

MATHEMATICAL LITERACY REVIEWED FROM MATHEMATICAL PROBLEM SOLVING ABILITY

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Abstract: This study is motivated by the importance of elementary school students' mathematical literacy skills in relation to 21st century education problems. This study aims to determine the mathematics literacy of fifth grade students in elementary school in terms of mathematical problem solving abilities. The research design used was qualitative descriptive with a case study research method. This study was carried out on 27 fifth grade students of one public elementary school in the city of Bandung. This research was carried out by observing and giving mathematics literacy tests. The results showed that students' mathematical literacy was still low. Accuracy in understanding the information in the questions about what was known and asked about the questions was lacking. Most students are still wrong when it comes to working on the calculation process and what procedures should be used to solve the given problem so that the results obtained are not correct. Based on these findings, learning needs to be designed to be as optimal as possible in order to improve mathematical literacy skills.

Keywords: mathematical literacy, mathematical problem solving skills

1. Introduction

In the current era of globalization, many things can change our view of everything, whether it be science, technology, or communication systems. These changes require people to use their knowledge optimally to process information that is obtained critically so that it can be useful for their lives. Of course, thinking critically can support a person in solving more complex problems. Therefore education has an important role in facing the challenges of the 21st century, as expressed by Moretti & Frandell (2013) that in facing these challenges education is a means of preventing risk and a tool that can help improve the quality of human life in a sustainable manner.

Education has an important role in equipping students with abilities that will be useful in the face of the globalization era or the 21st century. These abilities are expected to be developed in education through subjects taught at school. These expectations are reflected in the core competencies in the 2013 curriculum content standard. Based on Permendikbud No. 68 of 2013 concerning the Standards of 2013 Curriculum Content, the core competencies (KI) of cognitive domination for each subject are to equip students with factual, conceptual, and procedural knowledge based on students' curiosity about science, technology, cultural arts related to phenomena and occurrences of visible eyes. Competence The core skill domain for each subject is to process, present, and reason in the concrete domain (using, extracting, assembling, modifying, and making) and the abstract domain (writing, reading, counting, drawing, and composing) according to what is learned in schools and other sources in the same perspective / theory.

As a compulsory subject, mathematics is not only seen as a subject that can develop numeracy skills and apply the formula to a problem, but in this 21st century education mathematics can develop its reasoning and analytical abilities in solving everyday problems that exist in life student. This is in line with what has become the view of the NCTM (National Council of Teaching Mathematics) which makes problem solving, reasoning and proof, communication and representation as a standard process in mathematics learning.

Demands for mathematical abilities are not only proficient in numeracy but students are also required to think logically and critically to solve problems. Problem solving does not only answer routine questions, but non-routine questions are more often faced with problems of daily life. Mathematical skills are known as mathematical literacy skills. Based on the results of the 2009 and 2012 Programs for International Student Assessment (PISA) which shows that Indonesian students have literacy skills with a low average score. Even the latest PISA results in 2015 Indonesia ranked 63 of 69 countries evaluated for mathematics subjects.

Based on the description above, it can be seen a global picture of the state of mathematical literacy skills, therefore the researcher tries to prove again whether the global conditions in Indonesia represent the actual conditions in each school, especially in one of the elementary schools in Bandung, therefore it is necessary to have a research to find out how the real picture of the state of students' mathematical literacy abilities in terms of problem solving.

2. Related Works/Literature Review

Mathematical literacy in mathematics learning is a standard that needs to be mastered by students in enhancing mathematical skills and abilities to interpret mathematics in various contexts. According to PISA (2013) mathematical literacy is defined as follows:

“Mathematical literacy is an individual’s capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognizes the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens”.

Based on these opinions, shows that theoretical understanding is not enough to solve a problem but also needs reasoning, communication skills and explain the phenomena it faces with mathematical concepts.

In addition to the PISA, the term mathematical literacy has been coined by NCTM (1989) as one of the visions of mathematics education, namely to be literate / mathematical literate. In this vision

mathematical literacy is interpreted as "*an individual's ability to explore, to conjecture, and to reason logically as well as to use variety of mathematical methods to effectively solve problems. By becoming literate, their mathematical power should develop*". In this sense it provides an understanding that there are 4 main components of mathematical literacy in problem solving, namely exploring, connecting and reasoning logically and using various mathematical methods. These components can develop students' mathematical abilities and are used as a way to facilitate the problem solving process faced by students.

In line with this opinion, Stecey & Tuner (2015) defines literacy in the context of mathematics as having the power to use mathematical thinking in daily problem solving to be better prepared to face life's challenges. Mathematical thinking is intended to include a problem solving mindset, logical reasoning, communicating and explaining. This mindset is developed based on concepts, procedures, and mathematical facts that are relevant to the problem at hand.

Complementing the previous opinion, Steen, Turner & Burkhard (2007) added the effective word in terms of mathematical literacy. Mathematical literacy is defined as the ability to use mathematical knowledge and understanding effectively in facing the challenges of everyday life. A person who is literate in mathematics is not enough to only be able to use his knowledge and understanding but must also be able to use it effectively.

In addition, according to Suyitno in Firdaus, F., Wahyudin, and Herman, T (2017) mathematical literacy is defined as a person's ability (in this case, students) to formulate, implement, and interpret mathematics in various contexts, including the ability to do mathematical reasoning and use concepts, procedures and facts to explain, or predict phenomena / events.

Based on some of the opinions above, mathematical literacy both emphasizes how the process of solving mathematical problems uses its ability to reason logically and effectively. In the process of solving this problem, someone who has mathematical literacy will realize or understand which mathematical concepts are relevant to the problem at hand. From this awareness then develops on how to formulate the problem into its mathematical form and then finish it. This process contains activities to explore, connect, formulate, determine, reason, and other mathematical thinking processes. This thinking process can be categorized into 3 main processes, namely interpreting, formulating, and using.

Problem-solving ability according to Peer Review (2016) is an individual's ability to high-level cognitive aspects that require more basic skills to plan and conduct a series of activities in answering open questions in order to achieve the goals set when faced with new situations.

It is these basic skills that can help students solve problems step by step so that the problems faced become easier to solve. So that in the future, students are able to apply their problem-solving abilities in their daily lives because problem solving ability is an integral part and the main goal in learning mathematics that is needed in the future so that education today must be able to educate students to become capable individuals solving problems in the future (Muhsetyo, 2007 dan Harnett, 2008).

In the process of problem solving, students are not only required to get the right end result, but are also required to use optimal ways to get the final result. Through these ways it can be seen how students solve it and the patterns of thinking of students in solving the problem. This is in line with what was stated by Mutanen (2016) that problem solving does not only rely on knowledge, concepts or procedures, but also requires information to help students in choosing the right answer by guessing which possibilities are the correct answers, and of course by using certain strategies.

Apart from the importance of strategies or processes that are carried out in problem solving, it turns out that the problems faced by students need to be considered. This problem must be a problem that cannot be solved immediately. This is in line with what was stated by Lockhart in Zainiyah, U. & Marsigit (2018) a good problem is a problem when someone does not know immediately how to solve it. Therefore, in solving problems, strategies are needed so that the problem can be resolved. Therefore to be a problem solvers who are capable according to Herman, T (2007) students need to learn how to form mental representations of problems, detect mathematical relationships, and find new methods when needed. The fundamental characteristics needed in the problem solving process are flexibility. This flexibility develops through the expansion and deepening of knowledge needed to solve non-

routine problems, rather than routine problems. In solving routine problems, students know how to solve them based on their experience.

Problem solving abilities have four indicators that can be used to measure or assess students' abilities (2014). The first indicator is *Understanding the Problem*. This step involves access to knowledge and prior planning, understanding what problems are being faced, identifying elements that are known, what is being asked, and the adequacy of the elements needed. Sometimes in understanding a problem, it takes repeated reading activities, then then paraphrases the elements of the problem by using their own words or language to make them easier to understand.

The second indicator is *Devising a Plan*. This step involves the preparation of plans and strategies to be used, formulating mathematical problems or constructing mathematical models. In this step students can visualize a problem by drawing a schematic representation and hypothesizing or making a solution plan.

The third indicator is *Carrying Out the Plan*, this step involves implementing plans and strategies that have been prepared in advance to solve various problems (similar and new problems) in or outside of mathematics. In this step students can estimate or predict answers with computation or mathematical calculations.

And the last indicator is the *Looking Back*, this step involves monitoring, managing, and adjusting the business and the strategies needed, including checking the process and explaining the results in accordance with the original problem and using mathematics meaningfully. In this step, students check that the plan and the answer are correct.

3. Material & Methodology

The research design used in this study was qualitative descriptive with a case study research method. This study intends to collect data and describe students' mathematical literacy in terms of problem solving. This research was carried out on 27 fifth grade students in one elementary school in the city of Bandung. Data collection techniques in this study used interviews, observation, and document analysis in the form of test results. The interview was conducted as a preliminary study to find the existing problems. Then the test was conducted to see how far the students' problem solving abilities were.

Table 1. Interview Guidelines

Observed Aspects	The Question Asked
<i>Understanding the Problem</i>	Can students find the elements of the problem that are known and asked?
	Can students explain or interpret problems found in their own language?
<i>Devising a Plan</i>	Can students realize or explain the essence of a problem?
	Can students make mathematical models of a problem?
	Can students plan what steps to use in solving a problem?
<i>Carrying Out the Plan</i>	Can students solve problems according to the steps that have been planned?
	Can students show the process of solving a problem?
<i>Looking Back</i>	Can students check the calculations that have been done?
	Can students find other alternative solutions?

Furthermore, observations were carried out during the mathematics learning process to see students' mathematical literacy. Observations are carried out in a focused manner because observations are narrowed down to certain aspects. The observation guidelines are as follows.

Table 2. Observation Guide

Observed Aspects	Things to Pay Attention to
<i>Understanding the Problem</i>	Students can understand the problem by writing down the known data and the data in question and completing it with symbols to make it easy to understand. Students can explain the problem according to their own sentence.
<i>Devising a Plan</i>	Students can explain the core of the problem. Students can make mathematical models of a problem. Students can plan what steps to use in solving a problem.
<i>Carrying Out the Plan</i>	Students can solve the problem according to the steps that have been planned. Students can demonstrate the process of solving a problem.
<i>Looking Back</i>	Students are careful in each of the problems that are proven by checking again the answers that have been made.

Documents in this study are the results of students' mathematics tests. The steps in analyzing documents are, (1) determining indicators of mathematical problem solving abilities, (2) making 5 questions about the students' literacy skills (OECD, 2017). The following questions will be tested in this study:

1. The cake shop provides two types of square cakes with the same thickness, but different sizes. Small and large cake surfaces each have sides of 10 cm and 15 cm.



10 cm



15 cm

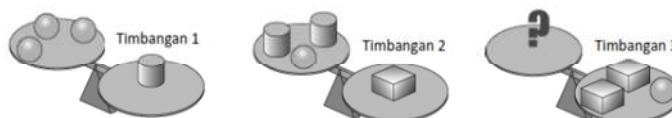
If each small and large cake is sold for Rp. 10,000.00 and Rp. 15,000.00, which is more profitable, buying three small cakes or two large cakes? Write down your reasons!

2. Nick wants to install ceramics on the porch of the house. This terrace has a length of 500 cm and a width of 300 cm.



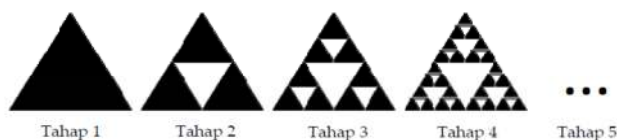
If the ceramic that is installed is 20 x 20, how many ceramics does Nick need?

3. Attention to the picture below!



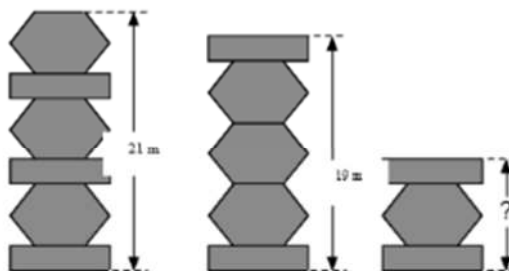
Scales 1 and 2 contain balls, tubes, and cubes with perfect balance. How many cylinders are needed to balance scales 3?

4. The black triangle in the image below is Sierpinski's triangle. The triangle divides itself into the same shape and size that keeps changing. The following are the stages of how Sierpinski's triangle divides itself from the beginning until it continues to change into a smaller size. Stage 1 consists of 1 triangle Sierpinski, stage 2 consists of 3 triangles Sierpinski, and so on.



How many Sierpinski triangles at the 5th stage? Show me how you got it!

5. Below are 3 towers that have different heights and are composed of two forms namely hexagon and rectangular shapes.



Based on the picture above, in your opinion, what is the shortest tower height?

Then (3) carry out a written test, and the last (5) analyze the students' answers. To analyze students' answers, indicators are needed that can measure mathematical literacy competencies when viewed from problem solving abilities. The following are indicators of achievement of mathematical literacy competencies in terms of students' mathematical problem solving abilities.

Table 3. Indicators of Mathematical Literacy in Terms of Problem Solving Abilities

Mathematical Literacy	Ability to Solve Mathematical Problems
Interpret math to solve problems	Identify elements that are known and asked, and the extent of elements needed.
Formulate problems mathematically	Formulate mathematical problems or compile a mathematical model.
Using concepts, facts, procedures, and reasoning in mathematics	Implement strategies for solving various problems (both similar and new problems) inside or outside mathematics.

4. Results and Discussion

The results of qualitative data analysis were obtained through observation and combined with the results of interviews, in order to trace students' mathematical literacy in terms of students' mathematical problem solving abilities. For more details, the findings are obtained based on the results of interviews and observations.

Table 4. Findings of Research Results

Observed Aspects	Teacher's Answer	Research Findings
<i>Understanding the Problem</i>	Grade 5 students have been able to identify the elements that are known and asked in a problem.	The fact in the study there are still students who do not understand what is meant in the problem, especially what is known in the problem.
	Grade 5 students have been able to explain the problem according to their own sentence.	Like what was found in the previous point, students who were able to write down the elements that were known and asked about the problem were able to explain the problem using their own sentence, while students who were not able to, needed guidance in understanding the problem given.

Observed Aspects	Teacher's Answer	Research Findings
<i>Devising a Plan</i>	Generally grade 5 students are able to simplify or explain the essence of a problem.	For some students still need to be explained the core problem that must be solved.
	Grade 5 students are able to make mathematical models of the problems given.	Most students have not been able to write down the mathematical model of the problem given.
	Grade 5 students are sometimes still confused about what steps to take in solving the given problem.	Some students ask if the steps they will use are correct, and some students seem confused about what procedures will be used to solve the problems presented.
<i>Carrying Out the Plan</i>	Grade 5 students can solve the problem according to the planned steps.	Grade 5 students can solve the problem in accordance with the steps that have been planned, but in the midst of workmanship some students in the process still ask the teacher how to use the calculation.
<i>Looking Back</i>	Grade 5 students still need to be reminded to re-read the problem in checking the answers to a problem.	Seen when students want to collect the answers, the teacher still needs to remind them whether the results of the answers have been re-checked to ensure that no one has miscalculated.

Based on the findings of the observations and interviews, it can be seen how the mathematics literacy of the fifth grade students of elementary schools in the understanding the problem aspect often find it difficult to understand the intended purpose of the problem, let alone express it using their own language. This is because students are still not accustomed to being faced with the type of story problems plus the questions given are non-routine questions. In the second aspect, devising a plan, generally students still feel hesitant in making a settlement plan, this is evidenced by the fact that there are still many students who ask the teacher whether the completion steps they have made are correct or not. This also happens in aspects of carrying out the plan, the child's confidence does not appear yet so the child feels the need to ask the teacher, besides that it seems that the less dominant is the most dominant factor so that students generally work without using good planning. And in the looking back aspect, students still need to be reminded to be careful in reading questions and working on questions.

Furthermore, to obtain the achievement of mathematical literacy competencies in terms of problem-solving abilities, an achievement analysis of the students' mathematical problem-solving ability indicators was proven through tests consisting of 5 questions. For more details, the following findings.

Table 5. Findings of Test Results

Mathematical Literacy	Ability to Solve Mathematical Problems	Findings of Student Test Results
Interpret math to solve problems	Identify elements that are known and asked, and the extent of elements needed.	Only 7 students apparently identified the elements that were known and asked about the questions given. While 20 students did not go through the stage of identifying in advance the elements known or asked about the problem. Most students immediately formulate the problem into a mathematical model
Formulate problems mathematically	Formulate mathematical problems or compile a mathematical model.	Most students are able to formulate the problems given in the mathematical model

		<p>even though the solution to the problem formulated is mostly still not correct. Only 1 student has not been able to formulate a mathematical model</p>
<p>Using concepts, facts, procedures, and reasoning in mathematics</p>	<p>Implement strategies for solving various problems (both similar and new problems) inside or outside mathematics.</p>	<p>In working on the given questions, it appears that most students have not been able to implement what resolution strategies and what procedures should be done to solve the problems given. Seen only 1 person who has been able to use his reasoning in solving a given problem</p>

Based on the findings, the following are examples of student answers and discussion of the achievement of mathematical literacy indicators in terms of problem solving abilities.

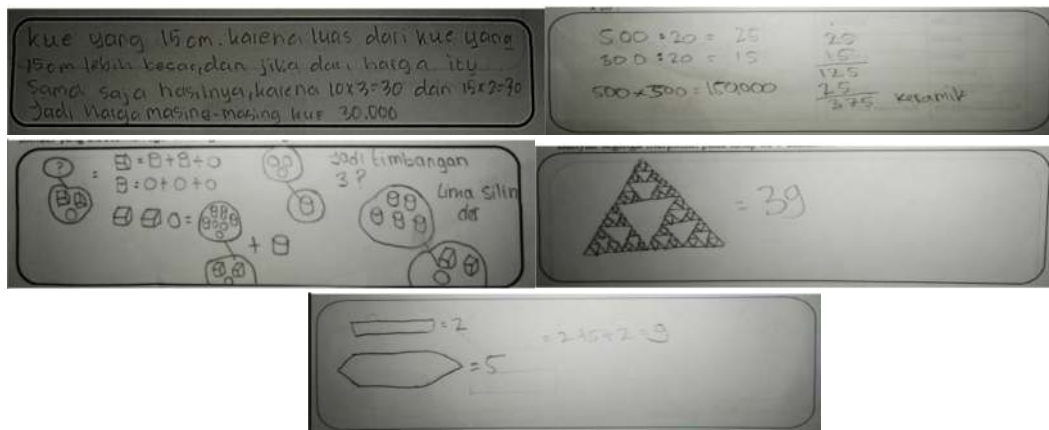


Figure 1. Student Answers

Seen in Figure 1. Students can identify elements in the problem what they know and what is asked based on what is meant by the problem. So it can also be seen that students can make mathematical models based on identifying elements in the problem and understanding what procedures should be used in solving problems, students also show correct understanding in performing operations counted in number 1, although written answers in the form of simplification of operations to calculate multiplication to be $10 \times 3 = 30$ and $15 \times 2 = 30$. When viewed based on accuracy in work, there are still some carelessness done by students as in number 3, students have been able to represent answers in the form of pictures correctly but when calculating the number of answers the students still wrong.

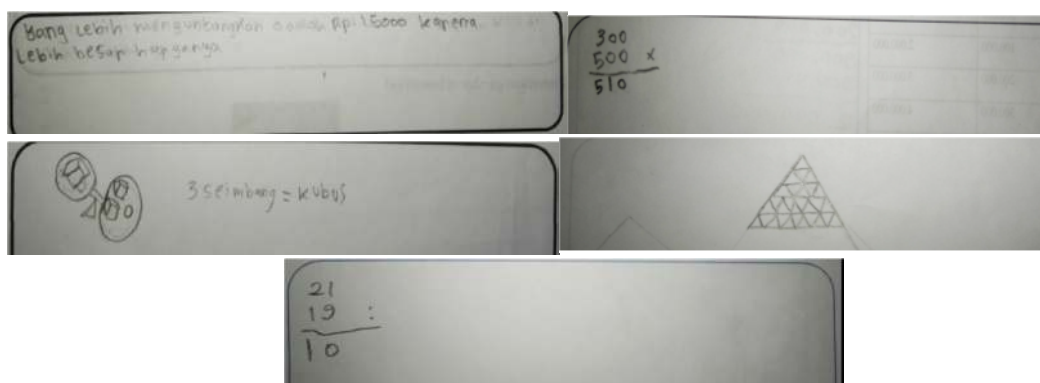


Figure 2. Student Answers

Figure 2. It is clear that students do not understand the problem, students do not identify what is known and asked about the problem, but immediately express it in the form of a mathematical model. In mathematical modeling, the settlement procedure used is still wrong. When asked for reasons regarding the answer students cannot express the reason, it indicates that students' misunderstanding in the use of procedures should be used by students to solve the problem so that the answers seem careless. Obviously if it is reviewed based on its accuracy, the student does not review the answer to be checked again.

Some of the findings and answers of the students indicated that mathematics literacy skills were still lacking, this happened because students were still not used to being faced with the type of story problems plus the questions given were non-routine questions. This is supported by research conducted by Nugroho (2017) and Zainiyah, U & Marsigit (2018) that in order to improve mathematics literacy students need to strengthen the exercise of mathematical literacy questions, and other strategies are needed to familiarize students with problems or problems that require logical reasoning to support students' mathematical literacy. In addition, according to Herman, T (2007) students need to learn how to form mental representations of problems, detect mathematical relationships, and find new methods when needed.

5. Conclusion

When viewed based on these findings, the researchers concluded that understanding children's literacy is still less visible. In the indicator formulating the problem into a mathematical form, almost all students have been able even though in identifying problems need to be guided by the teacher. It can be seen from the results of the students' work that only 1 student has not been able to formulate it mathematically, but most of them have been able even though not all of the steps done are right. This is because of the lack of accuracy and the lack of unfamiliarity of the questions in the form of context, so that for students the problem is difficult to identify. Accuracy in understanding the information in the matter about what is known and asked in the matter is still lacking. Most students are still mistaken in working on the calculation process related to multiplication and division as well as what procedures should be used to solve the problem given so that the conclusions obtained are not correct. In addition, they are not used to dealing with such problems so that their confidence and independence have not yet appeared. Teachers should provide opportunities for students to build their own knowledge so that the level of self-confidence and reasoning is more developed, in addition to the need for habituation and reinforcement in the form of exercises that can improve mathematics literacy.

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