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IMPROVING MATHEMATICAL PROBLEM-SOLVING SKILLS IN RATIO THROUGH THE APPLICATION OF PROBLEM-BASED LEARNING

Zulfa Maharani[1], Sakur[2], Armis[3]
[1,2,3] Universitas Riau, Indonesia
zulfa.maharani1502@student.unri.ac.id

ABSTRACT The main objectives of this study were to improve the quality of learning activities and enhance students' skills in Mathematical Problem Solving Skills. The research was conducted during the even semester of the 2023/2024 school year by implementing classroom action research over two cycles on ratio content. The subjects of this study were 41 students from class VII-3 of SMPN 42 Pekanbaru. The learning tools used in the study included the Flow of Learning Objectives, teaching modules, learner worksheets, teaching materials on ratio content, and assessment tools. The data collection instruments consisted of learner and teacher activity sheets and tests for assessing Mathematical Problem Solving Skills. Data analysis on the improvement of the learning process was obtained based on the activity sheets from both learners and teachers. Additionally, the improvement of students' Mathematical Problem Solving Skills was assessed through tests conducted at the end of each cycle. The results of the observation sheets from cycles I and II showed that the learning process improved with each meeting. The students' scores in Mathematical Problem Solving Skills increased from the initial test to the cycle I test by 11.73 points, with an initial average of 43.69 and a cycle I test average of 55.42. From the cycle I test to the cycle II test, there was an increase of 18.25 points, with an average score of 73.67 in the cycle II test. Therefore, the results of this research, conducted using the Problem-Based Learning model, indicate a potential to improve the learning process and enhance students' problem-solving skills.

Keywords: mathematical problem solving skills, problem-based learning, ratio content, classroom action research.

ABSTRAK Tujuan utama dari penelitian ini adalah untuk meningkatkan kualitas kegiatan pembelajaran dan mengembangkan keterampilan siswa dalam Penyelesaian Masalah Matematika. Penelitian ini dilakukan pada semester genap tahun ajaran 2023/2024 dengan menerapkan penelitian tindakan kelas selama dua siklus pada materi perbandingan. Subjek

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penelitian ini adalah 41 siswa kelas VII-3 SMPN 42 Pekanbaru. Alat pembelajaran yang digunakan dalam penelitian ini meliputi Alur Tujuan Pembelajaran, modul pengajaran, lembar kerja peserta didik, bahan ajar tentang materi perbandingan, dan alat penilaian. Instrumen pengumpulan data terdiri dari lembar aktivitas siswa dan guru serta tes untuk mengukur Keterampilan Penyelesaian Masalah Matematika. Analisis data mengenai peningkatan proses pembelajaran diperoleh berdasarkan lembar aktivitas siswa dan guru. Selain itu, peningkatan keterampilan siswa dalam Penyelesaian Masalah Matematika diukur melalui tes yang dilakukan di akhir setiap siklus. Hasil lembar observasi dari siklus I dan II menunjukkan bahwa proses pembelajaran semakin baik di setiap pertemuan. Skor keterampilan siswa dalam Penyelesaian Masalah Matematika meningkat dari tes awal ke tes siklus I sebesar 11,73 poin, dengan rata-rata awal 43,69 dan rata-rata tes siklus I sebesar 55,42. Dari tes siklus I ke tes siklus II, terjadi peningkatan sebesar 18,25 poin, dengan rata-rata tes siklus II sebesar 73,67. Oleh karena itu, hasil penelitian yang dilakukan dengan menggunakan model Pembelajaran Berbasis Masalah menunjukkan potensi untuk meningkatkan proses pembelajaran dan keterampilan siswa dalam penyelesaian masalah.

Keywords: kemampuan pemecahan masalah matematis, PBL, perbandingan, PTK.

INTRODUCTION

Mathematical problem-solving is an important skill that students must master in learning mathematics. According to the Ministry of Education and Culture Regulation Number 22 of 2016, problem-solving is one of the main goals of mathematics learning. The components necessary to improve students' mathematical problem-solving skills include understanding the problem, creating mathematical models, executing a plan, and interpreting the solution. As stated by Ulvah and Afriansyah (2016), mathematics learning focuses on problem-solving, and the essence of mathematics education lies in the process of solving problems.

Marlina et al. (2018) explain that mathematics learning teaches a great deal about problem-solving skills. According to Harahap and Surya (2017), mathematical problem-solving skills are learning activities that require a variety of strategies to solve problems. Students must possess problem-solving skills, especially when learning mathematics, as it serves as a fundamental ability. Ulvah Shovia (2016) adds that students who actively participate in learning activities demonstrate better problem-solving skills than those who do not. By engaging in effective learning activities, students will avoid boredom, allowing their problem-solving skills to develop further.

Researchers conducted interviews and observations in class VII-3 at SMPN 42 Pekanbaru, along with the mathematics teacher, to identify the issues present in that class. The interviews revealed that students considered mathematics a difficult and uninteresting subject to learn. This is consistent with the findings of Subekti et al. (2024), who reported that students generally view mathematics as a challenging subject, causing them to avoid it. Observations in the classroom showed that some students were not actively engaged in learning and still depended heavily on the teacher's explanations. Additionally, problem-based questions that emphasize

problem-solving skills are rarely provided, resulting in students lacking the ability to adequately solve such problems. Consequently, students are unable to plan solutions effectively because they do not fully grasp the information provided. Based on these findings, it can be concluded that students' mathematical problem-solving skills are low, and there are deficiencies in learning activities that need to be addressed to improve the overall quality of the learning process.

Class VII-3 students at SMPN 42 Pekanbaru underwent an initial problem-solving skills test to assess their level of proficiency in the topics of integers and fractions that they had studied. Table 1 below illustrates the measurement results based on the qualifications of problem-solving skills for 41 students in class VII-3 at SMPN 42 Pekanbaru, using the problem-solving skills scoring guidelines.

Table 1. Average Student Scores for Each Aspect of Problem-Solving Skills

No	Aspect of Problem-Solving Skills Measured	Total Student Score	Average	Problem-Solving Skill Qualification
1	Understanding the problem	81	61.58	Adequate
2	Planning a solution	91	40.64	Adequate
3	Executing the solution plan	98	46.34	Adequate
4	Interpreting the results	39	26.21	Beginning to Develop

Based on the averages obtained for each indicator in Table 1, it can be seen that, overall, students' problem-solving skills fall into the "adequate" category, but they are still not able to solve problems effectively. Students face difficulties in problem-solving due to their limited knowledge in understanding the problem itself and their lack of precision in selecting appropriate solution strategies. As a result, students often make calculation errors and fail to solve problems based on the required indicators of problem-solving skills. According to Mardiah et al. (2024), one of the causes of low problem-solving skills is teaching methods that do not fully allow students to present their ideas step-by-step.

Out of the 41 students who completed the test within 30 minutes, only one student was able to answer all the questions fully, based on the problem-solving skill indicators. In the second indicator, an average score of 40.64 was achieved, as many students lacked an understanding of the planning that needed to be done to solve the problem, and they immediately attempted to solve the third indicator without first preparing a solution plan. For the third indicator, an average score of 46.34 was obtained, as students worked directly on solving the problem, but some did so with incorrect steps. In the fourth indicator, an average score of 26.21 was achieved, where some students checked their work by providing conclusions, while others did not, resulting in no score.

Based on the explanation of the problems discussed above, it is evident that to improve students' problem-solving skills, improvements in the learning process are

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necessary. Students should be guided to engage in activities that focus on solving contextual problems, working collaboratively in groups to solve problems in an active learning environment, where the activities are centered on the students themselves. This requires an appropriate learning process aligned with the research objectives. The learning process involves applying the Problem-Based Learning (PBL) model. Teachers can use this model to guide students toward active participation in solving problems. Fadhly et al. (2017) explain that the PBL model is a learning approach that emphasizes how teachers and students engage in problem-solving at various stages of the learning process. This idea is supported by research conducted by Hidayatati et al. (2022), which found that applying the PBL model to students in class X at SMK Negeri 4 Pekanbaru resulted in improvements in both problem-solving skills and the learning process.

The stages of learning using the PBL model, according to the Directorate General of Teachers and Educational Personnel (2017), include introducing students to problems, organizing students, assisting groups and individuals in investigations, developing and presenting results, and analyzing and evaluating the problem-solving process. The advantages of the PBL model, according to Susanto (2016), include fostering a deeper understanding of the lesson through discussions, discovering new knowledge through problem-solving, developing new knowledge and taking responsibility for it, improving critical thinking skills, and providing opportunities to apply learned knowledge in real-life situations.

Anugraheni et al. (2018) state that the PBL model helps students gain knowledge and problem-solving concepts from real-life issues. In solving mathematical problems, students must carefully consider the steps they have taken to arrive at a solution. According to Lestari and Yudhanegara (2018), there are several stages for assessing students' problem-solving skills, including understanding the problem, creating a solution plan, executing the plan, and interpreting the results.

By using real-world problems as a context, the PBL model offers numerous benefits to students. In addition to helping them learn how to solve problems and think critically, PBL provides a better understanding of what they are learning and has the potential to enhance the learning process. This is consistent with research conducted by Nina Arni (2022), which found that the implementation of the PBL model improved students' problem-solving skills at PAB 1 Klupang Private Junior High School. The results of a study by Elvi Hidayatati (2022) also support the theory that applying the PBL model can enhance the quality of the learning process and improve students' problem-solving skills.

Based on the current problem conditions and the solutions provided, it is clear that applying the PBL model can improve students' problem-solving skills and the learning process. This research focuses on implementing problem-solving through ratio content learning in class VII-3 SMPN 42 Pekanbaru during the even semester of the 2023/2024 academic year.

METHODS

This research applies a classroom action research (CAR) approach, carried out in collaboration with the mathematics teacher during classroom activities. The study took place in class VII-3 of SMPN 42 Pekanbaru during the even semester of the 2023/2024 academic year, focusing on ratio content. The research involved all 41 students of class VII-3, consisting of 22 female and 19 male students with heterogeneous abilities. According to the classroom action research (CAR) framework as outlined by Arikunto (2014), each cycle consists of four key stages: planning, implementation of actions, observation, and reflection. The planning stage involves preparing all necessary learning tools, including the Flow of Learning Objectives, teaching modules that contain Student Worksheets, teaching materials, and assessments for six meetings. Additionally, tests on Mathematical Problem Solving Skills are developed alongside scoring guidelines to measure students' problem-solving abilities at each cycle. Observation sheets are also created to track teacher and student activities, ensuring that all aspects of the learning process are effectively monitored.

In the implementation of actions stage, the pre-planned learning activities are carried out in the classroom. For cycle I, the learning module covers the subtopics of comparing two quantities, the ratio of values, and inverse values. During cycle II, the module focuses on map scales and rates of change, such as speed and flow rate. The learning process follows the structure set out during the planning phase.

Next, the observation stage takes place concurrently with the learning sessions, as both teacher and student activities are closely monitored. The purpose of this observation is to evaluate how well the planned actions are being implemented and to identify areas for improvement in achieving the learning objectives.

Finally, reflection occurs after each cycle has been completed. During this phase, researchers and observers analyze the weaknesses and shortcomings of the cycle and use these insights to improve the process for the next cycle. The goal of reflection is to continuously refine the learning approach and ensure that each cycle is more effective than the last.

Student data on Mathematical Problem-Solving Skills was collected through a written test, with two Mathematical Problem-Solving Skills tests conducted: one in cycle I and another in cycle II. The scoring guidelines for assessing students' Mathematical Problem-Solving Skills were based on Hia & Chairunisa's (2017) criteria. These indicators assign a maximum score of 2 for problem understanding, 3 for planning the solution, 3 for implementing the solution, and 2 for interpreting the results.

The data used to assess improvements in the learning process was derived from student and teacher activity observation sheets, which were analyzed to identify which areas of the learning process showed improvement. Quantitative analysis was

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applied to the results of the students' Mathematical Problem-Solving Skills tests to evaluate whether there was an increase in Mathematical Problem-Solving Skills from the cycle I to the cycle II test. The data processing for students' Mathematical Problem-Solving Skills test results was carried out through the following steps: (1) Determining the score obtained from students' answers based on the scoring guidelines and converting it to an Mathematical Problem-Solving Skills qualification on a 0-100 scale; (2) Creating a table of student achievement scores and average Mathematical Problem-Solving Skills indicator scores; (3) Identifying overall improvements in Mathematical Problem-Solving Skills.

Students' scores were converted into Mathematical Problem-Solving Skills qualifications using the following formula:

$$N = \frac{S_p}{S_m} \times 100$$

Where:

N = Final Score

S_p = Score Achieved

S_m = Maximum Score

Students' scores were then classified based on the Mathematical Problem-Solving Skills qualifications shown in Table 2:

Table 2. Mathematical Problem-Solving Skills Score Qualification

Value Interval	Qualification
85.00 < x ≤ 100	Advanced (M)
65.00 < x ≤ 85.00	Proficient (C)
40.00 < x ≤ 65.00	Worthy (L)
0 ≤ x ≤ 40.00	Starting to Develop (MB)

Source: Guide for Learning and Assessment of the Merdeka Curriculum, 2022.

The classroom action research (CAR) was considered successful if there was an improvement in the quality of the learning process at each meeting and continuous progress until the final cycle. Additionally, success was measured if the number of students achieving Mathematical Problem-Solving Skills scores classified as proficient or advanced increased, while the number of students achieving scores in the worthy or starting to develop categories decreased between cycles I and II. An increase in Mathematical Problem-Solving Skills was also indicated if the average Mathematical Problem-Solving Skills value showed a consistent improvement across cycles, from the initial test to the cycle I test and then the cycle II test. If these conditions were met, the application of the Problem-Based Learning (PBL) model in this classroom action research could be deemed effective in improving both the

quality of learning and the Mathematical Problem-Solving Skills of class VII-3 students at SMPN 42 Pekanbaru.

FINDING AND DISCUSSION

The research data analyzed included teacher activity sheets, student activity sheets during the learning process, and students' achievements in Mathematical Problem Solving Skills.

Analysis of Teacher and Student Activity Data

In cycle I, observations from the teacher and student activity sheets revealed that preliminary activities were not effectively executed. At the start of the first cycle, the class became noisy when groups were formed, as students were still searching for group members. To address this, the teacher reorganized the seating arrangements to create more effective groups. However, as the first cycle progressed, students became more orderly, although there were still some noisy individuals. Initially, students were less active in learning, but by the end of the first cycle, they were more engaged. The shortcomings in cycle I were addressed during reflection, leading to improvements in the learning process in cycle II.

In cycle II, the formation of groups took less time, and students quickly took their seats in their assigned groups. There was also a significant increase in students actively participating in apperception and motivation activities. Observations from the teacher and student activity sheets in cycle II showed that the entire learning process was conducted according to plan, and students became more active in the core activities. The learning process improved progressively in each meeting. By reviewing activities in cycles I and II, it is clear that student participation increased, and deficiencies in the learning process were gradually reduced. Consequently, the overall learning process improved by the end of cycle II. The analysis of the learning process in cycles I and II demonstrates that the learning activities in class VII-3 SMPN 42 Pekanbaru improved significantly in ratio content during the even semester of the 2023/2024 academic year.

Analysis of Mathematical Problem Solving Skills (MPSS) Achievement

Throughout the action research from cycle I to cycle II, the learning process improved with each cycle. The weaknesses observed during the first cycle were minimized as the learning process was refined in the second cycle, resulting in continual improvement until the conclusion of cycle II. Table 3 presents the average scores for each aspect of MPSS in cycle I.

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Table 3. Average Scores of Students in Each Aspec of Mathematical Problem Solving Skills for Cycle I

No	MPSS Aspect Measured	Total Score Obtained by Students			Average	MPSS Qualification
		1	2	3		
1	Understand the problem	82	64	18	66.67	Capable
2	Plan problem solving	113	83	16	57.45	Worthy
3	Implement a problem solving plan	119	76	15	56.91	Worthy
4	Interpret the results obtained	72	21	7	40.65	Starting to Develop

Based on Table 3, although there was an increase in MPSS from the initial test to the first cycle, it was not significant as not all students achieved the maximum score, and some did not fully include all MPSS indicators. Table 4 shows the results after actions in cycle II.

Table 4. Average Scores of Students in Each Aspect of Mathematical Problem Solving Skills for Cycle II

No	MPSS Aspect Measured	Total Score Obtained by Students			Average	MPSS Qualification
		1	2	3		
1	Understand the problem	82	82	49	86.58	Proficient
2	Plan problem solving	118	85	45	67.20	Capable
3	Implement a problem solving plan	122	95	60	75.06	Capable
4	Interpret the results obtained	73	53	36	65.85	Capable

In general, students improved their MPSS scores in cycle II compared to cycle I. Table 5 compares the average student scores across MPSS indicators in both cycles.

Table 5. MPSS Achievements in Cycle I and Cycle II

Cycle	Understanding the Problem	Planning the Solution	Implementing the Plan	Interpreting Results
I	66.67	57.45	56.91	40.65
II	86.58	67.20	75.06	65.85

From Table 5, it is evident that students' performance improved in all aspects of MPSS. For example, understanding the problem increased from 66.67 in cycle I to 86.58 in cycle II. While implementing the plan improved more than planning the solution, some students skipped the planning phase, immediately jumping to

implementation. Overall, the MPSS improved in all aspects from the initial test to cycle II. Table 6 shows the number of students achieving different MPSS qualifications.

Table 6. Increase in the Number of Students in KPMM Qualifications

Value Interval	Initial Test	Cycle I	Cycle II	MPSS Qualification
$85 < x \leq 100$	1	5	16	Proficient
$65 < x \leq 85$	2	8	9	Capable
$40 < x \leq 65$	20	16	11	Worthy
$0 \leq x \leq 40$	18	12	5	Starting to Develop

The data in Table 6 shows that the number of students with proficient and capable qualifications increased, while those with worthy and starting to develop qualifications decreased. This indicates that students' MPSS improved with each cycle, leading to the success of the actions. Table 7 summarizes the average MPSS for each indicator from the initial test through cycle II.

Table 7. Average KPMM Aspects in Preliminary Tests

No	MPSS Aspect	Initial Test	Cycle I	Cycle II
1	Understanding the problem	61.58	66.67	86.58
2	Planning the solution	40.64	57.45	67.20
3	Implementing the plan	46.34	56.91	75.06
4	Interpreting results	26.21	40.65	65.85

Based on Table 7, students' MPSS improved across all aspects. The greatest increase was in understanding the problem, reaching advanced qualifications. Table 8 illustrates the classical improvement in average MPSS before and after each cycle.

Table 8: Improvement in the Average Classical KPMM Score

Test	Average MPSS Score	Improvement
Initial Test	43.69	
Cycle I	55.42	11.73
Cycle II	73.67	18.25

The improvement from the initial test to cycle I was 11.73 points, and from cycle I to cycle II, the increase was 18.25 points. The increase in MPSS between the cycles suggests that the learning process was enhanced during the research.

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The results of this research show that applying the problem-based learning model yields positive results during the learning process. This model encouraged active student participation in group discussions and enhanced their understanding of the material. The findings align with previous research by Widyastuti & Airlanda (2021), who concluded that problem-based learning helps students tackle problems more effectively. Similarly, Fitriani et al. (2018) found that students improved their MPSS with the implementation of problem-based learning. Based on these findings, it can be concluded that implementing the problem-based learning model enhances the learning process and improves students' Mathematical Problem Solving Skills.

CONCLUSIONS AND RECOMMENDATIONS

The results of this study demonstrate that students' mathematical problem-solving skills can be effectively improved through the implementation of the Problem-Based Learning (PBL) model. Based on the analysis of observation sheets across each cycle, it was concluded that the application of the PBL model significantly improves both the quality of the learning process and classroom engagement in Class VII-3 at SMPN 42 Pekanbaru during the Ratio topic for the 2023/2024 academic year.

As a recommendation, the PBL model can serve as an effective alternative teaching strategy to introduce students to mathematics in a way that encourages problem-solving skills applicable to real-world contexts. Teachers are encouraged to adopt this model to foster active learning and critical thinking in mathematics education.

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