**Proceedings of International Conference on Teacher Profession Education**
**Yogyakarta, 29 July 2023**

ISSN: 3025-020X

# Problem-Based Learning to Enhance Mathematical Communication Skills and Learning Outcomes in Grade V

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## 1. Abstract

The implementation of the Problem-Based Learning model can improve the learning outcomes in mathematics regarding the volume of rectangular prisms and cubes among fifth-grade students at Elementary School. This is evidenced by the increased learning outcomes of the students in mathematics during Cycle I, which was 83.3%, and Cycle II, which was 86.3%. In Cycle I, the average score of the students in the first meeting was 73, and in the second meeting, it was 72. In Cycle II, the score in the first meeting was 80, and in the second meeting, it increased to 91. Problem-based learning significantly enhances the learning outcomes in mathematics and mathematical communication skills of the fifth-grade students a Elementary School. The implementation of the Problem-Based Learning model is carried out through several steps, namely: (1) problem orientation, (2) learning organization, (3) student guidance, (4) presentation of work results, and (5) analysis and evaluation of the problem-solving process. The application of the Problem-Based Learning model can improve the learning outcomes and mathematical communication skills. This is evidenced by the observed improvement in the students' mathematical communication skills in each cycle. The average observation results in Cycle I were 75.84%, and in Cycle II, it increased to 86%.

***Keywords:*** Problem Based Learning, Learning Outcomes in Mathematics, Mathematical Communication Skills

## 2. Introduction

Problem-based learning is an instructional approach that allows students to learn through experiences in solving problems relevant to their daily lives (Abarang & Delviany, 2021).

ISSN: 3025-020X

Through problem-based learning, students are presented with real-world problems that require critical and creative thinking, collaboration with classmates, and the communication of their solutions. Problem-based learning enables students to develop their mathematical communication skills because they need to be able to explain their thoughts clearly and use appropriate mathematical language in solving the problems (Zainal, 2022). Furthermore, problem-based learning can also enhance students' learning outcomes as they actively engage in the learning process.

The topic of geometric shapes is chosen because it requires a good understanding of geometry concepts and the ability to visualize three-dimensional objects (Zulhelmi & Anwar, 2021). By using problem-based learning in teaching geometric shapes, students will be able to deepen their understanding of these concepts and improve their abilities to visualize and communicate solutions to problems related to geometric shapes. In this context, the implementation of problem-based learning can be an effective alternative in enhancing students' mathematical communication skills and learning outcomes in the topic of geometric shapes (Rohid et al., 2019).

Based on initial observations and interviews with the fifth-grade homeroom teacher, it is known that students' learning outcomes in mathematics, particularly in the topic of geometric shapes, are still inadequate. Here are the initial data obtained:

| Subject | Mid-term grade average | Final grade average |
|---|---|---|
| Religion education | 86 | 86 |
| Civic education | 83 | 83 |
| Bahasa | 80 | 80 |
| Math | 71 | 73 |
| Science | 80 | 80 |
| Social education | 80 | 80 |
| Arts | 80 | 81 |
| Physical education | 83 | 84 |
| Local content | 76 | 77 |

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The implementation of Problem-Based Learning in mathematics education offers several advantages (Rindengan & Wenas, 2020). Firstly, this method allows students to actively learn and engage in solving problems that are relevant to their everyday lives. In this way, students can see that mathematics is not merely theoretical but also closely connected to real-life situations. Secondly, Problem-Based Learning enables students to develop their mathematical communication skills effectively. While solving problems, students must be able to explain and defend their solutions clearly using appropriate mathematical language. This helps them enhance their mathematical communication abilities and improve their speaking and writing skills in the language of mathematics. Thirdly, Problem-Based Learning can enhance students' learning outcomes. Since students are actively involved in the learning process, they tend to understand mathematical concepts better and gain a deeper understanding compared to passive learning of theories. In PBL, students can also develop critical and creative thinking skills and learn to collaborate with their classmates (Kiswanto Kenedi et al., 2019).

Research conducted by (Eismawati et al., 2019)states that problem-based learning models can improve mathematics learning outcomes, especially in the area of plane geometry. This model has successfully increased the number of students achieving scores above the Minimum Mastery Criteria (KKM). Furthermore, there are differences in mathematical communication skills between students using problem-based learning and those using direct learning methods, as noted by (Kiftiah, 2022).

The implementation of Problem-Based Learning in teaching spatial figures also provides additional benefits. This topic requires the ability to visualize three-dimensional objects and understand geometric concepts effectively. Through Problem-Based Learning, students can develop these skills effectively in a fun and interactive manner (Tambunan, 2019). In Problem-Based Learning, students are given problems that involve geometric concepts in contexts relevant to their daily lives. For example, they may be asked to design a building with specific shapes and sizes or solve problems related to measurement and calculation of the volume and surface area of an object. In tackling these problems, students learn to visualize three-

ISSN: 3025-020X

dimensional objects and apply geometric concepts practically. Therefore, Problem-Based Learning is an effective teaching method to enhance mathematical communication skills and improve students' learning outcomes on the topic of spatial figures (Siagian et al., 2019). It allows students to learn actively and engage in the learning process while developing critical and creative thinking skills essential in solving mathematical problems.

## 3. Method

### 3.1. Participants and context

This research employs a collaborative classroom action research approach. Collaborative Classroom Action Research (CCAR) can be identified as an educational research approach involving cooperation between teachers and researchers, as well as active participation from students in the research process (Syahdan et al., 2022).

### 3.2. Material

The research instrument is a tool or facility used by the researcher to collect data more easily (Cheryl N. Poth & John W. Creswell, 1997). In this study, the instruments include an observation sheet, which functions to assess the activities carried out by the researcher during the research process. Furthermore, the test instrument consists of multiple-choice and essay questions related to the volume of three-dimensional shapes. These instruments are used to measure the mathematics learning outcomes and mathematical communication skills of the students

### 3.3. Data Collection and analysis

The data collection technique is the most strategic step in research because the main goal of research is to obtain data (Cheryl N. Poth & John W. Creswell, 1997). The data collection techniques employed in this study include observation,

ISSN: 3025-020X

used to gather data about the activities during the learning process, as well as to observe the mathematical communication skills of the students. Additionally, an evaluation sheet is used, which is given to the students to assess their mathematics learning outcomes and mathematical communication abilities.

### 3.4. Research Ethics

All research involving human subjects must adhere to basic principles of research ethics. In this study, the following fundamental ethical principles are observed:

1) Respect for individuals. As researchers, we must respect and value the students who are the subjects of this study. Respecting their autonomy, privacy, and dignity is of utmost importance.
2) Beneficence. This research aims to be beneficial by contributing to the improvement of learning in schools, particularly in the subject of mathematics, focusing on enhancing mathematical communication skills.
3) Non-harm. Throughout this study, the well-being and safety of the research subjects are prioritized. The research activities take place within the classroom setting, ensuring that the subjects are not exposed to any harm or risks beyond the normal classroom environment.

## 4. Results and Discussion

### 4.1. Result

#### 1) Description of the Initial Study Phase

This classroom action research was conducted in the fifth grade of Kembangsari Public Elementary School, Piyungan District, Bantul Regency, Academic Year 2022/2023. The research was carried out in two cycles to determine how to improve students' learning outcomes in mathematics on the topic of the volume of cubic and rectangular prisms, as well as their mathematical

ISSN: 3025-020X

communication skills, through the Problem Based Learning method in mathematics learning for the fifth-grade students Piyungan, Bantul.

**2) Pre-Action Data**

Data obtained from observations with the class teacher on April 14, 2023, revealed that there were still several students who had not achieved the Minimum Criteria for Mastery (KKM) standard for mathematics set at 65 at Kembangsari Public Elementary School. Additionally, the mathematical communication abilities of the students were low during the learning process. To determine the extent of students' low mathematical communication abilities, the researcher observed the thematic learning process in the fifth grade of Kembangsari Public Elementary School, which was the object of the study.

**3) Cycle I Action Results**

Observations were conducted by the researcher and two colleagues using observation sheets to assess the implementation of the Problem Based Learning model by the teacher and students. The results of the observation are presented in the following table:

Table 3.1Results of Observations on the Implementation of the Problem Based Learning Model for Teachers and Students in Cycle I.

| Steps | Cycle I | | | Cycle II | | |
|---|---|---|---|---|---|---|
| | Meeting 1 (%) | Meeting (%) | Average (%) | Meeting 1 (%) | Meeting 2 (%) | Average (%) |
| Problem orientation | 62,5 | 75 | 68,75 | 87,5 | 87,5 | 87,5 |
| Learning organization process | 62,5 | 75 | 68,75 | 75 | 87,5 | 81,25 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Student guidance | 75 | 75 | 75 | 87,5 | 87,5 | 87,5 |
| Presentation of work | 75 | 75 | 75 | 75 | 87,5 | 81,25 |
| Analysis and evaluation of problem-solving process | 75 | 75 | 75 | 87,5 | 87,5 | 87,5 |
| Average | 70 | 75 | 72,5 | 82,5 | 87,5 | 85 |

Explanation:

A = Excellent (85-100%)

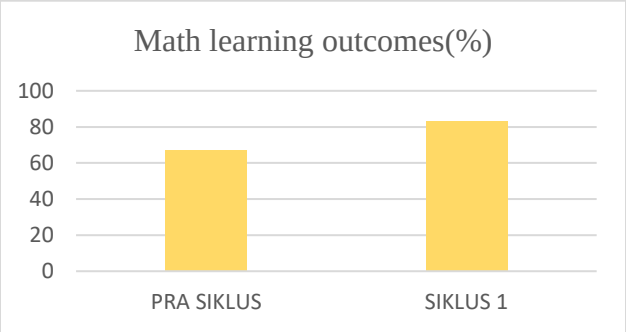
B = Good (75-84%)

C = Satisfactory (65-74%)

D = Poor (55-64%)

E = Fail (≤54%)

Here is the graph of the mathematics learning outcomes from pre-cycle to cycle I.



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Below is the table 3.2 of observations on students' mathematical communication skills in cycle I.

| Observation indicators | Percentage (%) | |
|---|---|---|
| | Meeting 1 | Meeting 2 |
| The mathematical statements are presented clearly and systematically | 76,42 | 77,14 |
| Using accurate and proper mathematical terms | 75,71 | 76,42 |
| Using mathematical symbols or notations correctly. | 77,14 | 77,14 |
| Communicating mathematical understanding with appropriate sentences. | 72,85 | 74,28 |
| Using visual representations, such as diagrams or graphs, to explain problem-solving | 75 | 75 |
| Ability to actively listen when someone explains mathematical concepts | 74,28 | 75 |
| Ability to respond and provide feedback to questions or explanations of mathematical concepts from others | 77,85 | 77,85 |
| Having the courage to explain the solution to mathematical problems. | 75,71 | 75,71 |
| Total | 604,96 | 608,54 |
| Average | 75,62 | 76,06 |
| Composite average | 75,84 | |

**4) Cycle II Action Results**

The observation was conducted by the researcher and two peers by filling out observation sheets on the implementation of the Problem Based Learning model for teachers and students. The observation results can be seen in the following table:

Table 4.1 Results of Observations on the Implementation of the Problem Based Learning Model for Teachers and Students in Cycle II.

| Steps | Cycle I | | Cycle II | | | |
|---|---|---|---|---|---|---|
| | Meeting 1 | Meeting (%) | Meeting 1 | Meeting (%) | Meeting 1 | Meeting (%) |

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| | (%) | | (%) | | (%) | |
|---|---|---|---|---|---|---|
| Problem orientation | 62,5 | 75 | 68,75 | 87,5 | 87,5 | 87,5 |
| Learning organization process | 62,5 | 75 | 68,75 | 75 | 87,5 | 81,25 |
| Student guidance | 75 | 75 | 75 | 87,5 | 87,5 | 87,5 |
| Presentation of work | 75 | 75 | 75 | 75 | 87,5 | 81,25 |
| Analysis and evaluation of problem-solving process | 75 | 75 | 75 | 87,5 | 87,5 | 87,5 |
| Average | 70 | 75 | 72,5 | 82,5 | 87,5 | 85 |

Explanation:

A = Excellent (85-100%)

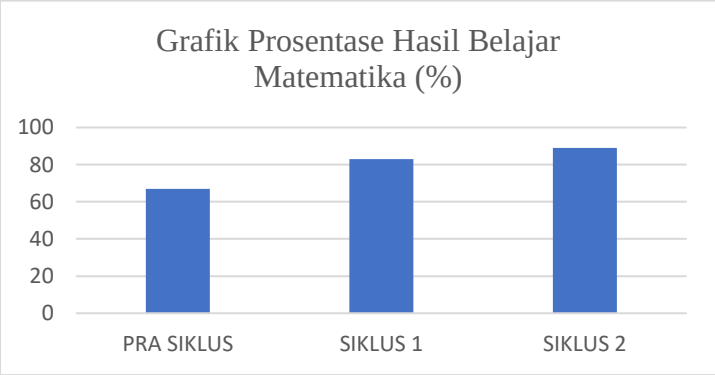
B = Good (75-84%)

C = Satisfactory (65-74%)

D = Poor (55-64%)

E = Fail (≤54%)

Here is the graph of the mathematics learning outcomes



ISSN: 3025-020X

Here is the table 4.2 of observation results on the mathematical communication skills of students in cycle II:

| Observation indicators | Precentage (%) | |
|---|---|---|
| | Meeting 1 | Meeting 2 |
| The mathematical statements are presented clearly and systematically | 87,14 | 87,14 |
| Using accurate and proper mathematical terms | 86,42 | 86,42 |
| Using mathematical symbols or notations correctly. | 85,71 | 86,42 |
| Communicating mathematical understanding with appropriate sentences. | 85 | 86,42 |
| Using visual representations, such as diagrams or graphs, to explain problem-solving | 86,42 | 86,42 |
| Ability to actively listen when someone explains mathematical concepts | 85 | 85,71 |
| Ability to respond and provide feedback to questions or explanations of mathematical concepts from others | 87,14 | 87,14 |
| Having the courage to explain the solution to mathematical problems. | 85,71 | 86,42 |
| Total | 688,54 | 692,09 |
| Mean | 86,06 | 86,51 |
| Composite average | 86,28 | |

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**5) Comparison of Inter-Action Results**

**(a) Math learning outcomes**

The mathematical learning outcomes of students regarding the volume of rectangular prisms and cubes were obtained from evaluation questions completed by the students at the end of each learning session in Cycle I and Cycle II. The table analyzing the comparison of the students' learning outcomes in Cycle I and Cycle II can be seen below:

**Table 5.1 Comparison of Learning Outcomes in Cycle I and Cycle II**

| Score | Cycle I | | Cycle II | |
|---|---|---|---|---|
| | Meeting 1 (%) | Meeting 2 (%) | Meeting 1 (%) | Meeting 2 (%) |
| 95-100 | - | - | 2,77 | 2,77 |
| 85-94 | 2,77 | 2,77 | 30,55 | 30,55 |
| 75-84 | 63,88 | 61,11 | 33,33 | 36,11 |
| 65-74 | 16,66 | 19,44 | 30,55 | 27,77 |
| 55-64 | 2,77 | - | - | - |
| 45-54 | 11,1 | 13,88 | - | - |
| <45 | 2,77 | 2,77 | 2,77 | 2,77 |
| Max | 88 | 88 | 96 | 96 |
| Min | 0 | 0 | 0 | 0 |
| Mean | 73 | 72 | 80 | 91 |
| Above the KKM | 83,33 | 83,33 | 83,33 | 86,11 |
| Under the KKM | 16,67 | 16,67 | 16,67 | 13,88 |

**(b) Mathematical Communication Skills**

The data on the observation of students' process skills were obtained from observations conducted during the learning process in Cycle I and

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Cycle II. The analysis of the comparison of students' process skill observations in Cycle I and Cycle II can be seen in the following table:

**Tabel 5.2 Comparison of Mathematical Communication Skills between Cycles**

| INDICATORS | Cycle I | | Cycle II | |
|---|---|---|---|---|
| | Meeting 1 (%) | Meeting 2 (%) | Meeting 1 (%) | Meeting 2 (%) |
| 1 | 71,52 | 76,42 | 87,14 | 87,86 |
| 2 | 72,22 | 75,71 | 86,42 | 86,42 |
| 3 | 72,91 | 77,14 | 86,42 | 87,14 |
| 4 | 71,52 | 72,85 | 86,42 | 88,58 |
| 5 | 72,91 | 75 | 86,42 | 86,42 |
| 6 | 72,22 | 74,28 | 85,71 | 85,71 |
| 7 | 72,91 | 77,85 | 87,14 | 88,58 |
| 8 | 72,22 | 75,71 | 86,42 | 86,42 |
| Mean | 72,30 | 75,62 | 86,51 | 87,14 |

Based on the table above, it can be observed that the observation results of students' process skills have improved from Cycle I to Cycle II. The average percentage of students' process skills in Cycle I, Meeting 1, was 72.30%, and in Cycle I, Meeting 2, it increased to 75.62%. In Cycle II, Meeting 1, the average percentage obtained was 86.51%, and in Meeting 2, it further increased to 87.14%. The percentage achieved has reached the targeted percentage, which was planned to be 85%.

## 4.2 Discussion

### 1) Implementation of Problem-Based Learning:

Based on the observations conducted by the observer during the implementation of Problem-Based Learning by the teacher in Cycle I and Cycle II,

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there was a continuous improvement demonstrated by both the teacher and the students. The improvement occurred because there were consistent refinements made in each cycle to overcome challenges that arose, enabling the achievement of the expected research performance indicators (Wahyuningtyas & Kristin, 2021). The improvement in the implementation of Problem-Based Learning in teaching mathematics on the topic of the volume of rectangular prisms and cubes is relevant to a study conducted by Putu Agus and Wilibladus (Agus et al., 2018)titled "The Effect of Problem-Based Learning Model on Mathematics Learning Outcomes of Elementary School Students." The study mentioned a significant difference in mathematics learning outcomes between the group of students who were taught using Problem-Based Learning and the group who received conventional teaching methods. Therefore, it can be concluded that Problem-Based Learning has an impact on students' mathematics learning outcomes.

**2) Improvement in Mathematics Learning Outcomes on the Topic of Volume of Rectangular Prisms and Cubes:**

The pretest results from the pre-cycle showed that the percentage of students' learning outcomes mastery was still very low, with only 65%. The researcher attempted to improve these results by implementing Problem-Based Learning during the teaching of the volume of rectangular prisms and cubes. The posttest results at the end of each cycle showed an increase in the percentage of students' learning outcomes mastery, reaching 83% in Cycle I and 86% in Cycle II.

The above research findings support previous studies conducted by Eismawati and colleagues (Eismawati et al., 2019)which stated that teaching with Problem-Based Learning model can improve learning outcomes in mathematics for elementary school students.

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**3) Improvement in Mathematical Communication Skills in Mathematics Teaching**

The observation results of process skills during the pre-cycle showed that the average percentage obtained had not yet reached the minimum target of 70.17%. The researcher attempted to improve the teaching process by implementing Problem-Based Learning during the teaching of the volume of rectangular prisms and cubes, resulting in an increase in the average percentage of process skill indicators to 75.84% in Cycle I and 86% in Cycle II.

These findings are relevant to a study conducted by Mirna and colleagues (Mirna et al., 2023)titled "Analysis of Improved Mathematical Communication Skills of Students through the Implementation of Problem-Based Learning Model," which demonstrated that the implementation of Problem-Based Learning model has a positive and significant impact on students' mathematical communication skills

## 5. Conclusion

The implementation of the Problem-Based Learning model has shown an improvement in mathematics learning outcomes regarding the volume of rectangular prisms and cubes among the fifth-grade studentsin. This improvement is evident from the increased mathematics learning outcomes of the students in Cycle I (83.3%) and Cycle II (86.3%). In Cycle I, Meeting 1, the average score of the students was 73, and in Meeting 2, it was 72. In Cycle II, Meeting 1, the average score was 80, and in Meeting 2, it was 91. The Problem-Based Learning model has significantly contributed to enhancing mathematics learning outcomes and mathematical communication skills among the fifth-grade students.

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## 6. Acknowledgement

The researcher acknowledges that the preparation of this Classroom Action Research (PTKK) would not have been possible without the cooperation and assistance from various parties. Therefore, the researcher would like to express gratitude to:

a. Prof. Drs. H. Pardimin, M.Pd., Ph.D., as the Rector of Sarjanawiyata Tamansiswa University Yogyakarta, for granting permission for this research.
b. Siti Amronah,S.Pd, as the principal of Kembangsari Elementary School, for granting permission and providing the opportunity to conduct the research at the school.

Their support and cooperation have been invaluable in the successful execution of this research.

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