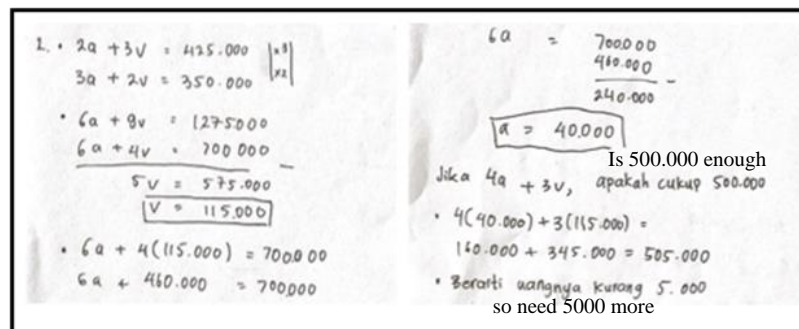
R: You didn't answer that question. Why?

A: I didn't read carefully the question. I thought it was enough to write how much money he needs to buy 4 audio cassettes and 3 video cassettes because usually the question was like that.

From the interview it can be said that student A met the comprehension error. Misunderstanding the instruction, misinterpreting the keyword, and poor information selection are the three signs of a student's comprehension

problem. (Ahyan et al., 2019). She correctly solved the problem, correctly applied the formula, but incorrectly answer the question due to misunderstanding the instruction. Students need to understand the problem and the question to correctly answer the question. Correct steps will guide students to the correct answer but never guarantee them to give the correct answer. Hence, this kind of student didn't meet all criteria of the proficiency in level 3 because she still found difficulty in understanding the question. While the other students fail to answer the question accurately, the two other students (Student B and C) can interpret and represent the question well. They made the mathematical modeling and giving the reason why they need more money to buy 4 audio cassettes and 3 video cassettes. Student B's answer can be seen in Figure 2.

From the Figure 2, it can be seen that student B gave the clear mathematical modeling to find the price of each cassette. She knew the steps to solve the problem and understands the process to answer the question. This attitude shows that this student didn't have any difficulties in solving the problem number one. This statement can be clarified by seeing student B's answer in the questionnaires. She stated that question number one was easy, she didn't have any difficult to solve the problem, and she often gets this kind of question. Thus, student B already have a good mathematical literacy in level 3 since she could use representation and solve the problem without misinterpretating it.

Figure 3. Student's Correct Answer for Question Number One

Analyzing the Second Question

Question number two is the question containing mathematical proficiency level 4 including being able to select and integrate different representations, including symbolic, linking them directly to aspects of real-world situations, being able to utilise their limited range of skills and can reason with some insight, being able to construct and communicate explanations and arguments based on their interpretations, arguments and actions (OECD, 2017). For the problem number 2, all of the students failed to give the correct answer. Nine of them only wrote what was known. An interview was conducted to know deeper reason why student failed to answer this question. Here is the conversation with student E.

R: Did you understand the problem?
E: No, it was so difficult. I had no idea what I should do to solve the problem.

R: Why did you think it was difficult?

E: It talked about bank interest. I already forgot the formula. I also got confused with what was known in the problem, so I just wrote what I understand.

R: Do you know the concept of bank interest in real life?

E: I know.

R: Can you tell me what you know about it?

E: Our saving gains some amount of money each month or year in accordance with how much our money is.

R: Why do not you try to use that concept? That is simillar to the case in the problem.
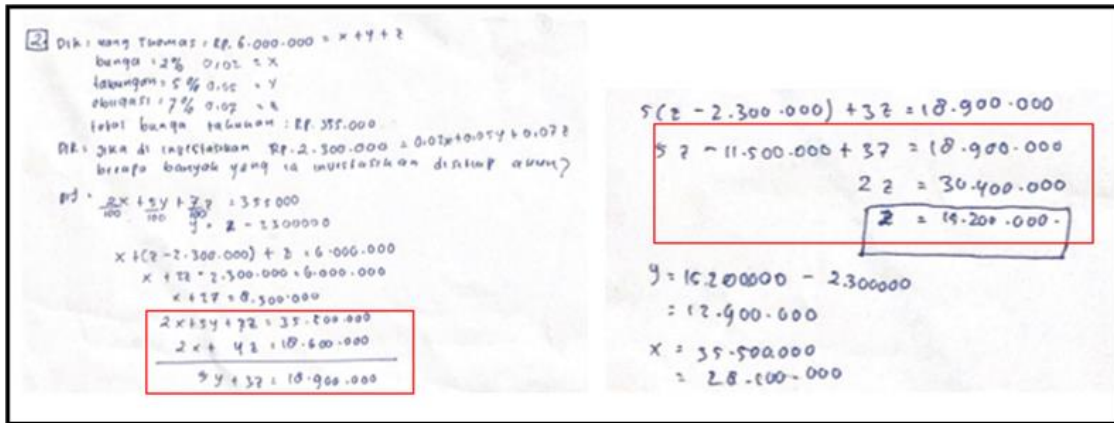
E: I do not know how to write them mathematically.

From the interview, it can be said that student E still have lower ability in interpreting the problem and did not know how to write the information mathematically even though she knew the concept of bank interest in real life. Many students found it difficult and do not understand in applying their mathematical knowledge to solve problems that exist in everyday life (Afni & Hartono, 2020). Some students faced complexity to write the information in the form of mathematical model so she could not find any steps to solve the problem (Suciati & Subagyo, 2018). Additionally, student E had difficulties to link the informations from the question directly to the aspects of real-world situations, she struggled to construct and articulate the justifications and reasons that would have supported her interpretation. All of those behaviors indicate that student E did not understand the problem. Students' error in understanding the problem also affect their ability in solving the problem (Mahmudah, 2018). Students whose problem-solving ability in the low category often make fundamental and causal errors (Son et. al, 2019). Hence, they find the hardship in developing the solution of the problem.

From the questionnaire, they stated that this problem was so difficult that they didn't know what strategy they should use to solve the problem. They also stated that they rarely found this kind of problem before. Students who rarely met non-routine contextual problem would be confused in developing mathematical reasoning and interpretation. The poorly considered selection of problems can hinder rather than encourage the development of principled-conceptual knowledge (Kolar & Hoknik, 2020). Besides that, the prior understanding also has a big role on solving this problem. Because of those difficulties, students fail to made mathematical model, devising strategy, communicating explanations and arguments based on their interpretations and actions and solving the problem. Thus, these students didn't have a good mathematical literacy in level 4 due to unable to fulfill the criteria of proficiency in level 4.

Out of ten students, one student gave the answer using mathematical model. Unfortunately, she gave an incorrect answer. The student who answered the question incorrectly was student C. this student's answer can be seen on the Figure 3 below.

From the Figure 3 above, it can be seen that this student made mistakes in subtracting the number, she calculated $35.500.000 - 18.600.000$ and got the value $18.900.000$. It should have been 16.900.000. Another

mistake she made was the addition $5z + 3z = 2z$, that should have been $8z$. These mistakes led this student to incorrect value of $x, y,$ and z. Therefore, she failed to give the correct answer. She stated that she thought this problem was difficult because the number was big. It was reasonable because this students made errors in calculating. She also stated that she rarely get this kind of problem before. An interview was conducted to know the further information about student's difficulties in solving this problem.

Figure 4. Student Incorrect Answer for Number Two

R: Did you understand this problem?

C: Yes

R: You made some calculation errors, did you notice it before?

C: No, I thought I already worked carefully on it. I didn't recheck my answer

From the interview it can be said that this student understand the problem and can solve the problem. What she missed was looking back process whereas looking back is one of the steps which is important in solving the problem (Huang, 2012). Students' error in process skill error and notation also play a role on the properly creating the solution (Mahmudah, 2018). It also showed that student had a difficulty so solve the problem level 5 (Wulandari, 2015). Therefore, this student already had a good mathematical literacy in level 4 but faced the difficulty in calculation the arithmethic operation due to skip the looking back step in solving the problem.

Analyzing the Third Question

Question number three is the question containing mathematical proficiency level 5 including developing and working with models for complex situations, selecting, comparing and evaluating appropriate problem-solving strategies for dealing with complex problems related to these models. They can use well-developed thinking and reasoning skills, formulate and communicate their interpretations and reasoning (OECD, 2017). Unfortunately, most of the student failed to answer that question, 7 out of 10 students left the answer blank. From their questionnaire answers, it can be known that students didn't understand the question, they thought this question was difficult, they didn't know the strategy to solve it and was never given the similar question before.

On the other hand, there was a student (Student D) who answered the question using her logic, she could give the number of cube, cuboid, and cylinder. However, her answer was incorrect. Student D's answer can be seen in Figure 5 below.
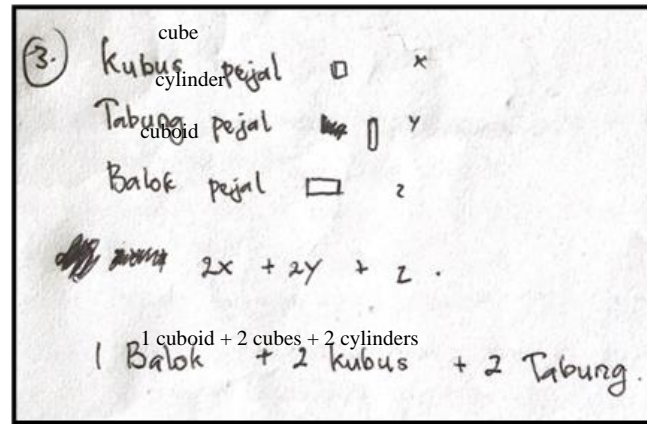

Figure 5. Student's Incorrect Answer for Number Three

From the Figure 5 it can be seen that student D answer the question without making any mathematical model. She also didn't write any explanation why she gave such answer. From her questionnaire, she stated that this problem was kind of difficult, she was not sure with her answer, she subtracted the wight of the balance on the left side using her logic, she also stated that she forgot the formula and she rarely got this type of question.

However, her logic to subtract the wight of the balance on the left side was incorrect. From this attitude, it can be said this student failed to use not only well-developed thinking and reasoning skills but also failed to formulate and communicate her interpretations and reasoning. Students need to know the weight of each solid figure to determine the number of cube, cuboid, and cylinder. To deepen the reason why they fail to answer this question, an interview was carried on with student D. Here is the conversation about student D's difficulties in solving problem level 5.

R: Did you solve this problem well?

A: Actually, I am not sure with my answer.

R: Can you tell me your reason?

A: I knew the direction of the question, but I didn't understand how to complete the task. I also got confused which formula I should use. That was why I used my logic.

R: Did you notice this question was about three variables linear equation?

A: Yes, but I didn't know what should I do to find the value of x and z. I never solve this kind of problem before.
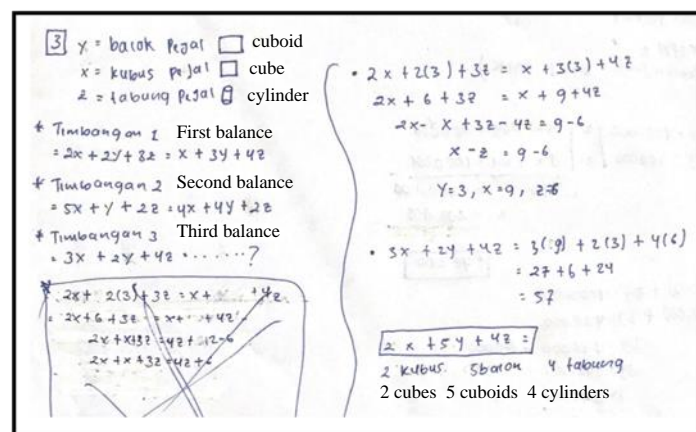
From the interview session it can be said that student D had difficulty in working with models and didn't know how make the approriate strategy to solve the problem. She also stated that she never has a chance to solve

similar problem before because questions asked to students in the exams held in schools primarily measure mathematical operation skills (Fatih & Bekdemir, 2017) as it was opposite with the statement that students can improve their mathematical literacy by engaging in various types of tasks from procedural tasks, word problems, to pure and applied mathematics reasoning tasks (Hwang & Ham, 2021).

The same situation also followed the students who left the answer blank. Both students who left the answer blank and using incorrect logic mean they failed to fulfill the ciretia of mathematical literacy which requires students to perform arithmetic operations and recognize mathematical problems in the context of real life, and express them mathematically (Satıcı in Ada et al., 2021). They also can't fulfil the proficiency in level 5 problem. Thus, they have difficulty in solving mathematical literacy problem level 5 (Wulandari et al., 2015) as mathematical literacy is related to the ability in solving problems and using mathematical knowledge (Kurniawati & Mahmudi, 2019). Students had difficulties in interpreting the problem, making mathematical model, communicating their interpretation and mathematical reasoning, using well-developed thinking and reasoning skills. They also lack in employ mathematical concepts, facts, procedures and reasoning.

In contrast, 2 out of 10 students can solve this problem correctly. They use mathematical model to find the weight of cube and cylinder to give the exact number of cube, cuboid, and cylinder to be added on the right side of the third balance. However, one of the students (student C) made mistakes in determining the weight of cube and cylinder. This student's answer can be seen in the Figure 6 below.

From the Figure 6 above, it can be said that student C falsely made the conclusion that the value of x is 9 and the value of z is 6. Even though the answer was correct, the mathematical process was broken. The operation of $x - z = 9 - 6 = 3$ can be formed using the other expression such as $x - z = 9 - 6 = 8 - 5 = 3$. This expression shows that the value of x and z can have many values which makes the process was incorrect. It shows that this student already understood the meaning of the problem and knew what she should do. Unfortunately, she made error in calculating and lacked in employ mathematical procedures.

Figure 6. Student's Correct Answer for Number Three

Conclusion

Data analysis revealed that in level 3 student had difficulty in calculating the arithmetic operation which support them to make an incorrect answer. Students also have difficulty in interpreting the problem which make them solve the problem without understanding the question well. In level 4 students have difficulties in interpreting the problem, calculating the arithmetic operation, making mathematical models, communicating explanations and arguments, solving the problem due to forget the prior knowledge and not knowing how to apply the formula and deciding a strategy to solve mathematical literacy problem. In level 5 students also have difficulties in interpreting the problem, calculating the arithmetic operation, devising the strategy to solve the problem, making mathematical models, and using the formula. They lack in employ mathematical concepts, facts, procedures and reasoning. In this level students also have difficulty in communicating their interpretation and reasoning and have difficulty in using well-developed thinking and reasoning skills. For some cases in level 4 and level 5, students left the answer blank due to the unknown steps they should choose to solve the problem which shows that they have lower mathematical literacy.

Recommendations

Based on these results, researcher suggest that students should be given non routine problem to develop their understanding in interpreting the problem. The learning process in the class should be focused on the concept instead of the formula so that student still can use their prior knowledge even though they forgot the formula.

Acknowledgements

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