Students Mathematical Communication Skills in Solving Contextual Problems of Three Dimensional Figures at Junior High School Level

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Abstract
The purpose of this study was to describe the mathematical communication skills of students in solving three-dimensional space problems based on contextual problems. The research was carried out at SMP Muhammadiyah 7 Bayat, Klaten, Jawa Tengah. The study utilized a descriptive qualitative research method. Data was collected through written test questions and interviews. The subject of this research consist of three classes of students from grade. The data analysis techniques used were data reduction, data presentation, and drawing conclusions. The findings indicate that not all students met the indicators of mathematical communication ability. Subject 1 has met all the indicators of mathematical communication skills. Subject 2 had difficulty mentioning the information contained in the problem, as required by the first indicator of mathematical communication ability. In contrast, subject 3 had difficulty fulfilling the second and third indicators of mathematical communication, which are the ability to understand, interpret, and evaluate mathematical ideas, and the ability to use mathematical terms, notations, and structures to present ideas and describe relationships with situation models.
Keywords: Mathematical Communication, Geometry, Contextual Problems

Introduction

Education is a conscious effort of each individual to obtain information about learning, life experience or the surrounding environment. This is done with the aim of staying alive to adapt to the development of an increasingly advanced era, therefore education is one of the needs of individuals including the Indonesian state to adapt to the times (Sarumaha, 2022). Mathematics is a subject taught at all levels of education and is a requirement in intellectual readiness and adequate cognitive abilities. Mathematics is very important to use in daily activities. One of the mathematical skills that need to be possessed is the ability to communicate clear mathematical ideas. This is in line with the National Council of Teachers of Mathematics (NCTM) said in 2000, one of the goals of learning mathematics is learning to communicate (Mathematical communication) (Nugraha & Pujiastuti, 2019).

Communication is the act of transmitting information, opinions, or actions either directly or indirectly through the media by sending messages from a sender to a receiver. Mathematical understanding activities can be considered as a form of mathematical communication (Wijayanto et al., 2018). Mathematical communication, according to Prayitno, is the method utilised by students to describe and express mathematical concepts in various forms such as pictures, tables, diagrams, and formulas (Siregar, 2018). Yusra & Saragih concur, stating that mathematical communication ability refers to the capability to articulate mathematical problems using information related to mathematical ideas expressed via mathematical language in the form of diagrams, tables, and symbols during school mathematics learning activities (Noor, 2020).

Proficiency in mathematical communication is essential for every student learning mathematics. The process of communication aids students in comprehending and mastering mathematical concepts (Khadijah et al., 2018). Teachers can evaluate students' understanding of mathematical concepts and limitations by assessing their mathematical communication (Wardhana, 2018). Labina et al.(2020) indicate the importance of mathematical communication ability as a skill required in mathematics. This refers to the ability to orally and in writing, express mathematical concepts in an integrated manner to peers and educators. In her study, Dewi (2021) elaborates on the significance of mathematical communication abilities. She proves that it enables students to broaden their viewpoint and achieve optimal learning outcomes. As such, proficiency in mathematical communication is indispensable for learners. Silvianti et al.'s (2016) research highlights the significance of enhancing students' mathematical communication skills. This involves the capacity to effectively convey an understanding of concepts, reasoning and problem-solving, which are central to the goals of learning mathematics. Applied mathematics is a field that involves selecting materials that can translate mathematical knowledge to practical applications useful in the lives of students.

The development of mathematical ideas and concepts, as stated by Fauzan, begins by connecting real-life problems with their mathematical solutions. In effect, when learning mathematics, a realistic problem is transformed into a mathematical process and connected back to reality. These processes eventually lead to the comprehension of concepts (Putra & Sibarani, 2015). Zulkardi and Ilma defined mathematical contextual problems as mathematical problems that use different aspects to represent real-world

situations. To enhance the mathematical communication abilities of students, they must learn and practice contextual problems. Providing contextual problems to students gradually helps them master mathematical concepts (Kurniasih, 2016).

One of the problems in mathematics that requires mathematical communication of students in solving it is three-demensional figure is studied at all levels of education, from low to high level or from elementary, junior high and high school to universities. The lack of mathematical communication skills of students in solving three-demension space problems is in line with the results of research Nurlaila (2018) with the title analysis of mathematical communication skills of junior high school students on three-demension space problems, resulting in the conclusion that the mathematical communication skills of junior high school students on three-demension space building material is low. This can be seen from the total average percentage obtained by students of 40%. The influencing factors are students' less thorough understanding of the given problems, students' lack of understanding of mastering the concept of three-demension space building material, and students' lack of ideas in solving problems. This research aims to describe students' mathematical communication skills in solving contextual problem-based problems at Muhammadiyah 7 Bayat junior high school students.

Method

This study utilizes a form of qualitative research employing descriptive qualitative methods. Descriptive qualitative research aims to fully describe the facts relating to the research subject (Sasmi et al., 2020). This study involved 25 eighth-grade students from SMP Muhammadiyah 7 Bayat who had studied the material of Three Dimensional Figures. Subsequently, the students received a written test consisting of 2 descriptive questions to assess their mathematical communication skills, and then 3 students were selected at random for an interview.

An instrument is utilized to gather and acquire research data in an objective manner. For the purpose of this study, the instrument chosen is a written test consisting of essay questions based on the subject of Building a Three-dimensional space, which consists of two questions. The test comprises two questions and has been thoroughly examined for its validity, having undergone correction and revision to ensure its fitness for research purposes. The questions employed in this study are presented below:

Problem 1

Risma got an invitation to a birthday party from one of her friends at school. The party will take place this weekend. Risma plans to attend her friend's birthday party. Today, Risma will buy eight gifts for her friend and each gift will be wrapped in a block-shaped gift box. Each gift box measures 7cm x 5 cm x 4 cm in length, width and height. The eight gifts will be put together using a large gift box. Help Risma find the volume of the large gift box. with the steps below

a. What information do you know in the problem above?
b. Illustrate the shape of the gift into a spatial shape?
c. What is the volume of the large gift box that can be filled with the eight gift boxes?
d. What is the ratio of the volume of one small gift box to the volume of the large gift box? Give the reason?

Soal 2

SMP Muhammadiyah 7 Bayat held a scout day celebration that included a scouting competition attended by both class 8A and class 8B. The competition involved several activities, including United Nations, morse letters, knot making, and tent building. The tent making competition was split into two groups; team A with class 8A and team B with class 8B. Budi, Fahri, Andi, and Roki from team A participated in the tent making competition. Calculate the amount of fabric required to make a tent with a length of 4m, width and upright side of 3m, and a height of 2m, for team Budi.

a. What information do you know in the problem?
b. Illustrate it into a picture of a building!
c. How much fabric area can be used to make a scouttent by Budi's team?
d. If team B will make a tent with a length of 5 m, width and upright side of 2 m and 1 m height. Determine the ratio of fabric area used by team A and team B!

Picture 1. Question Sheet

Data analysis is carried out periodically during the research process, this is done so that the data obtained can be more systematic so as to prevent data errors. According to Sugiyono (Faiz & Soleh, 2021) qualitative data analysis techniques in general have three stages, namely: 1) The data reduction stage, at this stage the researcher analyzes the data by analyzing the results of student answers assisted by interviews to determine the stages of students in answering description questions, 2) The data presentation stage, at this stage the researcher presents the results of the analysis and is presented in the form of narrative or descriptive text without any manipulation which will then be analyzed in accordance with the subject matter and conclusions are drawn to answer the problems in this study, 3) The conclusion stage, researchers draw conclusions that have been obtained from the data reduction and data presentation stages.

Results and Discussion

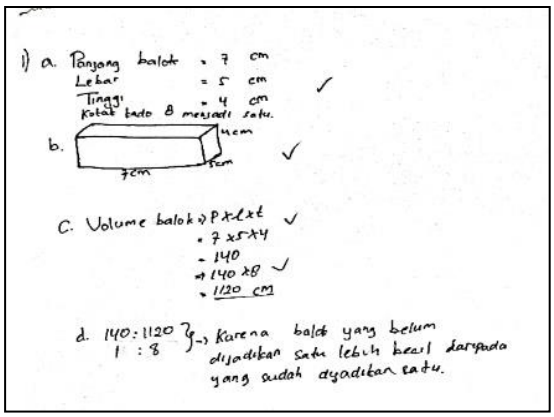
The researcher randomly selected the written and interview test results of three students and analyzed their mathematical communication skills. Table 1 presents a summary of the students' test results related to mathematical communication ability.

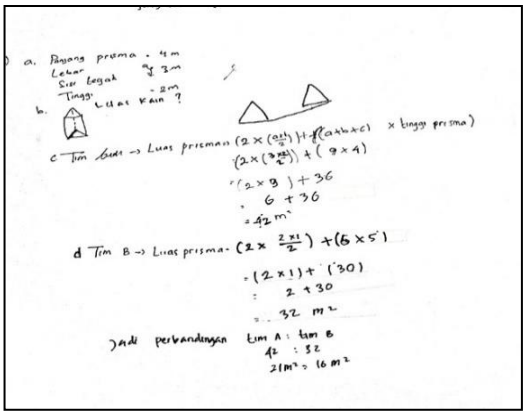
Table 1. Results of the written mathematical communication ability test

Indicator of mathematical communication skill	Subject 1		Subject 2		Subject 3	
	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2
1.1 Ability to express mathematical ideas through writing	√	√	-	-	√	√
1.2 Ability to demonstrate mathematical ideas in writing	√	√	√	-	√	√
1.3 Ability to visually represent mathematical ideas	√	√	√	√	√	√
2.1 Ability to understand mathematical ideas	√	√	-	-	-	-
2.2 Ability to interpret mathematical ideas in writing	√	√	√	√	√	√
2.3 Ability to evaluate mathematical ideas	√	√	-	√	-	-
3.3 Ability to use mathematical terms, notations and structures in presenting mathematical ideas structures in presenting ideas	√	√	√	√	-	-

Mathematical Communication Skill Subject 1

This paper will provide a detailed discussion on students' mathematical communication skills, based on the results of conducted research. The following section describes the results of the analysis conducted on mathematical communication skills of subject 1.





Picture 2. S1 answer no. 1 **Picture 3**. S1 answer no. 3

Subject 1's performance in problem number 1 can be analyzed based on the information provided in picture 2, which demonstrates their ability to record the given information about one gift box's size. Subject 1 was able to represent the shape of the gift box as a three-demension space. Subject 1 employed relevant terms and notations to articulate their ideas in the problem. Furthermore, Subject 1 demonstrates the ability to evaluate and interpret the provided answers. This performance is consistent with their previous work in the second question presented in picture 3, where Subject 1 successfully fulfilled all mathematical communication indicators.

The following displays the outcomes of interviews conducted to reinforce the responses of subject 1. The questions issued by the researcher are labeled as "P," whereas those directed to subject 1 are labeled as "S1".

P : "What information do you know?"

S1 : "cardboard in the shape of a block with the size of 7cm x 5cm x 4cm"

P : "What is asked in the problem?"

S1 : "What is the volume of the gift box to wrap the eight gifts?"

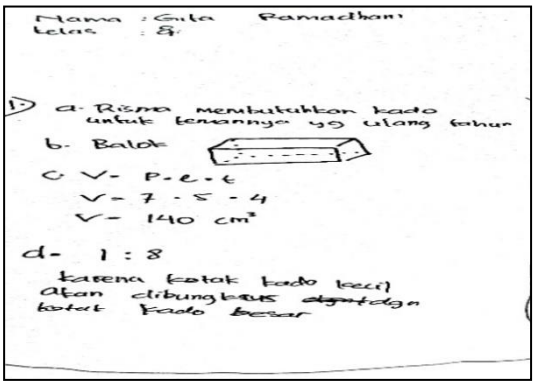
P : "Do you know what shape the gift box in the problem is?"

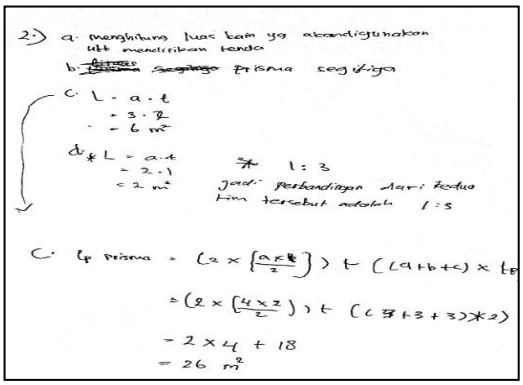
S1 : "I know, in the problem the gift box is a block shape because the size of each side is different."

The analysis of the test questions and interviews shows that subject 1 is capable of correctly solving problems one and two. Subject 1 meets all indicators for mathematical communication skills. During the interview, subject 1 answered all questions confidently and accurately evaluated all the answers. According to research Ikhsan et al (2020), students who meet all indicators of mathematical communication ability are more successful in solving problems.

Mathematical communication skill Subject 2

This section describes the results of the mathematical communication skills analysis performed on Subject 2.





Picture 4. S2 answer no. 1 **Picture 5**. S2 answer no. 2

Subject 2's answers, as shown in Picture 4 indicate that they currently lack the ability to effectively convey mathematical concepts in writing, as evidenced by their failure to include the size of the gift box when answering point A of problem number 1. It was observed that Subject 2 could effectively demonstrate and explain the meaning of 'space building' in the given problem. Subject 2 demonstrated proficiency in using technical terms and notation when presenting ideas, as evidenced by their ability to successfully complete the formula provided. In Picture 5, Subject 2 was unable to provide a visual description of what 'space building' meant in the problem when compared to their performance in question number 2. Furthermore, their answer to point B of question number 2 was

inaccurate as they incorrectly inputted numbers into the formula, failing to meet indicator 2.

The following displays the outcomes of interviews conducted to reinforce the responses of subject 1. The questions issued by the researcher are labeled as "P," whereas those directed to subject 1 are labeled as "S2".

P : “Do you know what shape is the tent picture in the question?”

S2 : “I know, in the question the tent is in the shape of a prism”

P : “Why don't you draw point b as instructed in the problem? “

S2 : “Sorry sis, can't draw it sis.”

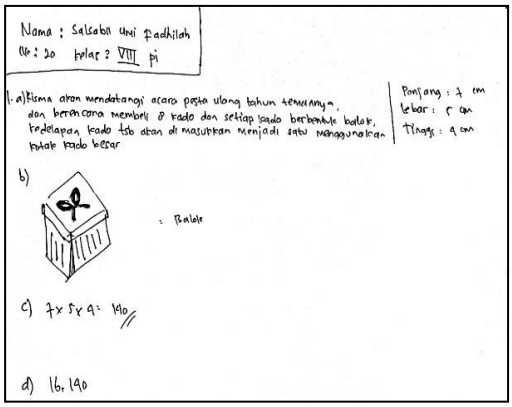
P : “For question point d, why can you answer even though there are no steps that you use in the answer sheet?”

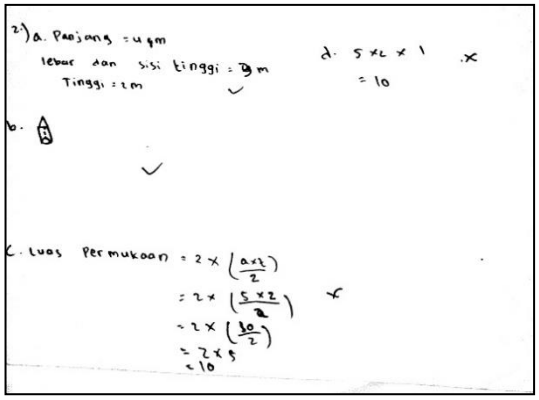
S2 : “The formula is too long”

Based on the analysis of the conducted tests and interviews, it can be concluded that subject 2 is unable to state what information is acquired from problem one and two while solving them, however, during the interview, they can describe the information obtained from the problem. This is consistent with a previous study Wulandari & Astutiningtyas (2020) which found that while students struggle to express mathematical concepts in writing, they comprehend the problem statements. Research Swastika (2016) has affirmed that students' communication skills in mathematics improve through the expression of their ideas in writing. This will affect the development of mathematical communication skills in students. Subject 2 in question 2. b) only provided the name of the building in the problem without describing it. Subject 2 did not meet the second criterion for mathematical communication ability, which involves comprehending, interpreting, and assessing mathematical concepts. This finding is based on results from conducted interviews, indicating that subject 2 is unable to describe the building in question number 2.

Mathematical communication skill Subject 3

This section describes the results of the mathematical communication skills analysis performed on Subject 3.





Picture 6. S3 answer no. 1 **Picture 7**. S3 answer no. 2

Based on the results of Subject 3's answers to the questions contained in Picture 6, it can be seen that when working on Problem 1, Subject 3 can write down the information that is known in the problem by mentioning the size of the gift box contained in the problem. Subject 3 was unable to demonstrate and describe what is meant by item b in problem number one, which should describe the shape of the room, but instead Subject 3 drew a picture of the gift box. Subject 3 could not use mathematical terms, notations and structures to present ideas, describe relationships with problem models as evidenced by Subject 3 who only wrote answers without using existing formulas and steps. This is consistent with what subject 3 did in question number 2, as seen in Picture 7, where subject 3 was unable to correctly write the formula used to answer the questions from items c and d.

The following displays the outcomes of interviews conducted to reinforce the responses of subject 1. The questions issued by the researcher are labeled as "P," whereas those directed to subject 1 are labeled as "S3".

P : “Are you sure the formulas used to work on problem number 2 in points c and d are correct?”

S3 :” I doubt the formula I used because I don't know the formula for finding the surface area of a prism.”

Based on the analysis of the test results and the conducted interviews, it can be inferred that Subject 3 was unable to meet Indicator 2 and Indicator 3 relating to mathematical communication skills in working on Problem 1 and Problem 2. Subject 3 did not use the appropriate formula and steps to solve the problem. Moreover, in Points C and D of Problem 2, Subject 3 did not write and use the formula for the surface area of the

prism correctly. This is supported by the interview results indicating that Subject 3 was not aware of the formula for calculating the surface area of a triangular prism. Consistent with prior research Nurlaila (2018), students were found to understand the instructions for the question, but many of their solutions were still incorrect.

Conclusion and Suggestion

The results and discussion of this study lead to the conclusion that VIII-grade students possess mathematical communication skills in solving three-demension spaces based on contextual problems. Specifically, subject 1 met all the indicators of mathematical communication skills. Subject 2 failed to meet all the indicators of mathematical communication skills, specifically in mentioning the information contained in the problem and in being consistent while demonstrating and describing visually, in accord with the first indicator. Subject 3 was also unable to fulfill the second and third indicators of mathematical communication skills, specifically in the ability to understand, interpret and evaluate mathematical ideas, and in the ability to use mathematical terms, notations, and structures to present ideas, describe relationships with situation models.

To enhance students' mathematical communication skills, objective exercises involving contextual problems can be provided and practice questions can be increased by instructors to familiarize students with the required procedures for problem-solving. Furthermore, it is desirable for other researchers to explore the determinants of students' mathematical communication abilities.

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