Analysis of elementary school students’ ability on mathematical communication and mathematical representation

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Abstract. This research is motivated by the importance of communication ability and mathematical representations of elementary school students as part of the standard process that students must have towards mathematical learning. The purpose of this study was to determine how far the communication and mathematical representations of students have. The research design used was descriptive qualitative. This research was conducted on 24 students of the fifth-grade elementary school in Bandung by providing communication skills and mathematical representation tests and interviews. The results of the study showed the low communication skills and mathematical representations of students in terms of the test instruments given to students. Most students find it difficult to conclude because of errors in understanding the meaning of mathematical questions in real-life contexts. Based on these findings learning activities must be developed to achieve the expected indicators so that communication ability and mathematical representations of students can be improved.

1. Introduction
Mathematics is one of the basic sciences that has a considerable role in both daily life and in the development of science and technology. Mathematics as one of the subjects taught in school certainly has a role in achieving a law-mandated educational goal. As for the purpose of mathematics education according to the 2013 curriculum Ministry of Education and Culture [1], emphasize on the modern pedagogical dimension in learning, namely using the scientific approach. In mathematics learning activities are carried out so that meaningful learning is observing, asking, trying, reasoning, presenting, and creating. In NCTM [2] there are 5 standard processes emphasized in mathematics learning including: 1) Problem Solving, 2) Reasoning and Evidence (reasoning and proof), 3) Communication, 4) Connections, and 5) Representations. The above capabilities are expected to be owned by the students to achieve the expected mathematical learning objectives. Of the five standard processes, communication and mathematical representation are two important things that can be owned by students in order to be able to communicate knowledge and represent their understanding both verbally and in writing. Barrody [3] mentions at least two important reasons, why communication in mathematics needs to be developed in students' circles. First, mathematics as language, it means that mathematics is not just a thinking tool, a tool to find patterns, solve problems or draw conclusions, but mathematics is also a valuable tool for clearly communicating various ideas, precisely and carefully. Second, mathematics learning as social activity: meaning, as a social activity in learning mathematics, mathematics is also a vehicle for interaction between students, and also communication between teachers and students.
According to Sumarno [4] mathematical communication indicators include the ability to: a) describe or represent real objects, images, and diagrams in the form of ideas and or mathematical symbols; b) explain ideas, situations and mathematical relations, verbally and in writing using real objects, images, graphics and algebraic expressions; c) state daily events in a language or mathematical symbol or suckle a mathematical model of an event; d) listening, discussing and writing about mathematics; e) reading with an understanding of a mathematical presentation; f) arrange conjectures, compile arguments, formulate definitions and generalizations; g) re-express a description or paragraph of mathematics in its own language.

A way to express mathematical communication ability among students at all levels of the school is with relevant representation. Representation is a new form as the result of the translation of a problem, or idea of translating a diagram or physical model into symbols or words NCTM [5]. Some examples of mathematical representations as suggested by Cai, Lane & Jakabcsin [6] are visual offerings, such as drawings, graphics, and tables, and similarities in mathematical expression and writing in their own languages, both formal and informal (written texts). To communicate mathematical ideas, students can represent them in various ways, whether in the form of writing, symbols, images or real objects. From these opinion students are expected to master the indicators of communication skills and mathematical representations to facilitate students in learning mathematics. The purpose of this study was to describe the level of mastery of communication skills and mathematical representations of students in mathematics learning.

2. Methods
This study uses descriptive qualitative research. This research was implemented on 24 students of fifth grade elementary school in the city of Bandung. The purpose of this study was to describe the level of mastery of communication skills and mathematical representations of students in mathematics learning. The research was conducted using communication and representation ability test instruments and followed by interviews. The test instrument includes fifth grade math material in elementary school. The test instruments provided in the form of communication skills and mathematical representation test instruments are described in table 1.

| No | Indicators of Mathematical Communication Ability | Mathematics Material Content | Problem |
|----|-----------------------------------------------|--------------------------------|---------|
| 1  | Connecting real objects, images, and diagrams into mathematical ideas | Cube | 1. Aldo has a cube-shaped gift as below. Explain what do you know about the picture! |
|    | Write down which ones include:                |      | A. Side/Field |
|    | A. Side/Field                                 |      | B. Edge       |
|    | A. Side/Field                                 |      | C. Angle Point|
| 2  | Declare daily events in a mathematical language or symbol or compose a mathematical model of an event | Cube | 4. Bathtub in the cube-shaped Ali house with a length of the ribs 90 cm. The body contains its 2/3. To fulfill the body, Ali had to fill it as much... Liters |

Table 1 shows the indicators of expected achievement in students' mathematical communication skills through cube material questions. The first problem is to know the properties of building a cube and the second is to know the volume of a cube-shaped bath.
Table 2. Mathematical Representation Ability Test instruments

| No | Indicator of Mathematical Representation Ability | Mathematics Material Content | Problem |
|----|--------------------------------------------------|------------------------------|---------|
| 1. | Make geometric drawings to clarify problems and facilitate resolution. | Cuboid | 2. Aquarium in Risna house in the form of a cuboid. 60 cm long, 40 cm wide and 50 cm high. Calculate the volume and draw the cuboid aquarium! |
| 2. | Answer questions using written words or text. | Cuboid | 3. A place of rice cuboid shaped with a long size, width and height in a row is 10 cm, 15 cm, and 100 cm. Place the rice will be filled full with rice for Rp. 8,000.00/ liters. How much money should be spent on buying the rice? Write the conclusion! |

Table 2 shows the expected achievement indicators in the ability of students' mathematical representation through beam material questions. The first problem is to calculate the area and describe the building of blocks with a known length, width and height.

Then the interview was conducted after the completion of the communication test and mathematical representation was given. Questions are asked in connection with collecting student opinions on the tests given, confirming the difficulties that are felt when answering, and the students' mistakes in answering.

3. Result and Discussion

In the answer to the first question the results of the patterns of answers obtained are quite diverse seen from the process of mathematical thinking and mastery of mathematical content. The first question shows a picture of a cube. Then the students were asked whichever includes the sides / fields, edge, and vertices. However, there are still many students who are mistaken about which side, which edge is, and which is the vertex.

In problem no. 4, it is known that the bath in Ali's house is a cube with a 90 cm edge length. The tub contains 2/3 of them. To fill the tub, Ali had to fill it again with a few liters. The student's answer is only to calculate the volume of the cube and multiply it by 2/3. But there also students only divide by number 3 without multiplying it by 2. The answer should be to find the volume of the cube and multiply it by 2/3. The result is 486,000 cm$^3$. Then the volume of the cube is 729,000 cm$^3$ and the result is 243,000 cm$^3$ and converted into liters (dm$^3$) to 243 liters. From the students' answers, it can be concluded that there is still a lack of mathematical communication skills in expressing daily events in mathematical language or symbols.

The students are asked to calculate the volume of the aquarium and are asked to illustrate or describe an aquarium in the form of a cuboid. But almost all students only answer and write down the volume of the cuboid, not describing the building of a cuboid aquarium. The ability of representation is seen from the ability of students to draw geometric patterns to clarify problems and facilitate resolution. Students only complete the counting operation on the volume of the cuboid. Even though in the problem students are asked to change their units to liters / dm$^3$ after finding the volume results. Then multiplying it by the price of rice per liter which is Rp. 8,000. Then concluded how much money must be spent to buy the rice. Here, it can be seen that students are still able to answer correctly as instructed by the questions.

4. Conclusion

The results showed that students' ability to solve mathematical story problems still showed that students were still experiencing difficulties. The number of students who do not understand the meaning of the questions given so that they have not met the expected indicators.

Some students who do not understand the meaning of the question become wrong in concluding the answer correctly. Students also still seem confused in answering questions that should have several steps
to solve, students only complete until the counting operation is done. While in some question students should be able to make the requested picture, then conclude the answer findings. The factor of lack of accuracy in understanding the sentence from the question encourages students to conclude the answer only in a limited way to the information implied in the problem without proving it mathematically.

The mistake that often arises related to this ability is when students are confused in determining what procedures should take precedence to work on and collecting the premise of problem solving to formulate a problem solving conclusion.

The next ability that plays an active role is the students' mastery of the content of previous mathematical material. Students' mistakes in understanding mathematical content such as a fundamental understanding of the properties of a geometry, how to determine the extent of the geometry, and understanding in arithmetic operations.

The results of this study are expected to be one of the knowledge that can open insight into the importance of developing communication skills and mathematical representation in the realm of mathematics education. In connection with the results of this study, students need to be more accustomed to being introduced to mathematical questions with the help of appropriate methods to improve communication skills and mathematical representation. Learning activities need to be designed as optimally as possible so students can master mathematical concepts in a structured manner. Thus, learning can be expected to be able to form mathematical logical thinking patterns that can be useful in the future.

Further research can be done by deepening how communication and representation skills can be improved. Through the Think Pair Share learning model that is seen from the indicators is a learning model that can improve students' communication skills and mathematical representation. Think Pair Share model is a cooperative learning model. In the first implementation the students are given the questions done by each student, then discussed with their peers to get the most correct answers among the answers that have been done by each. After that, representatives from each group presented their answers. From learning to use the model, we can find out the extent to which increased communication skills and mathematical representation of students who have worked on the pre-test to the post-test.

5. References
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