Analysis of Student’s Errors in Solving Mathematical Communication Problems

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Abstract. This research aims to analyze student’s errors in solving mathematical communication problems about Euclidean solid. The type of the research is descriptive in the form of case study. The technique of collecting data as follows: tests, interviews, and documentation. The subject in this research are students in grade eight. Based on the results of research the students errors such as: (1) errors to receive information of the problems (2) errors in applying formula (3) errors related to the concept of euclidean solid (4) errors in calculating. The cause of errors made by students are they don’t carefully read and solve the problems, they lack understanding the concept of the prism, they doesn’t understand the elemen of pyramid, they don’t know how to calculate the pyramid surface area.

1. Introduction
Mathematics is one of the most important disciplines. Mathematics is full of symbols that require a high mathematical understanding. Budiono et al (2014) explained that Mathematics need to be given to all students starting from school primary and secondary to equip students with the ability to think logically, analytical, systematic, critical, and creative, as well as ability to cooperate. Besides, for develop the ability to use mathematics in problem solving and communicate ideas or ideas with use symbols, tables, diagrams, and other media.

One of the goals of learning mathematics according to NCTM is learning to communicate that is mathematical communication (Gordah and Astuti, 2013). Mathematical communication is a way for students to express mathematical ideas either orally, written, drawing, diagrams, using objects, presenting in algebraic form, or using mathematical symbols (NCTM, 2000; Hirschfeld and Nebraska, 2008). In fact, Wichelt (2009) considers that communication is a vital skill in mathematics. While Ontario Ministry of Education states that “Mathematical communication is an essential process for learning mathematics because through communication, students reflect upon, clarify and expand their ideas and understanding of mathematical relationships and mathematical arguments” (Ontario Ministry of Education, 2005).
Another opinion states that the ability of students' mathematical communication is very necessary to be developed, because through mathematical communication students can perform the organization of mathematical thinking both orally and in writing (Suhaedi, 2012). But the reality in the field shows that students' mathematical communication ability in Indonesia is still low (Prayitno, Suwarsono and Siswono, 2013). It's similar with the result of observation showed that students mathematical communication still low because they experience difficulties in learning mathematics. Students also make some errors when solve the mathematical communication problem. Thus, this study aims to analyze students errors in solving mathematical communication problems.

1.1. Mathematical Communication
Mathematical communication is one of the studies in the development of mathematics curriculum in schools. Mathematics learning in class (NCTM, 2000) should enable students to: (1) organize and consolidate mathematical thinking and communicate to other students; (2) expressing mathematical ideas coherently (logically arranged) and clear to other students, teachers, and others; (3) increasing or expanding students' mathematical knowledge by thinking of the thoughts and strategies of other students; (4) using mathematically correct language in various mathematical expressions. According to NCTM so indicators of mathematical communication in this study should enable students to (1) stated a situation, picture, diagram, or real object into a mathematical form; (2) Stated a mathematical idea into a picture; (3) Explain ideas and drawings into written mathematical models; (4) Express daily stories in mathematical language or symbols.

1.2. Errors analysis
Errors can occur at any time when the students solving the mathematical problem, therefore error analysis is a major step to be taken to avoid causing errors (White, 2005). Newman (Abdullah, 2015) suggests that there are five stages in the solution mathematical problems, namely (1) reading error is the ability of students to read mathematical problems given and to identify sentences and mathematical symbols used, (2) comprehension errors of the ability of students to understand math problems, (3) transformation errors that is the ability of students to determine the method of mathematical solution, (4) process skill errors that is the ability of student in doing process skill errors of mathematics correctly or not, and (5) enconding errors that is student ability to write enconding errors according to question. So this study using Newman’s theory to analyze the type of student’s errors in solving mathematical communication problems.

2. Method
This study is a descriptive in form case study. The subject was five students with most errors in the test indicators who were taken from 34 students of 8th graders in a secondary school in SMPN 1 Lembang. Data was obtained through test students’ interview. The instrument used for this study was five test questions to identify the types of students' errors. The items contained in the instrument is about euclidean solid. The time allocated to answer questions was 60 minutes. The errors were analyzed using five types of errors by Newman that are reading errors, comprehension errors, transformation errors, process skill errors and encoding errors.
Table 1. Item question of mathematical communication problems

<table>
<thead>
<tr>
<th>Item</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>A dice has volume 216 cm³. If a matchbox has a length of 2 times the dice length and the width is ¾ of its length, then specify the matchbox height if it is known that the surface area is 426 cm². Make a mathematical model to calculate the matchbox height!</td>
</tr>
<tr>
<td>Item 2</td>
<td>A prism with base length 6 cm, base height 8 cm, and height prism 12 cm prism. Based on the shape of the base, what is the prism? then draw the prism!</td>
</tr>
<tr>
<td>Item 3</td>
<td>A miniature roof of the house has a base square shape 18 cm x 18 cm and its upright side consists of four congruent isosceles triangles. The area of one of the triangles is 135 cm². Make a mathematical model of the roof. Then specify the surface area!</td>
</tr>
<tr>
<td>Item 4</td>
<td>A prism-shaped aquarium made of glass with a right trapezoidal base that is 0.6 m and 1.5 m length and 0.5 m trapezoidal height. If the height prism is 0.8 m, determine the volume of the aquarium!</td>
</tr>
</tbody>
</table>

Analysis student's errors in solving mathematical communication problems
3. Result and Discussion

The results of this study are five students with the most errors in indicators of mathematical communication. The results of the study are presented in the following table.

<table>
<thead>
<tr>
<th>Student's code</th>
<th>Item 1</th>
<th>Item 2</th>
<th>Item 3</th>
<th>Item 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>02</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>03</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>04</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>05</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Total score of item</th>
<th>Maximum score of item</th>
<th>Percentage of item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>50</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>30</td>
<td>40%</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>45</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>25</td>
<td>24%</td>
</tr>
</tbody>
</table>

Based on the results in the table above we can see that item 1 has percentage 20% for indicator stated a situation, picture, diagram, or real object into a mathematical form. Item 2 with percentage 40% for indicator stated a mathematical idea into a picture. Item 3 has percentage 20% for indicator explain ideas and drawings into written mathematical models. Then item 4 has percentage 24% for indicator express daily stories in mathematical language or symbols. From the percentage we know that students mathematical communication ability still low because for each item we don’t get more than 40%. Its cause students make some error in solving mathematical communication problem. Now we will show the type of errors made by students. There are three types of students’ errors that are reading error, comprehension error and process skill error.
3.1. Reading error

Reading error occur when students are not able to read mathematical problems given and to identify sentences and mathematical symbols used. This is an example student’s error when write the information about the problem:

![Figure 1. Student can’t use mathematical symbol, can’t write the shape of Euclidean solid, can’t write the right denomination of volume.](image)

From figure 1 we can see that student can’t use mathematical symbol for write volume, length, width, and surface area. He must use mathematical symbol such as $v$ for volume, $p$ for length and $l$ for width. They also can’t representated the real object to mathematical object. He don’t know the dice has similar shape with the cube and matchbox has similar shape with beam. The interview showed that this error caused because the subject was careless.

3.2. Comprehension error

Comprehension error occur when students not able to understand math problems. So the student was not able to identify the procedure and solve the problem. Here’s the example when student not able to indentify how to calculate volume of prism:
From figure 2 student can’t calculate the volume of prism because he don’t know concept of prism and formula to calculate volume of prism. So the answer was wrong because the formula was wrong too. The procedure to calculate the volume were calculate area of the trapezoid then multiplied by the height of prism. So we can find the volume of the aquarium $0.42 \text{m}^3$. s

### 3.3. Process skill error

Process skill error occur when student doing process of mathematics correctly or not. Its cause student not carefully when doing mathematics. The process skill error that made by students was the subject could not use the operation correctly. For the process skill error made by students was determining final solution due to the previous errors.
From figure 3 the student was not able to compute the operation. She made an error such as multiplying whole numbers and addition the surface area of pyramid and cube. The interview showed that this error caused because the subject was careless, don’t know elemen of pyramid, and don’t know the pyramid surface area.

4. Conclusion
As conclusion, it was found that students tend to make three types of errors; they were reading error, comprehension error, and process skill error. The specific error such as: (1) errors to receive information of the problems (2) errors in applying formula (3) errors related to the concept of euclidean solid (4) errors in calculating. The cause of errors made by students are they don’t carefully read and solve the problems, they lack understanding the concept of the prism, they doesn’t understand the elemen of pyramid, they don’t know how to calculate the pyramid surface area.

References


