Analysis of Mathematical Communication Ability of Junior High School Students in Learning using Three-Dimensional Teaching Materials

Kartinah, Dina Prasetyowati, Sutrisno, Eny Hartadiyati Wasikin Haryan

Abstract: ***The purpose of this study was to describe the mathematical communication abilty of grade VII students after they were in Mathematics learning in the classroom using media in the form of three-dimensional teaching materials. The method used in this study is a descriptive qualitative method with research subjects in grade VII students in building material that includes: Beams, Cubes, Pyramid, Prisms, Cones, Tubes, and Balls. The auxiliary instruments in this study were interview sheets, and the problem of mathematical communication test. From the results of the analysis of the answers and the results of interviews with the subjects, it can be concluded that: (1) students with high mathematical communication abilities meet all the existing indicators, namely the ability to write about stories or events in everyday life into mathematical models, the ability to explain ideas mathematically both verbally and in writing, and the ability to pour mathematical ideas into pictures; (2) students with moderate mathematical communication abilities are fulfilling two indicators from three indicators, namely: the ability to write questions about stories or events in everyday life into mathematical models, and the ability to explain mathematical ideas orally and in writing; (3) students with low mathematical communication skills only fulfill one indicator, namely the ability to write questions about stories or events in everyday life into mathematical models.***

Key words: Mathematical Communication Ability, Junior High School, Teaching Material, Three Dimentional, Three Dimentional Shape

I. INTRODUCTION

The National Council Teaching Mathematics (Baxter, Hastings, Law, & Glass, 2008) formulated five mathematical abilities that students must master in learning mathematics, namely: problem solving, reasoning and proof, communications, connections, and representation. Students' mathematical communication abilities are important for students because they support the ability to understand concepts when students face mathematical problems. Mathematical communication is the competence of students to understand, express and interpret mathematical ideas both verbally and in writing (Baroody, 1993). In addition, mathematical communication also includes the ability to use language approaches and mathematical representations. While mathematical communication abilities can be interpreted as a student's ability to convey something he knows through dialogue or mutual relations events that occur in the classroom environment, where there is a message transfer. The message that is transferred contains about the mathematics material that students learn, for example in the form of concepts, formulas, or strategies for solving a problem. The parties involved in communication events in the classroom are teachers and students. The way to transfer messages can be oral or written (Cuoco, n.d.). In the process of learning mathematics in class, communication of mathematical ideas can take place between the teacher and students, between books and students, and between students and students (Cai, Jakabcsin, & Lane, 1996). Every time we communicate mathematical ideas, we must present the idea in a certain way. This is a very important thing, because if not, the communication will not be effective. The idea must be adapted to the ability of the person we are communicating with. We must be able to adjust to the representation system they are able to use. Without it, communication will only take place from one direction and not reach the target (Qohar & Sumarmo, 2013). Communication abilities can be trained to students in classroom learning activities, one of them with the help of media. Media that can be used can be student worksheets, videos, or teaching aids. Media is a tool that can improve the ability of students' mathematical communication. So that in this study produced a mathematical communication profile of seventh grade junior high school students in building material.

Mathematical Communication Ability

Communication in general can be interpreted as a way to deliver messages from the messenger to the recipient of the message either verbally or indirectly through the media. In communicating, you must think about how to make the message someone conveyed can be understood by others. To develop communication abilities, people can communicate in various languages including mathematical language. While mathematical communication abilities can be interpreted as a student's ability to convey something he knows through dialogue or mutual relations events that occur in the classroom environment, where there is a message transfer. The message that is transferred contains about the mathematics material that students learn, for example in the form of concepts, formulas, or strategies for solving a problem.

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Indicators of students' ability in mathematical communication according to NCTM (Baxter et al., 2008) can be seen from: (1) The ability to express mathematical ideas through oral, written, and demonstrate them and describe them visually; (2) Ability to understand, interpret, and evaluate mathematical ideas both orally and in other visual forms; (3) Ability to use terms, mathematical notations and their structures to present ideas, describe relationships and situation models.

Indicators that indicate mathematical communication abilitiy (Hidayat & Sumarmo, 2013) are: (1). Linking real objects, images, and diagrams into mathematical ideas; explain mathematical ideas, situations and relations, orally or in writing with real objects, pictures, graphics and algebra; (2). State everyday events in a language or mathematical symbol; (3). Listen, discuss, and write about mathematics; (4). Read with understanding a written mathematical presentation.

Indicators of mathematical communication abilities in this study are as follows: (1). The ability to write questions about stories or events in everyday life into mathematical models (using symbols and mathematical notation) (2). Ability to explain mathematical ideas orally and in writing (3). The ability to pour mathematical ideas into the form of images (visual).

To develop students' mathematical communication abilities, Pugalee (Date, Type, Cit, & Price, 1996) suggested that in mathematics learning students must be encouraged to answer questions accompanied by relevant reasons, and to comment on mathematical statements in their own language, so that students become aware of mathematical concepts and meaningful arguments.

Three Dimensional Mathematics Book

Build space is a naming or designation for a three-dimensional shape or a building that has a space limited by its sides. Examples of building space include cubes, beams, prisms, tubes, cones, pyramid and balls. The material used in this study includes: surface area and volume of cubes, beams, prisms, tubes, cones, pyramid and balls.

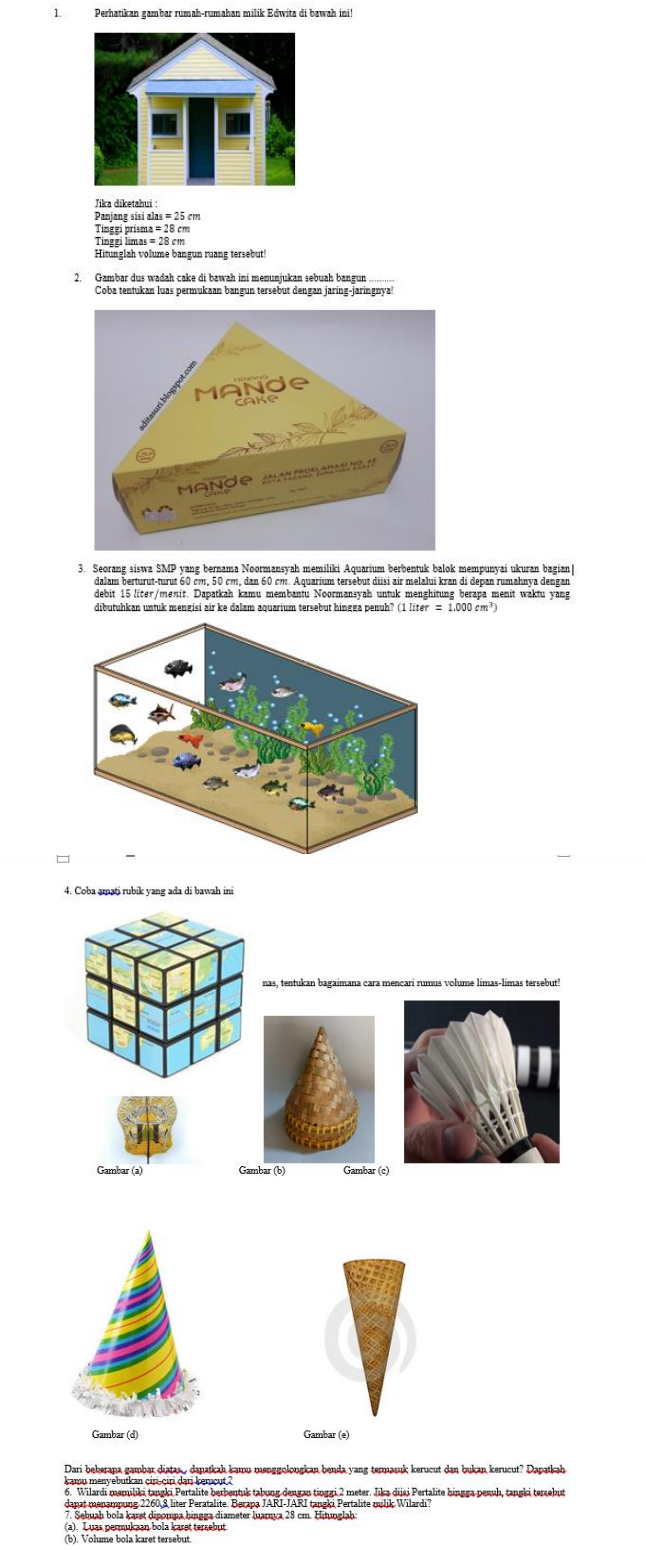
A three-dimensional book is a three-dimensional learning media, which is a media whose appearance can be observed from any point of view and has dimensions of length, width and thickness / height. Three-dimensional media can also be interpreted as a media group without projections which are three-dimensional visual presentation. This media group can be either original or dead, can also form as an imitation that represents the origin. The original object when it will function as a learning medium can be brought directly into the classroom, or students in one class are told directly to the real world where the original object is. The following is a three-dimensional Mathematics book that was created in the first year of this study.

Figure 1. Three Dimensional Shape

II. METHOD

The main instrument in this study is the researcher itself. While there are two instruments, the interview sheet and the written test instrument (about the mathematical ability of three dimensional shape). This written test instrument has previously been through the stage of validation and reliability testing. The interview instrument has also passed the validation step. The number of questions in this study were six questions.

The following are the test instruments used in the study.



This study took the research subject of high school junior grade seven students and to obtain research data required three research subjects who had different abilities. The subjects selected were S1 subjects with low mathematical communication abilities, S2 subjects with moderate mathematical communication abilities, and S3 subjects with high mathematical communication abilities. The three subjects were used to reveal the profile of the mathematical communication ability of junior high school students in solving mathematical problems in building materials. Researchers examine theories related to different abilities, so that it constructs indicators of students' level of mathematical communication skills in solving mathematical problems (Smieskova, 2017) , as in the following table:

Table 1. Indicator of mathematical communication abilities

No.	Indicator	Behavior
1.	The ability to write questions about stories or events in everyday life into mathematical models	a. Students are able to write mathematical problems into mathematical symbols / notations b. Students are able to formulate definitions of mathematical concepts and develop generalizations
2.	Ability to explain mathematical ideas orally and in writing	a. Students are able to express images, diagrams, or real situations into mathematical language, symbols, ideas, or models b. Students are able to explain or clarify mathematical ideas, situations, or relationships in everyday language orally or in writing
3.	Ability to pour mathematical ideas into pictures	a. Students are able to read, clarify, and examine mathematical presentations meaningfully b. Students are able to appreciate the power of mathematical notation and use it accurately and precisely

III. FINDING

Analysis of subjects S1 (Students with Low Mathematical Communication Abilities)

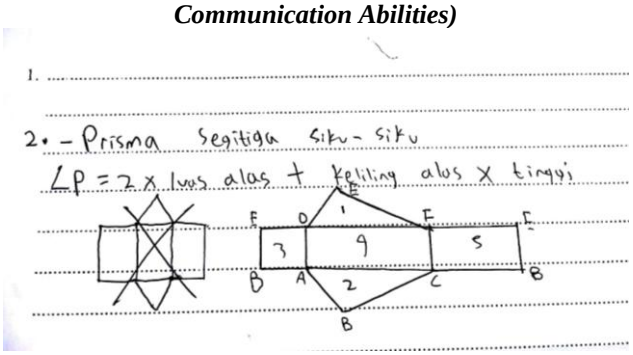


Figure 2. Answers of subject S1 problem 1 and 2

S1 subject empties the answer for problem number one, does not write any information at all. Interviews conducted on S1 subjects revealed that S1 subjects did not know what to write, because they were confused in distinguishing the shape of the pyramid with the prism (looking for the volume of the house).

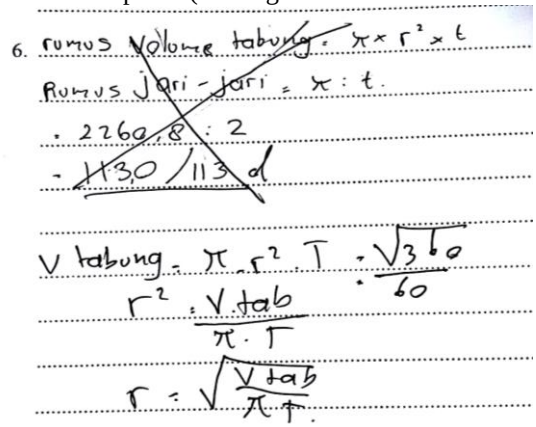


Figure 3. Answers of subject S1 problem 6

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Undergraduate subjects in answering number six questions write the tube volume formula correctly, the subject's mistake is to write a high notation using the letter "T", not "t". Thus, from the answers to questions number one and six, S1 subjects are not able to write mathematical problems into mathematical symbols / notations. Although for number one, the subject does not fulfill any indicator of mathematical ability, but in problem number six, the subject is able to write mathematical problems into mathematical symbols / notations (indicator 1 point a) and the subject is able to express pictures, diagrams, or real situations to in mathematical language, symbols, ideas, or models (indicator 3 points a).

Analysis of subjects S2 (Students with Middle Mathematical Communication Abilities)

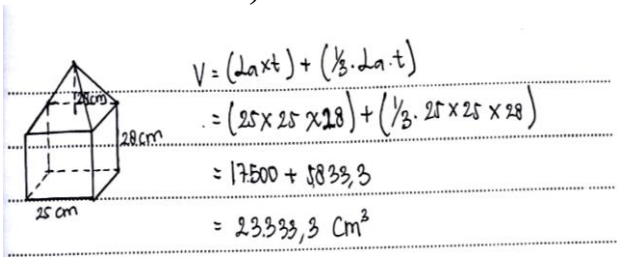

Figure 4. Answers of subject S2 problem 1

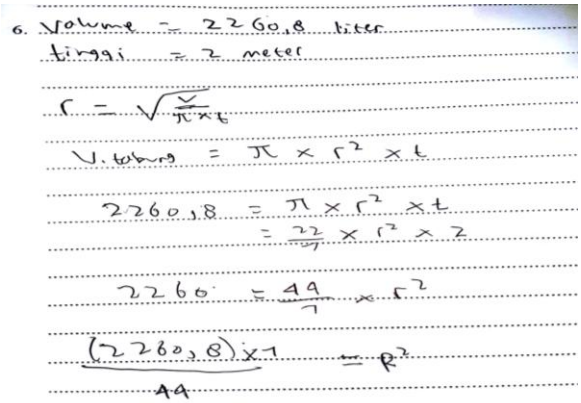

Figure 5. Answers of subject S2 problem 6

S2 subjects write answers to number one questions by writing symbols / mathematical notations well (indicators 1 and 2) and fulfilling the behavior of a and b in each of these indicators. But the subject made a mistake in writing the answer of sixth problem that is writing the notation of the radius and could not complete the answer completely.

Analysis of subjects S3 (Students with High Mathematical Communication Abilities)

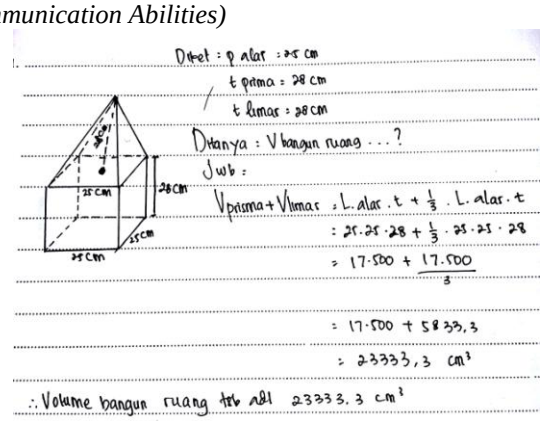

Figure 6. Answers of subject S3 problem 1

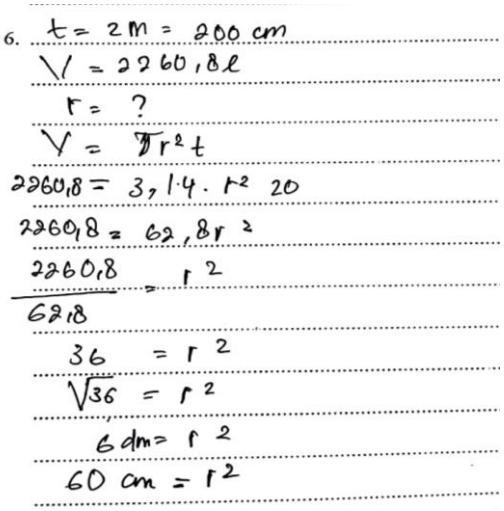

Figure 7. Answers of subject S3 problem 6

S3 subjects write answers to number one questions by writing symbols / mathematical notations good (indicators 1 and 2) and fulfilling the behavior of a and b in each of these indicators. Subjects can also complete the answer to question number six to complete, there is no error in writing mathematical notation, so that the S3 subjects fulfill all three indicators of mathematical communication abilities.

IV. CONCLUSION

From the results of the analysis of the answers and the results of interviews with the subjects, it can be concluded that: (1) students with high mathematical communication abilities meet all the existing indicators, namely the ability to write about stories or events in everyday life into mathematical models, the ability to explain ideas mathematically both verbally and in writing, and the ability to pour mathematical ideas into pictures; (2) students with moderate mathematical communication abilities are fulfilling two indicators from three indicators, namely: the ability to write questions about stories or events in everyday life into mathematical models, and the ability to explain mathematical ideas orally and in writing; (3) students with low mathematical communication skills only fulfill one indicator, namely the ability to write questions about stories or events in everyday life into mathematical models.

Talk about mathematics does not come naturally. "Because mathematics is so often conveyed in symbols, oral and written, communication about mathematical ideas is not always recognized as an important part of mathematics education. Students do not necessarily talk about mathematics naturally; teachers need to help them learn how to do so (Cobb, 2015). It is very significant at mathematics that strong mathematical communication be articulated. Because of this reason, the mathematical communication using three-dimensial book should be constructed properly.

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