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Improving Elementary School Students' Mathematics Problem Solving Skills through Problem-Based Learning (PBL) Based on Higher Order Thinking Skills (HOTS)

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ABSTRACT

Mathematics is a subject that requires critical and creative thinking skills to solve problems. Meanwhile, this research aims to determine the effectiveness of using problem-based learning (PBL) based on higher-order thinking skills (HOTS) to improve students' mathematical problem-solving skills. This research is classroom action research with two cycles, each consisting of planning, implementation, observation (act & observe), and reflection. This research targeted 11 fifth-grade students at SDN Wirogunan 03. Data was obtained from the results of formative tests by answering ten questions and observation sheets of learning activities. The research results showed that students' mathematical problem-solving skills had increased. Cycle I experienced an average increase of 17.95%, and cycle II experienced an average increase of 31.85%. The research results show that HOTS-based PBL can improve students' mathematical problem-solving skills and effectively improve the mathematics learning outcomes of fifth-grade students at SDN Wirogunan 03 Kartasura.

INTRODUCTION

Mathematics is a universal science that underlies contemporary developments, plays an essential role in many other fields, and enhances human thinking (Bakhri & Supriadi, 2017). This statement aligns with the 2022 National Education System Bill, article 7, paragraph 2, which outlines mathematics as a subject that must be studied at all levels of education, from primary school to secondary education. From a curriculum perspective, one of the goals of learning mathematics at school is to develop problem-solving skills (Depdiknas, 2006).

Problem-solving skills are important skills that require special consideration for

students during mathematics learning (Simatupang et al., 2020). Mathematics teaches logical and systematic thinking. Through mathematics, students learn to follow certain steps to solve problems, which helps them develop analytical and structured thinking skills through mathematical problem-solving. Therefore, for students to overcome their challenges, their mathematical problem-solving skills must continue to be developed (Nastiti & Kaltsum, 2022).

However, facts in the field show that the problem-solving skills of class V students at SDN Wirogunan 03 in mathematics learning are still relatively low. The data collected shows that 90.3% of students had difficulty solving mathematics problems because they always complain and find it difficult to understand mathematics questions during the mathematics learning process. Students are fixated on the example questions given by the teacher, so when given different queries or HOTS (Higher Order Thinking Skills) questions, students have difficulty solving them.

One alternative solution that can overcome mathematical problem-solving skills is PBL (Kurniawati & Hadi, 2021; Wulandari et al., 2023). The PBL learning model is learning that helps students learn how to solve problems and think critically by connecting real-world problems with topics (Sudrajat et al., 2020; Sulastri & Pertiwi, 2020). The PBL model encourages students to participate actively in learning activities and not just memorize mathematical concepts; it also requires understanding and proficiency when solving mathematical problems. Through problem-based activities, students will collaborate, share ideas, and communicate their points of view (Nastiti & Kaltsum, 2022; Susilo et al., 2020).

Research on the effectiveness of PBL has previously been conducted to improve problem-solving (Novianti et al., 2020; Sukmawarti et al., 2022; Widyastuti et al., 2021). Anggiana (2019) states that by using PBL learning, students can develop their critical thinking skills and look for other solutions. PBL will be more effective if combined with HOTS problems. PBL is a learning model that uses real problems as a context for students to develop problem-solving, critical thinking, and independent learning skills. Combined with HOTS, the focus is to push students beyond basic understanding and simple application toward analysis, evaluation, and creation (Diniyyah et al., 2022; Widhiyani et al., 2019).

Students can develop their mathematical problem-solving skills through training by answering HOTS-based questions. Therefore, students' problem-solving skills must be developed and carefully considered by honing their critical, creative, and rational thinking skills by getting used to mathematical problem-solving techniques. Therefore, teachers should ask HOTS questions to students, which can challenge them to be skilled at thinking and solving

problems more critically and creatively (Widhiyani et al., 2019).

HOTS refers to problem-solving skills that require creative and critical thinking. Higher-order thinking must connect, evaluate, and understand problems to produce new ideas or solutions (Saraswati & Agustika, 2020). HOTS is designed to help students develop their capacity to more critically and creatively evaluate or understand a problem in the form of information to produce final results (Muhassanah et al., 2022).

Several studies have been conducted on the role of HOTS in improving problem-solving skills by Anisah et al. (2018). This study's results align with research by Agusta (2020), which states that students' problem-solving skills increase positively with the HOTS-based learning paradigm characterized by an increase in students' learning completeness. HOTS-based learning in improving problem-solving skills is also supported by research by Widhiyani et al. (2019), which states that for students to be adept at solving mathematical puzzles in the 21st century, their thinking processes must adapt to current developments. Hence, students are more analytical and inventive in solving problems. Based on the benefits of HOTS, it will be more effective if combined with PBL in helping optimize students' mathematical problem-solving skills.

Implementing HOTS-based PBL is important because, through PBL, students are faced with real problems that require the application of mathematical concepts and techniques to find solutions. HOTS-based PBL will improve students' ability to face and solve complex and unstructured problems. HOTS-based PBL can make learning more interesting and meaningful for students. When students feel challenged and see the immediate relevance of their learning, their motivation to learn increases, which can improve learning outcomes (Selirowangi et al., 2024). Therefore, this research aims to explain how HOTS-based PBL can help students become more proficient in solving mathematical problems. Hopefully, this research will provide benefits by supporting the development of knowledge and education in improving student competence in line with current developments.

METHOD

The type of research used is Classroom Action Research (CAR). This CAR aims to improve students' mathematical problem-solving skills, which is carried out in two cycles. The action model design used for action research is the Kemmis & Taggart (2014) model. Kemmis & Taggart's design consists of several cycles, including planning, implementation, observation, and reflection phases. These cycles are repeated repeatedly until the research objectives are

achieved. In a visual representation, Kemmis & McTaggart's design would look in Figure 1 (Prihantoro & Hidayat, 2019).

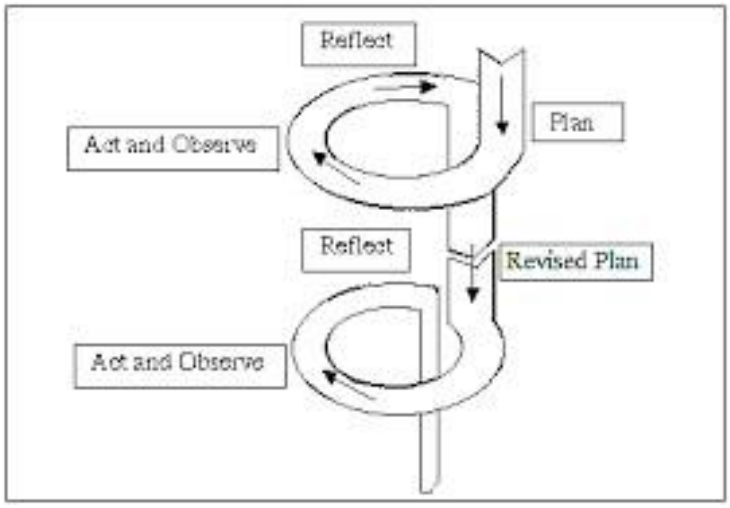

Figure 1. Kemmis & McTaggart Action Research Step (2014)

Two cycles were carried out in this research. The data extracted shows the improvement of students' mathematical problem-solving skills through HOTS-based PBL. The data source for this research consists of fifth-grade students at SDN Wirogunan 03 Kartasura, with 11 students comprised of 3 male students and 9 female students.

The data collection techniques used include observation of students' mathematical solving skills, a test by answering 10 HOTS-based problem-solving skills questions, and documentation of the results of observations made by the teacher and the results of the students' test work. In this research, the observations carried out aimed to observe students' mathematical problem-solving skills when participating in mathematics learning. The test carried out in this research is a HOTS-based problem-solving skills test, which tests problem-solving skills in mathematics. The results of this test will be the main data in this research to measure the effectiveness of the HOTS-based PBL model. The supporting documents required in this research are teaching module documents and a list of student grades.

Triangulation techniques were used in this research to ensure the validity of the data. Data from various sources can be compared by comparing information from student tests, documentation, and observations. Triangulation procedures were used to verify the applicability of the data. The research tool used is HOTS-based fraction addition and subtraction problem-solving problems. The test instrument consists of 10 questions about problem-solving

skills, which can be measured through relevant indicators. Indicators of problem-solving skills include a) understanding the problem, b) planning problem-solving, c) solving the problem according to plan, and d) checking the results obtained. The test results produce grades for each student. The next step is data analysis, which involves analyzing students' ability to solve math problems using information from their written test answers.

Data analysis used the Miles & Huberman (1994) model: data reduction, data presentation, and concluding/verification. Findings of problem-solving skills tests and observations of selected individuals were used to obtain data. Data will be presented in pictures and tables, and information obtained from test findings, observations, and documents. Making conclusions based on the evidence discussed is the final step.

Extensive data collection was done by distributing HOTS-based skills test questions to students selected as research subjects. After completing these tasks, the answers will be described to reflect problem-solving abilities. The results are used as data, which is then summarized to facilitate analysis and provide an overview of students' skills in solving mathematical problems.

RESULTS AND DISCUSSION

This research aims to determine the effectiveness of the HOTS-based PBL learning model on students' mathematical problem-solving skills through lesson study. Through lesson study, teachers can monitor student progress to achieve maximum results. This result aligns with research by Anggrella et al. (2021) that lesson study can train to develop innovative learning to maximize student competence. Based on the Plan stage, the teacher creates a learning design according to the HOTS-based PBL model. The teacher analyzes students' different learning styles and competencies. This step is useful for helping students learn optimally through heterogeneous group discussions. The Do stage is carried out in two cycles. In cycle I, there were changes in students' mathematical problem-solving skills, but students were still not used to solving problems, so their thinking skills were not optimal. In cycle II, students' problem-solving skills become optimal, as indicated by a score above the minimum criteria. This result is because the teacher reflects at each stage to improve his teaching, and students get used to it during HOTS-based PBL learning.

Based on the results of observations show that students are more enthusiastic about learning mathematics in cycle II. According to them, mathematics is interesting and fun to learn. Students consider mathematics a challenge when completing the assignments given by the

teacher. The data analysis results show that mathematical problem-solving skills have increased along with students' progress from cycle I to cycle II, as shown in Table 1.

Table 1. Problem-Solving Skills Indicator

Problem-Solving Skills Indicator	**Pra-cycle**	**Cycle I**	**Cycle II**
Understand the problem	5 (45,4%)	7 (63,6%)	9(81,8%)
Plan problem solving	3 (27,2%)	5 (45,4%)	9(81,8%)
Resolve problems according to plan	3 (27,2%)	4 (36,3%)	8(72,7%)
Check again the results obtained	1 (0,90%)	3 (27,2%)	7(63,6%)
Average percentage increase		17,95%	31,85%

Based on Table 1 shows that in the pre-cycle, students' mathematical problem-solving skills were relatively low. It was proven that pre-test results were answering 10 mathematics story questions, students' understanding of the indicators of problem-solving skills in answering questions, namely the indicator of understanding the problem was only 45% of students, planning and solving problems was only 27.2%, while the indicator of rechecking the results was only 0, 90%.

Students' lack of understanding of the operations of adding and subtracting mixed fractions is the cause of students' inability to master indicators in solving mathematical problems. Before starting the learning process, students have initial knowledge of mathematics. When students' prior knowledge is not used in learning advanced material, the new material will be difficult to accept.

The solution to overcome the problem of students' mathematical problem-solving skills is to apply the HOTS-based PBL learning model. In HOTS-based PBL, students are grouped heterogeneously into small groups. In contrast, in one group, there are students with high mathematical abilities and students with medium or low mathematical skills. Through a group peer tutoring system, this seeks to refresh their basic understanding of the operations of adding and subtracting mixed fractions.

In cycle I, the HOTS-based PBL is implemented. After that, there was a clear increase in the proportion of students who completed each HOTS problem-solving indicator. In cycle I, 63.6% of students were able to understand the situation, 45.4% were able to plan the problem, 46.3%) were able to solve it, and 27.2% were able to double-check the answers.

In cycle I, after the action in the form of using the HOTS-based PBL learning model, students experienced changes in attitudes such as being active in discussing with groups, students began to understand the basic concepts of addition and subtraction in mixed fractions,

some students also began to understand again in solving problems based on HOTS and several students began to be confident and understand the indicators of mathematical problem skills so that students started to feel happy and challenged to solve other HOTS-based problems.

In cycle II, it was discovered that 81.8% of students could understand the problem and plan to solve it. Then, the indicator of solving the problem according to plan increased by 72.7%. Meanwhile, the indicator for rechecking the results increased to 63.6%. The problem-solving abilities of cycle II participants increased on average by 31.85%. Based on the research results, students' mathematical problem-solving skills improve in the HOTS-based PBL model, which impacts students' achievement of their mathematics learning goals. The increasing number of students who can reach and exceed the minimum score (75) indicates that students have achieved completeness in mathematics learning outcomes.

Implementing the HOTS-based PBL model shows the findings of this research in mathematics learning, especially in addition and subtraction material on mixed fractions, helping students solve mathematics problems. In line with research results from Pitaloka & Suyanto (2019), students' mathematical problem-solving skills are more successful when using the PBL model compared to classrooms that use a scientific approach. This research is similar to the expression by Siswantoro (2018) that the PBL learning model can help students become more adept at solving problems if it is successfully applied at each stage of learning.

The increase in indicators of understanding problems is because students are faced with real issues relevant to their lives, so they are more interested and motivated to understand the problems in depth. Through group discussions, students can share views and information, which helps them identify various aspects and perspectives of the problem. Students are trained to analyze problems critically, identify causes, and understand the context and implications of the problem.

Indicators of planning completion also increased frequently as cycles I and II progressed because students were taught to reflect on their plans and make revisions, if necessary, based on the feedback they received during the learning process. Students are encouraged to plan the steps to solve the problem. They learn to develop strategies and choose the right mathematical methods to solve mathematical problems.

Teamwork in PBL allows students to collaborate in solving problems, share ideas, and discuss various approaches to find the best solution to improve indicators of solving problems. Students are encouraged to think creatively and find solutions to solve mathematical problems. They are also trained to think critically and evaluate the effectiveness of their solutions by

routinely providing HOTS-based problems.

Apart from that, there was also an increase in indicators looking back at results. This result is because, during the learning process with the HOTS-based PBL, students are asked to evaluate the results of their solutions, identifying what works and what does not. HOTS-based PBL involves critical reflection on the process and the results achieved. The increase in each indicator of problem-solving skills is also caused by each step of PBL facilitating students to think in solving problems. This result aligns with research by Rahmawati & Anggrella (2023) that shows that the PBL learning model can empower students' thinking skills.

It is believed that the PBL approach, especially when combined with HOTS, can positively impact students' mathematical problem-solving abilities. In cycle II, there was a significant increase because students were used to solving HOTS questions, so they could improve their critical and creative thinking skills in solving mathematical problems. This result is supported by the opinion of Kodariyati & Astuti (2016), stating that the PBL learning model influences students' problem-solving skills when answering HOTS questions. Another opinion from Aras et al. (2022) also supports this, that after implementing the PBL model, students' problem-solving skills on HOTS questions are developed.

The hope is that this research will become a valuable source of knowledge for educators, especially those who teach mathematics. Teachers can more easily help their students improve their mathematical problem-solving skills by implementing HOTS-based PBL. In this way, learning mathematics will be easier and more efficient. Apart from that, this research also aims to improve and advance Indonesian education.

CONCLUSION

The HOTS-based PBL learning model influences participants' problem-solving skills by increasing their understanding of problem-solving skills in each cycle. The research results showed an average increase of 17.95% in cycle I and 31.85% in cycle II. The HOTS-based PBL model also provides opportunities for students to express opinions, thoughts, ideas, and questions so that they feel they are being paid attention to.

Improving the mathematics problem-solving skills of fifth-grade students at SD N Wirogunan 03 Kartasura through HOTS-based PBL succeeded in developing problem-solving skills and impacted their mathematics learning outcomes. It is hoped that the HOTS-based PBL model can be applied in core learning, not just during evaluation, so that students' critical and creative thinking skills in solving mathematical problems can be well honed.

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