ANALYSIS OF ELEMENTARY SCHOOL STUDENTS ABILITY IN MATHEMATICS LITERACY

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Abstract: This study is motivated by the importance of mathematics literacy abilities of elementary school students in relation to 21st century education issues. The purpose of this study is to find out how students are able to apply mathematical concepts in problems that arise in everyday life and the factors that influence them. The research design used was descriptive qualitative. This research was carried out on 30 fourth grade elementary school students in Bandung regency by giving mathematics literacy tests and followed by interviews. The results showed that the students' mathematics literacy abilities were low in terms of level one and two. Level one includes the ability to use knowledge about mathematical concepts directly. Level two includes the ability to use mathematical knowledge procedurally in solving problems. Mathematics literacy abilities are influenced by mastery of mathematical content and mathematical process thinking ability. Most students mistakenly understand the properties and difficult to solve the problem of measuring geometry. Students also find it difficult to draw conclusions due to errors in understanding the purpose of mathematical problems in real life contexts. Based on these findings, learning activities need to be designed optimally so that students can master mathematical concepts in a structured manner.

Keywords: students' mathematics literacy abilities, mathematics education, elementary education

1. Introduction

Mathematics is one of the subjects listed in the national education curriculum in Indonesia. Mathematics becomes one of the material that must be given starting from elementary education to higher education because of its usefulness aspects. Structured mathematical material content is delivered to students in accordance with the level of education they undergo (Minister of Education and Culture, 2016). The range of material studied in mathematics at the primary education level of class I-VI is limited to three main content, including numbers, geometry, and statistics (Minister of Education and Culture, 2016).

Mathematics as a structured science directs students to understand and realize the connection between each concept in it. But in reality most students have difficulties in solving problems in mathematics because of the lack of students' understanding of the mathematics material at the previous level (Untari, 2013). One of the factors that causes it is because the mathematical content is abstract, so students have difficulty understanding and interpreting it (Suherman, 2003). This relates to the developmental stages of students' thinking abilities which are still at a concrete stage (Thobroni, and Arif, 2013).

The lack of students' ability in interpreting the mathematics material they learn is feared to form an ignorant and pessimistic personality when studying mathematics or solving mathematical problems. Whereas if viewed in terms of its usefulness, mathematics is one of the sciences that cannot be separated from human life because mathematics is a servant for every other science (Suwangsih and Tiurlina, 2006). Competencies that must be achieved in mathematics learning also direct students to have other mathematical thinking abilities, including procedural fluency, problem solving, and logical reasoning (National Research Council, 2002).

Studies show that students' mathematics literacy ability in Indonesia are still low. This can be seen from studies that show the lack of ability of junior high school students in applying the concept of algebraic understanding in story problems in real life contexts (Setiawati, Jupri, Suherman, 2017). International lessons conducted by the OECD measure students' mathematics literacy abilities from junior high school to senior high school level, however, along with the development of the age needs, mathematics literacy abilities ideally begin to be studied since students attend elementary school. Therefore, the purpose of this study is to analyze about the mathematics literacy ability of grade IV students at level 1 and 2 and the factors that influence it cognitively from the mathematical process capability.

2. Related Works/Literature Review

The use of the literacy develops and expands to several skills such as understanding, communication skills, thinking skills, and the skills of connecting and solving problems. PISA as a study activity carried out by the OECD brings a new approach of literacy into the field of mathematics. Mathematics literacy ability requires someone to have an understanding of concepts, procedures, facts, or principles in mathematics to make decisions and provide an assessment of the problems that exist in everyday life (Ojose, 2011). Mathematics literacy involves things that are more complex than just applying algorithmic concepts. This ability encourages students to use their knowledge of the concepts they have learned and apply them to problems that are appropriate to the context of everyday life (Johar, 2012). Mathematics literacy skills ultimately form a person's intelligence in providing an appropriate problem solving assessment so that he is able to be part of a caring, critical, and constructive community member in dealing with real life problems.

Mathematics literacy involves seven fundamental abilities including: communicating, mathematisation, representation, reasoning and argumentation, devising strategies for solving problems, awareness and ability to read mathematical symbols and use them procedurally (De Lange, 2006; OECD, 2016). This ability is closely related to the three mathematisation processes. This mathematisation process is in the form of a thinking cycle which includes: a) the ability to understand problems in a real context or imaginable context; b) identify relevant mathematical content in the problem; c) transforming problems into formal mathematical models; d) solve problems using knowledge in mathematics (De Lange, 2006).

Mathematics literacy is a multilevel ability. Mastery at lower levels will help develop higher levels. There are several levels that can be used as indicators that a person has mathematical literacy skills (OECD, 2016). Table 1 describes the sequence of levels of mathematics literacy abilities.

Table 1. Levels of Mathematics Literacy

Level	Description of Student Ability
6	Students can conceptualize, generalize and utilize information based on inquiry and modeling complex problem situations.
5	Students can develop and work with models for complex situations, identify constraints and determine assumptions.
4	Students can work effectively in concrete but complex situations which may involve constraints in making assumptions.
3	Students can carry out procedures clearly, including procedures that require decisions in sequence.
2	Students can interpret and recognize situations in context that require direct conclusions.
1	Students can answer questions that involve a known context where all information is relevant and the questions are clearly defined.

Mathematics literacy abilities lead students to understand the benefits of learning mathematics, not just memorizing them. Mathematical problems that involve mathematics literacy abilities provide opportunities for students to feel the benefits of learning mathematics. This is supported by the opinion of Anthony and Walshaw (2009) that students begin to understand interesting and relevant mathematics to be learned when students can use concepts in mathematics to solve everyday problems. The existence of a movement to conduct international studies on mathematics literacy abilities through the PISA program adds to the importance of these abilities to be owned by students.

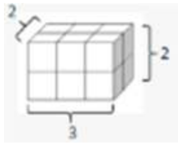
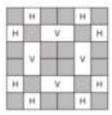
3. Material & Methodology

The research design used was descriptive qualitative. This study intends to collect data, and describe objectively and systematically the students' mathematics literacy abilities. This research was carried out on 30 students of grade IV elementary school in Bandung regency. Research participants were selected through purposeful sampling with a homogeneous sampling strategy. The study was conducted using mathematics literacy test instruments and followed by interviews. The test instrument consist mathematics material content of elementary school grade I-IV.

The test instruments given are described in Table 2.

Table 2. Mathematics Literacy Test Instrument

No.	**Mathematics literacy Ability Level**	**Mathematical Process Thinking Ability**	**Mathematics Material Content**	**Problem**
1	Level two. Problems are given to measure students' ability to apply knowledge of mathematical concepts procedurally.	Explain the answers to the solutions proposed and make conclusions of the answers make sense or not based on the interpretation and application of mathematical concepts in a real problem situation.	Measurement.	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!

No.	Mathematics literacy Ability Level	Mathematical Process Thinking Ability	Mathematics Material Content	Problem
2	Level one. Problems are given to measure students' ability to apply mathematical conceptual knowledge directly.	The ability to apply mathematical facts, rules, algorithms, and mathematical structures when looking for solutions.	Geometry space shape and structure.	Dudi is in charge of arranging boxes to make aquarium models. As an example in the following picture you can see a beam consisting of 12 boxes with a size of 3×2×2.  Determine all beam sizes consisting of 24 boxes that can be made!
3	Level two. Problems are given to measure students' ability to apply knowledge of mathematical concepts procedurally.	Formulate situations mathematically by recognizing mathematical structures (including order, relationships and patterns) in problems or situations.	Change the balance pattern between the weight of the ball, the cylinder, and the cube.	 Scales 1 and 2 contain balls, cylinders, and cubes with perfect balance. How many cylinders are needed to balance 3?
4	Level one. Problems are given to measure students' ability to apply mathematical conceptual knowledge directly.	Applying mathematical facts when looking for solutions to problem solving.	Symmetry folding forms on geometry.	The following is a picture of a square garden. Part of the garden to be planted with vegetables is (H) and fruits are (V). The gray square section is empty land. The garden is made symmetrically. Draw a fold symmetry line from the garden image! 
5	Level two. Problems are given to measure students' ability to apply knowledge of mathematical concepts procedurally.	Use concepts or procedures in mathematics to solve problems.	Measurement in geometric concepts.	Pay attention to the following picture!  The school will make a parking lot that has a length of 12 m and a width of 6 m. The parking lot is planned to be installed with paving blocks as shown above. If for every 1 square meter it takes 60 paving blocks, how many paving blocks are needed to make the parking lot?

(OECD, 2017)

Interviews are conducted in order to explore data about students' mathematics literacy abilities in more detail. Interviews are conducted after the completion of the given mathematics literacy test. Problems were asked regarding the gathering of students 'opinions on the tests given, confirming the perceived difficulties when answering, and the students' errors in answering.

4. Results and Discussion

Findings and analysis of answers to the first problem (see table 2).

In the answer to the first problem, the results of the patterns of answers are quite diverse, seen from the mathematical thinking process and mastery of mathematical content. The first answer can be seen in figure 1.

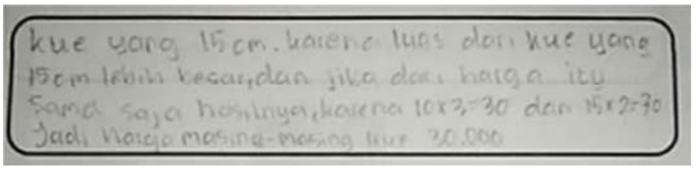


Figure 1. Student’s First Answer Pattern on First Problem

In these results students can determine the results of a more profitable purchase by using their knowledge about the area of the square, because the problem has been stated that the thickness of the cakes are as large. Students also showed the correct understanding in performing count operations, even though students answer in the form of simplification of operations. Count multiplication becomes $10 \times 3 = 30$ and $15 \times 2 = 30$. In the end students could conclude that with the same price, the purchase of a wider cake would more profitable even though the amount is less than small cakes. The interview results show that students can easily understand the problem, but do not realize that the use of the square area formula can be used to explain the reason more strongly.

The difference in interpretation of the first problem can be seen from the students' answer patterns that reflect the different abilities of the previous students in solving problems. The difference in research results is shown by the students' answers which can be seen in figure 2.

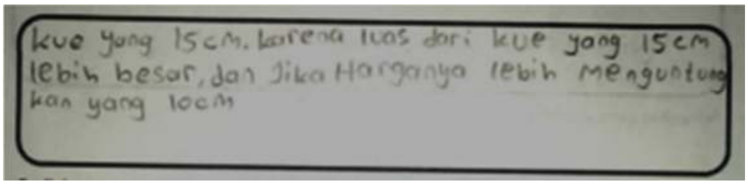


Figure 2. Student's Second Answer Pattern on First Problem

In this answer students have been able to use their knowledge of a wide area, but still have not found a relationship between the concept of price and the area concept. This can be seen from the conclusions of students who revealed that the benefits were viewed from a wider cake and the price which he thought would be smaller when buying small cakes. Students are wrong in drawing conclusions that the benefits referred to seen in terms of the size of the cake and from the different prices, even though the information is clearly stated.

The next difference can be seen in figure 3.

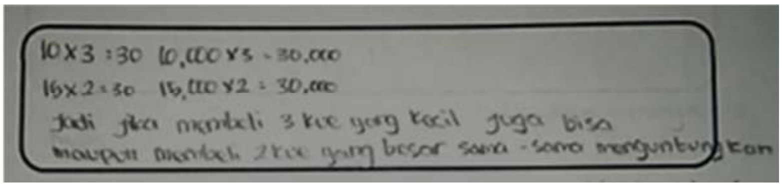


Figure 3. Student's Third Answer Pattern on First Problem

In the following answers students are wrong in taking an explanation because they lack the right information gathering, which is about the different cake area. The interview results show that students do not re-examine the problems in the problems after answering the problem.

Findings and analysis of answers to the second problem (see table 2).

The answer to the second problem about the structure of the cubes numbered 24 pieces are shown in figure 4.

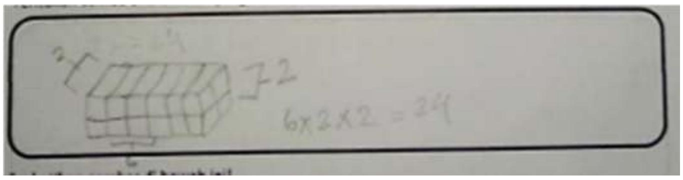


Figure 4. Student's First Answer Pattern on Second Problem

In this answer, students are able to make a picture representation of the beam structure consisting of 24 small cubes based on the information shown in the problem. Students also showed an understanding of the number of cubes based on the structure of beam, namely the base × height × width equivalent to 24 small cubes. Based on the results of the interview, students suggested that she did not realize there was a mistake between the difference between the picture and the writing he made. Students can also show a different representation of the structure of the box structure when interviewed.

Some students show different answer patterns than before, without giving a symbolic representation of small beams. Figur 5 is an example of the next student answer.

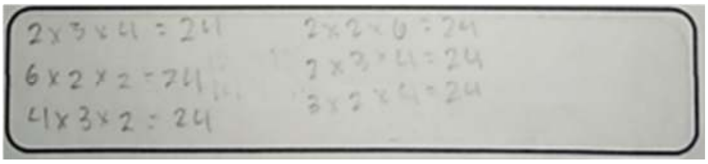


Figure 5. Student's Second Answer Pattern on Second Problem

The answer shows that students are able to directly make written representations. Students understand that the arrangement of the beam structure can change as long as the multiplication results from the base × height × width shows the results of 24.

The answer in figur 6 shows a student's mistake in understanding the problem.

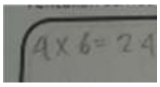


Figure 6. Student's Third Answer Pattern on Second Problem

Student answers show that students are wrong in understanding the structure of the beam. Students show multiplication which consists of only two elements, whereas the beam is a space that is composed of three structures, namely base, height and width.

Findings and analysis of answers to the third problem (see table 2).

Figure 7 shows the results of students' answers to number three mathematics literacy tests. The following student answers show structural thinking patterns in determining conclusions.

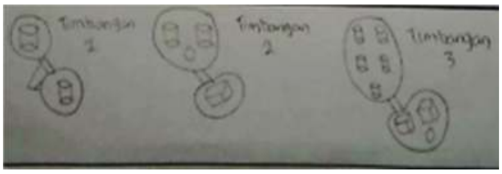


Figure 7. Student's First Answer Pattern on Third Problem

In the results of these answers students show their understanding in drawing conclusions from answers. Students reinterpret premise I to premise II, although there is a misrepresentation in premise I which should be one cylinder equivalent to three balls. In conclusion, students show that the result is two cubes and one ball will be balanced with five cylinders, even though the balance should be five cylinders with two cubes.

Other students only show the final answer to problem number three. Figure 8 is one of them.

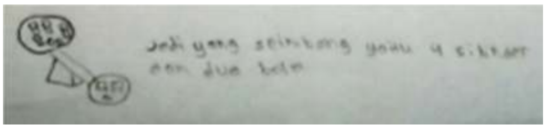


Figure 8. Student's Second Answer Pattern on Third Problem

The following student answers show students' ability to recognize the structure of relationships. There is a mistake when drawing the final conclusion which is indicated by the more one ball on the scale containing the cube in which the total of the three balls can be replaced by the weight of one cylinder. The interview results show that students miss the information available in the first scale that can be used to determine the final conclusion correctly.

Findings and analysis of answers to the fourth problem (see table 2).

Problem four measures students' knowledge in folding symmetry material in the form of contextual problems. One of the patterns of the answer that appears is represented by figure 9.

Figure 9. Student's First Answer Pattern on Fourth Problem

Students are able to recall what is meant by a symmetry line in a geometrical construct based on the results of these answers. The answer shown is also correct, because the garden image is a square that has the same side length so that the fold symmetry line that is right in the picture is four.

The next answer in figure 10 shows the students' mistakes about the concept of folding symmetry.

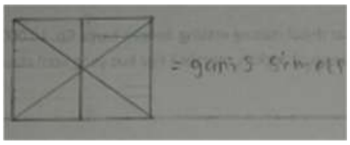


Figure 10. Student's Second Answer Pattern on Fourth Problem

The other students showed a representation of the symmetrical line drawing of a square image is three. The student's mistake here is because it is less precise in determining the symmetry line horizontally and forgetting the concept of square properties.

Students' mistakes in answering are also shown in the figure 11.

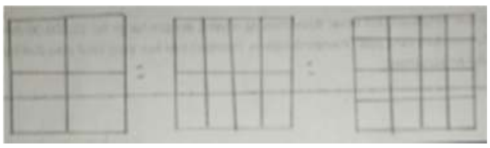


Figure 11. Student's Third Answer Pattern on Fourth Problem

In the results of these answers, students show errors in determining fold symmetry lines. Students show the understanding that the fold symmetry line is a line that can divide a two-dimentional figure with a size that is the same size, not as a line that can divide the two two-dimentional figure builds equally.

Findings and analysis of answers to the fifth problem (see table 2).

The next finding is related to students' ability to apply procedural mathematical concepts from contextual problems related to the measurement of the area of a field in a rectangular form. Here is figure 12 of the answer pattern.

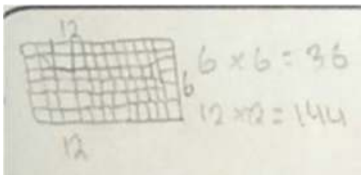


Figure 12. Student's First Answer Pattern on Fifth Problem

Students have been able to show pictures of representations of a rectangular field with a length= 12 cm and width= 6 cm, although not neatly. Students show errors in using the operating procedure to calculate the multiplication of a rectangular area, because the element multiplied by students is the length multiplied by the length and the width multiplied by the width. Based on the results of interviews, students admit that they are still often mistaken in using algorithms to search around and the area of a rectangular shape. Students also have not been able to demonstrate an understanding of the relationship between mathematical information to be used as problem solving in the context of the story above. Students show misunderstanding between the area as the overall content of an area, with a circumference that only shows the length of the four sides framing the rectangular representation. Therefore, finally students with misunderstanding will find it difficult to determine how much paving block is needed to fill the entire field area.

Other answers indicate a good understanding of students in solving problems at number five. Figure 13 is one of them.

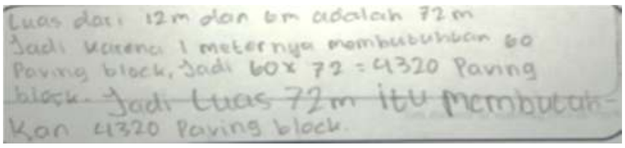


Figure 13. Student's Second Answer Pattern on Fifth Problem

The following students demonstrate an understanding of how to determine the required pavingblock by first finding the area of the parking lot. Students describe the answer in a detailed and structured manner. A good understanding of reading math vocabulary in story problems, helping students to determine problem solving strategies and understanding the right algorithms used to solve problems so students can communicate answers to problem solving logically and precisely.

5. Conclusion

The results showed that students' ability to solve contextual mathematics story problems was built by several aspects. These aspects include the ability to understand the purpose of the problem, the ability of the mathematical process, the ability to master mathematical material content.

The ability to understand problems includes accuracy in understanding the information in the question and how it relates to the problems listed in the question. Some students who do not understand the purpose of the problem are wrong in concluding the answers correctly. The factor of lack of rigor to understand the sentence of the problem encourages students to conclude the answer is only limited to the information implied in the problem without proving it mathematically.

Stages of students' thinking in sorting a problem solving procedure also become an important key in solving problems in the form of contextual stories. The mistake that often arises with regard to this ability is when students are confused in determining what procedures must be prioritized to do; and collect the premise of problem solving until formulating a problem solving conclusion.

The next ability that plays an active role is the mastery of students towards the previous mathematics material content. Students' mistakes in understanding mathematical content such as a fundamental understanding of the properties of a geometrical construct and how to determine the extent of building geometry. The next mistake is related to the error of completing a procedural multiplication count operation.

The results of this study are expected to be one of the knowledge that can open up insight into the importance of developing literacy abilities, especially in the realm of mathematics education. In connection with the results of this study, students need to be more accustomed to being introduced to contextual math problems. Learning activities need to be designed as optimally as possible so that students can master mathematical concepts in a structured manner. Thus learning can be expected to form mathematical logical thinking patterns that can be useful in the future.

Subsequent research can be carried out by deepening how mathematics literacy abilities are viewed from all thinking levels. Research on efforts that can be done through the implementation of learning to foster mathematics literacy abilities or how mathematics literacy abilities can correlate with other aspects can also be developed.

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