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Students' problem in communicating mathematical problem solving of Geometry

Sumaji¹, C Sa'dijah¹, Susiswo¹ and Sisworo¹

¹ Post Graduate School, Universitas Negeri Malang

sumaji.1503119@students.um.ac.id

Abstract. This research describes students' problems in communicating geometry mathematic problems solving. The research is descriptive qualitative. The subject is 30 eighth graders of SMP 2 Kudus. Those students are grouped into three categories: (1) students experiencing problems in communicating mathematic solution in the form of mathematical expression, (2) drawing, and (3) written text. The steps to categorize the subjects are: (1) giving mathematic communication task, (2) doing assignment based interview to confirm the answers of the students, and (3) grouping the subjects into three categories experiencing mathematic solving problems. The instruments to collect the data are problem solving tasks and interviews. The findings show students with the problems take form into mathematical expression, drawing, and written text.

1. Introduction

Some researchers argue similarly toward the importance of mathematic communication in learning mathematics [10, 13, 16, 17,22,25,27]. Through mathematic communication, students can manage, think, and clarify their notions, relations, and mathematical thought and arguments [13,17, 22, 25]. Aligning with the notions above [27] states that mathematic communication facilitates students about process, discussion, and taking decision. It is different with [16] stating that mathematic communication can develop conceptual understanding. Aligning with the notion [10] explains mathematical communication can develop conceptual understanding, problem solving, and mathematical reasoning of the students. Therefore, it is important for them to have the ability in learning and understanding a mathematical object [30]. Reasoning is a skill used both to teach and learn mathematics [14].

[6] states to realize mathematic communication of the students in the class can be done by using 4 strategies: (1) giving appropriate tasks, (2) creating conducive environment to express their notions,(3) directing them to explain and argue toward the given results, and (4) directing them to actively process various ideas and notions. Aligning with those opinions, [7] explain that to realize mathematic expression requires teacher to motivate in discussion and to share their ideas in solving problems with other people. The same thing also stated by [1] that teachers need to motivate oral questions, written, concrete representation, explanation and until correcting in solving mathematic problems. Without teacher motivation, then the process of mathematic communication in delivering the mathematic ideas both oral and written will not be maximum [7]. It is different to [28] stating that one of the best ways to motivate mathematic communication is by giving them active participative environment for the students, by giving challenging tasks. This challenging task gives opportunity for the students to have more ideas so they can develop their mathematic communication [23]. Aligning with those opinions,

[5] states that challenging problem will motivate the communication through problem solving by having reason in each step.



Mathematical communication can take form into written or oral forms [21]. Written communication is an individual's ways to explain in detail about specific mathematic ideas [13]. Some researchers have similar arguments, written mathematic communication [5,18,24,28,29]. [28] states that written mathematic communication can be using text, pictures, tables, diagrams, or mathematic symbols. It is also stated by [5,24,29] to find out mathematical communication can be seen from three aspects: (1) communicating mathematic ideas by writing texts, (2) communicating mathematic ideas by drawing, covering from: drawing pictures, tables, diagrams, graphics, and (3) communicating mathematic ideas by mathematic expression (making model/equation then calculate them). Aligning with the opinions, [18] explain the aspect of written mathematic communication are: (1) communicating mathematic ideas by having algebraic (explaining the ideas using equation), (2) communicating mathematic ideas by using numerical (explaining the ideas using arithmetic by involving calculation and manipulation), and (3) communicating mathematic ideas verbally (explaining written ideas using words), (4) communicating mathematic ideas using diagrammatically and graphically (explaining diagrams, graphics, or other illustrations).

Some researchers [4,8,13] explain the importance of written communication in mathematics. This communication facilitates students in using vocabulary, phrases, symbols, and mathematic meanings [4]. Furthermore [4], states that written mathematic communication is important because it is a meant reflecting the students' mathematical understandings. Written mathematic communication can help students to express their thought in explaining strategies, improving knowledge, writing algorithm, and improving cognitive skills [13]. Mathematic communication can facilitate low level students to improve their conceptual understanding [8].

Oral communication is an activity to explain the procedures of problem solving which has been done, then it is expressed orally [15]. Aligning with the notion, oral communication can be explained as situation where students understand a problem and have capability to share argument or opinion orally [2]. Oral communication covers about talking, listening, asking, explaining, defining, discussing, drawing, and correcting [18]. Aligning with the opinions above [3] states that the indicators of oral communications are: speaking, listening, oral expression, discussion, dialog, and thinking while talking.

Studies related to mathematical communication and its problem solving have been frequently done. The studies are about: (a) process of mathematic communication in class [9,10,16,26], (b) the forms of mathematic communication [10,11,20,25], and (c) mathematic communication involving gestures [12,19].

The findings of the research about mathematic communication can be explained as follow: (a) related to communication process in the class by giving information: communication process occurring between teachers and students and among students. Mathematic communication can train their cooperation; motivate their higher order thinking; it helps students to realize their cognitive and emotional aspects; (b) related to the forms of mathematic communication by giving information that mathematic communication can take form into various ways, such as: (algebraic expression, arithmetic), drawing (graphic, figures, diagram, and tables), (c) communication involving *gesture* to give information that gesture can facilitate and make mathematic understanding clear. Gesture can decrease misleading in understanding the concept of mathematics.

Based on the findings done by previous studies, there is an absence of a theory discussing about the problem of the students in communicating geometry mathematical problem solving in mathematical expression, drawing, and written text aspects.

2. Method

This research describes students' problems in communicating mathematic problem solving in geometry material in aspects of drawing, mathematic expression, and written texts. It is a descriptive qualitative research, describing the problems of communicating mathematic problem solving in geometry material of eighth graders of SMP 2 Kudus. The selected students are eighth graders because: (1) they are in formal operational stage, (2) they have had basic knowledge to solve

mathematics problems, and (3) they are still in basic educational level so they can express their ideas well.

The subjects of this research are 30 graders eight grade of SMP 2 Kudus. Those students are grouped into three categories: (1) students with mathematics problem solving communication in the form of mathematical expression, (2) students with problems to communicate mathematics problem solving communication in the form of drawing, and (3) students with problems to communicate mathematics problem solving communication in the form of written text.

The steps in categorizing the subjects are: (1) giving mathematics communication tasks, (2) interviewing based on tasks to reconfirm the answers of the students to get unguined information from written test, and (3) grouping the subjects into three categories based on the hindrances in communicating the problems. Based on the explanation, it can be shown as in diagram 1 below.

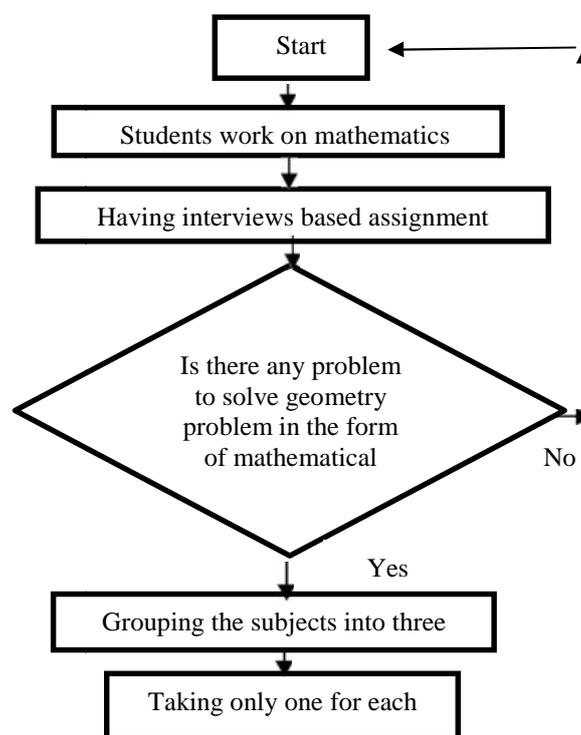


Figure 1. Selecting the subjects.

The next step after for each category has been taken only one subject to be investigated, then the students do assignment on written form as follows.

Instrument

Mr Joko builds house whose roof with pyramid shape. Draw at least three possibilities of the pyramid with volume 96 m^3 . Is the base always square? Explain!

Then, the researcher analyzes the written answer and the interview results to get the data about the students' problems in communicating mathematics problem solving in geometry in terms of drawing, mathematics expression, or written text. Based on the purpose of the research, the technique of analyzing the data is qualitative analysis. The steps are: transcribing the collected data, reducing the data by creating abstraction, arranging each part of the data and categorizing by creating coding,

creating category of students' problems in communicating mathematic problem solving, and creating conclusion.

3. Result and Discussion

Below are the explanations of the findings related to the students' problems about mathematic problem solving in geometry. The subjects are 30 eighth graders of SMP 2 Kudus. They are grouped into three categories: (1) students with mathematic problems solving communication in the form of mathematic expression, (2) students with mathematic problem solving communication in the form of drawing, and (3) students with mathematic problem solving in the form of written text. The findings related to the problems are shown in Table 1.

Table 1. The categories of the students in communicating mathematical problem.

Number	The Categories	Percentage
1	Mathematical expression	13,33 %
2	Drawing	23,33 %
3	Written texts	10 %
	Average	46,66%

Based on Table 1 13,33% of the students have problems in communicating mathematical ideas in the form of mathematical expression or symbolic language. 23.33% of the students have problems in communicating mathematic problem solving in the form of drawing, covering: creating the drawing. 10% of them have problems in communicating mathematic problem solving in the form of written texts. It means about 46.66% of the students still have problems in communicating geometry problem solving. Based on the table, the most experienced problems is to draw with percentage 23.33%, then mathematical expression with percentage 13.33%, and the lowest one, written text with percentage 10%.

Then, each subject will be elaborated started from S1, S2, and S3 from each category of mathematic problem solving communication problems. S1 is a student with mathematic problems solving communication problem about geometry in the form of mathematical expression. S2 is a student with mathematic problem solving communication problem about geometry in the form of drawing. S3 is a student with problem in the form of written text.

The problems in mathematical expression

Here is the written work of S1 with mathematic problem solving in the form of *mathematical expression*. The problems are the use of symbolic language, as for example assuming the height or a side of pyramid. The work of S1 can be seen on Figure 2.

Name : wiranda Randi P
Class : 9A

Number: 33 4 pyramids = 96 m³

$$= \frac{96}{4}$$

$$= 24$$

$$V = \frac{1}{3} \cdot \text{La} \cdot t$$

$$24 = \frac{1}{3} \cdot \text{La} \cdot T$$

$$\frac{3}{1} \cdot 24 = \text{La} \cdot t$$

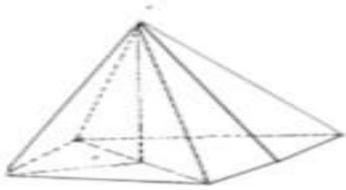
$$72 = \text{La} \cdot t$$


Figure 2. The answer of S1 with mathematical expression problem.

Here is the interview excerpt of S1 with problem in communicating mathematic problem solving in the form of mathematical expression. The problem is using symbolic language to make analogies for height and the area of pyramid. The interview was done after finishing the written mathmatic pobleml solving task.

A: Did you ever work on such task?

S1: Never

A: Do you know what it is?

S1: It is a pyramid.

A: Can you explain the definition of pyramid? Please tell me!

S1: I don't know

A: Why do you divide the volume of the pyramid by 4? Please explain to me!

S1: Because it has 4 sides.

A: Do you think in a pyramid there are four pyramids?

S2: Yes

A: Why do you think so?

S2: I don't know

A: Which one is height of the pyramid? Please explain to me!

S1: I do. It is the straight line across the area.

A: Do you know which one is the area? Please tell me!

S1: I do. It is the square.

A: How did you get the area and the height of the pyramid? Please explain!

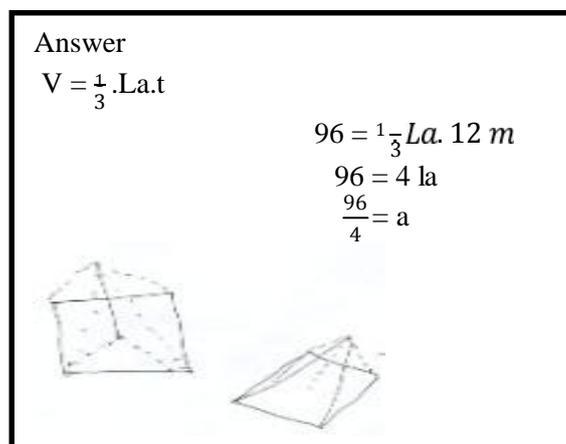
S1: I don't know

Based on the written test and interview, it can be explained S1 has not fully understood the definition of pyramid. It is shown that S1 divides the volume by 4 because S1 does not understand the definition of pyramid. He does not understand the characteristics and the elements of pyramid. He thinks inside of pyramid there four pyramids. S1 also has not determined the base area or the height using analogy to represent the base area or height, so he cannot calculate to get the height and sides. Therefore, S1 has problems in mathematical expression to use the symbolic language in solving the problems. This finding supports the previous findings by [5,29] stating that only a few subject can mathematical expression ideas by using mathematical model and correct formulation.

Based on the written test and interview, it can be concluded S1 experiencing mathematical problem category that is S1 has not been able to use symbol to represent base area or height of the unknown pyramid. It makes her not able calculate. According to [5,29], mathematical expression is an embodiment of mathematical communication in the form of creating equation then doing calculation. The different thing is expressed by [24], telling that mathematical expression is a embodiment of mathematic communication in the form of symbol. Therefore, when subjects are given mathematic problems, they have not been able to communicate mathematical ideas in the form of symbols. Furthermore, [24] states symbols is a statement of situation into mathematic language. According to [29], symbolic language is transformation a certain situation to mathematics model.

The problems in drawing

Here is the written work of S2 with problems in communicating problem solving in the form of *drawing* pyramid. The work of the subject can be seen on Figure 3.



Answer

$$V = \frac{1}{3} \cdot La \cdot t$$

$$96 = \frac{1}{3} La \cdot 12 m$$

$$96 = 4 la$$

$$\frac{96}{4} = a$$

Figure 3. The answer of S2 with drawing problem.

Here is the excerpt of interview with S2 with the communication problem to draw pyramid. The interview was done after finishing the work on written problem solving task.

A: Tell me what do you know about pyramid?

S2: I don't know

A: How many sides of pyramid? Please tell me!

S2: 5 (five) they are 2 (one) base, and 3 sides

A: Is base area same with side? Please tell me!

S2: I don't know

A: What is the shape of pyramid's side?

S2: triangle

A: How many corner points does a pyramid have?

S2: 6 (six)

A: How many edges of a pyramid?

S2: 7 (seven)

A: Before drawing, what components should you know? Please tell me!

S2: Sides with triangle shapes, area, and height.

A: Can you tell me the steps of drawing pyramid?

S2: I don't know

A: From the pictures you drew in figure 2, what are the differences?

S2: Similar

According to the written test, S2 has not understood the characteristics of pyramid. It can be shown from interview that she has not understood the numbers of pyramid's sides. S2 also has not been able to differ the shape of base area and the sides. S2 also has not been able to determine the numbers of corner points. They also have not understood the numbers of edges of the pyramid. They also have not understood the components needed to draw a pyramid. They also have not explained the steps of drawing the pyramid. It causes them to have drawing problem. According to [5,29], drawing is an embodiment of mathematical ideas by drawing, such as: drawing figures, tables, diagrams, and graphics. It aligns with [18, 24], drawing is an embodiment of communication in the form of diagrams, graphic, or other illustrations. This finding supports the previous findings [24,29] stating only a few subjects can express mathematical ideas by drawing them correctly.

Based on the explanation, S2 can be concluded to have not been able to understand the characteristics of pyramid. It affects into his drawing. Therefore, S2 has difficulty of mathematic problems solving problem in *drawing* both written and oral.

The problems in written text

Here is the written work of S3 with problems in communicating mathematical problem solving in the form of written text. The problems are to express ideas into written text. The written work of S3 can be seen on Figure 4.

Name : Rico arya dwi putra R
 Class : 9A
 Number:28
 Known: the roof of Mr Joko's house is pyramid
 Asked : if the design of pyramid has $V = 96 \text{ m}^3$ is the base square?
 Answer = formula $V = \frac{1}{3} \cdot L_a \cdot t$

$$= \frac{1}{3} \cdot 12 \cdot 24$$

$$= 96 \text{ m}^3$$

The base is square because it has:
 $p = 4 \text{ m}$
 $l = 3 \text{ m}, t = 24 \text{ m}, \quad L_a = p \times l$
 $= 4 \text{ m} \times 3 \text{ m}$
 $= 12 \text{ m}$

$$t = L_a \cdot 2$$

$$= 12 \text{ m} \times 2 \text{ m}$$

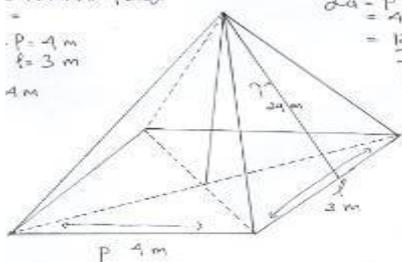
$$= 24 \text{ m}$$


Figure 4. The answer of S3 with drawing problem.

Below is the excerpt of interview with S3 with the problem in the form of written text. The interview was done after finishing written mathematical problem solving.

A: is the base area of pyramid a square?

S3: Yes

A : Do you know what is meant by square? Please tell!

S3: I don't know

A: Why is the area of pyramid shaped square?

S3: I don't know

A: Are the length of the square same?

S3: Yes

A: Why? Can you tell me the reason?

S3: I don't know

A: Do the angles of the corners have similar measurement?

S3: Yes

A: Can you tell the reasons?

S3: I don't know

A: Do you know what is meant by corners? Please tell!

S3: I don't know

A: In your opinion, is the area a rectangular always a square?

S3: I don't know

Based on the interview and written test, S3 agrees the area of pyramid is a square but he cannot explain the reasons. They also have not understood the definition of square but they know if the sides of square are similar in length. They have understood that angles in squares are equal but cannot tell the reasons. Generally, S3 has not been able to explain both in written and spoken why the area of pyramid is a square. According to [5, 29] writing text is an embodiment of communication in the form of written phrases. Agreed to that notion [18], written text is an embodiment of verbal communication into written text.

Based on the explanation, it can be concluded S3 has problem with communicating mathematical problem solving in geometry about the volume of pyramid in the form of written text both orally and written because he has not understood the area of pyramid. This finding supports previous studies [24,29] stating only a few of subjects can express mathematical ideas in the form of correct written texts.

4. Conclusion

Based on the findings, it can be concluded the problems experienced by students in communicating mathematical problem solving in the form of mathematical expression is they have not been able to use symbolic language by creating analogy of area and height of the pyramid, both the unknown one or being calculated. Students have problem in communicating mathematical problem solving in the form of drawing that is they have not understood the characteristics of pyramid and the steps to draw. It influences to their difficulties in describing the pyramid and the students have problems in communicating mathematical problems in the form of written text. They have not been able to understand the shape of pyramid so they cannot communicate the form into written wordings.

Suggestions are addressed to teachers. They should frequently give mathematic problem solving tasks so the students are able to communicate mathematic problem solving in the form of mathematical expression, drawing, and written text. For the next researchers, there is a need to not limit the research

in junior high school level but in primary school or high school levels. The topic is not limited in geometry but also the different topics.

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