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Improving Geometry Problem Solving Abilities Through Spatial Reasoning-Based Problem Based Learning in Elementary Schools

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ABSTRACT

Problem-solving ability is the core of mathematics learning, but in reality, the problem-solving ability of elementary school students, especially at SD N Cimanggis 02, has not shown satisfactory results. This research aims to improve the geometric problem-solving abilities of class VB students at SD N Cimanggis 02 by using a Problem-Based Learning model based on spatial reasoning. This research is Classroom Action Research which was carried out on 38 VB class students at SD N Cimanggis 02 as research subjects and involved the VB class teacher as a collaborator. Research data was obtained through geometric problem-solving ability tests, interviews, field notes, and documentation. Indicators of problem-solving ability in this research include understanding the problem, planning to solve the problem, implementing the problem-solving plan, and evaluating or checking again. Classroom Action Research (PTK) was carried out in three cycles with research procedures that included four stages: planning, implementation, observation, and reflection. The research results showed an increase in geometric problem-solving abilities, with an increase of 66% in cycle I, 70% in cycle II, and 80% in cycle III. These results illustrate that Problem-Based Learning based on spatial reasoning can improve the geometric problem-solving abilities of class VB students at SD N Cimanggis 02.

Keywords: Problem-Solving Ability; Problem Based Learning; Spatial Reasoning

ABSTRACT

Kemampuan pemecahan masalah merupakan inti dari pembelajaran matematika, namun pada kenyataannya kemampuan pemecahan masalah siswa SD, khususnya di SD N Cimanggis 02, belum menunjukkan hasil yang memuaskan. Penelitian ini bertujuan untuk meningkatkan kemampuan pemecahan masalah geometri siswa kelas VB di SD N Cimanggis 02 dengan menggunakan model Problem Based Learning berbasis penalaran spasial. Penelitian ini merupakan Penelitian Tindakan Kelas yang telah dilakukan terhadap 38 siswa kelas VB SD N Cimanggis 02 sebagai subjek penelitian dan melibatkan guru kelas VB sebagai kolaborator. Data penelitian diperoleh melalui tes kemampuan pemecahan masalah geometri, wawancara, catatan lapangan, dan dokumentasi. Indikator kemampuan pemecahan masalah dalam penelitian ini meliputi memahami masalah,

merencanakan penyelesaian masalah, melaksanakan rencana penyelesaian masalah, dan evaluasi atau memeriksa kembali. Penelitian Tindakan Kelas (PTK) ini dilakukan dalam tiga siklus dengan prosedur penelitian yang meliputi empat tahap: perencanaan, pelaksanaan, pengamatan, dan refleksi. Hasil penelitian menunjukkan adanya peningkatan kemampuan pemecahan masalah geometri, dengan peningkatan sebesar 66% pada siklus I, 70% pada siklus II, dan 80% pada siklus III. Hasil ini menggambarkan bahwa Problem Based Learning berbasis penalaran spasial dapat meningkatkan kemampuan pemecahan masalah geometri siswa kelas VB SD N Cimanggis 02.
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Kata Kunci: Kemampuan Pemecahan Masalah; *Problem Based Learning*; Penalaran Spasial

INTRODUCTION

Mathematics is the queen of educational sciences, so mathematics education must be implemented optimally so that maximum results will be obtained (Hidayat et al., 2022) . Mathematics does not only teach about formulas and calculations but discusses material that can be applied in everyday life and mathematics teaches how to solve problems (Elita et al., 2019) . Learning mathematics is a means of organizing one's way of thinking so that one is able to reason in solving contextual problems (Agustin et al., 2024) . Mathematics is the most useful subject in improving the quality of life and expanding one's scientific horizons (Hayati et al., 2023) . Mathematics is not only a supporting tool in solving problems but also an activity to communicate ideas systematically and clearly (Silvi et al., 2020) .

The aim of learning mathematics is to develop the mathematical understanding and skills needed to solve problems and think critically (Ahdhianto & Nurfauzi, 2021) . Mathematics is a universal language used to communicate and think about the world. By studying mathematics, students can develop the skills needed to: (1) Understand and use mathematical concepts in everyday life, (2) Solve problems effectively, (3) Think critically and logically, (4) Communicate ideas clearly and effective, and (5) Develop creativity and imagination (Walle, 2013) . Problem solving standards are one of the five process standards that students must master. The five process standards are problem solving, argumentation and proof, communication, connection, and representation (Novianti & Yuanita, 2020) . Problem solving standards describe problem solving as a means for students to develop mathematical ideas (Walle, 2013) .

The ability to solve problems is the main goal of mathematics learning (Wardani & Purnomo, 2010) . The ability to solve problems is one of the goals in understanding mathematical concepts and this ability is important for students and teachers to master, however this ability is the most difficult part for students to learn and for teachers when teaching it (Yerizon et al., 2021) . Problem solving abilities are the core of mathematics learning (Oktaviana & Haryadi, 2020) . Mathematical problem solving ability is one of the basic competencies that students must have (Kurino et al., 2023) . This ability is needed to solve various problems in everyday life (Siswanto, 2024 ; Dirmansyah & Febriandi, 2023) . Problem solving ability is an effort to find solutions to the difficulties faced to achieve the desired goals (Putri et al., 2019) .

Geometry problem-solving abilities in elementary school often become a big challenge for students. This phenomenon can be seen from the low geometry learning outcomes obtained by students in various academic evaluations. This problem is not only limited to students' ability to memorize formulas or recognize geometric shapes but also includes their difficulties in understanding basic geometric concepts and applying them in problem-solving. One of the

main causes of low geometric problem-solving abilities is the lack of development of spatial reasoning among students. Spatial reasoning is the ability to visualize and manipulate objects in space, which is an important skill in understanding and solving geometric problems. Students who have good spatial reasoning are able to imagine geometric transformations, understand relationships between shapes, and apply geometric concepts in different contexts. However, many students in elementary school do not get enough practice in developing spatial reasoning. Existing curricula often place more emphasis on procedural teaching and memorizing formulas than on developing critical thinking and spatial reasoning skills. As a result, students become accustomed to a mechanical approach to solving geometric problems without truly understanding the concepts behind them. When faced with complex geometric problems that require critical thinking, they tend to feel difficult and frustrated.

Apart from that, teaching approaches that are less interactive and less contextual also contribute to low geometric problem-solving abilities. Students often do not see the relevance between the geometric concepts taught in class and the real situations they face every day. This hinders their ability to apply geometric knowledge to solve more complex problems. To overcome this problem, a more innovative and contextual learning approach is needed. Problem-based learning that integrates spatial reasoning can be an effective solution. Through this approach, students are invited to be actively involved in the learning process, facing real problems that require critical thinking and a deep understanding of geometric concepts. In this way, they not only learn about geometry theoretically but also develop practical skills in solving problems.

Problem-based learning also helps students develop the ability to identify problems, formulate hypotheses, and explore various solving strategies. In the context of geometry, students can be trained to use spatial reasoning in understanding and visualizing problems, as well as finding effective and efficient solutions. Overall, improving geometric problem-solving abilities through problem-based learning based on spatial reasoning in elementary schools will not only help students understand geometric concepts more deeply but also prepare them to face more complex academic and daily life challenges. With the right approach, students can become more confident and competent in solving various geometric problems.

Problem solving ability is an important aspect in learning mathematics, but in reality students' problem solving abilities, especially elementary school students, have not shown satisfactory results. This problem solving ability is still low because in general students have not been able to identify problems, formulate problems, develop mathematical models, work on practice questions and students have not been able to apply appropriate strategies in solving mathematical problems (Yerizon et al., 2021) . Factors causing low geometric problem solving abilities are lack of understanding of basic concepts, lack of training in using critical thinking skills, and lack of self-confidence (Permatasari Sintya, 2023) . The problem solving abilities used in this research are guided by the components of problem solving abilities from Polya (1973), namely understanding problems, making problem solving plans, implementing plans and evaluating (Polya, 1973) .

Mathematics education has a very important role in the world of education because it not only teaches formulas and calculations, but also how to apply the material in everyday life and solve problems. Mathematics helps organize a person's way of thinking so that they are able to reason in solving contextual problems. This makes mathematics a tool that is not only useful for solving problems but also as an activity for communicating ideas systematically and clearly. The main goal of learning mathematics is to develop the mathematical understanding

and skills necessary for problem solving and critical thinking. Apart from that, mathematics also plays a role in developing students' creativity and imagination through understanding and applying mathematical concepts in everyday life. Effective mathematics learning can help students develop the ability to understand and use mathematical concepts in everyday life, solve problems effectively, think critically and logically, and communicate ideas clearly and effectively.

Process standards in mathematics learning include five main aspects, namely problem solving, argumentation and proof, communication, connection, and representation. Despite its importance, students' problem-solving abilities are still low, especially among elementary school students. This is caused by various factors such as a lack of understanding of basic concepts, lack of critical thinking practice, and low self-confidence. To overcome this problem, the Polya approach to problem solving can be applied. Polya's steps which include understanding the problem, making a solution plan, implementing the plan, and evaluating the results have proven to be effective in improving students' problem-solving abilities. By implementing these strategies effectively, mathematics education can play a significant role in improving the quality of life and broadening students' scientific horizons. A deep understanding of mathematics and the ability to apply it in a variety of situations is key to preparing students for future challenges.

Based on a preliminary study conducted by researchers at SDN Cimanggis 02 in the VB class, it was revealed that in general students were not able to understand the problem of the questions presented, namely students could not identify the information that was known and what was asked about in the question, could not identify the purpose of the problem and could not determine appropriate solution strategy. This can be seen in the results of the Mathematics Odd Semester Midterm Test scores for the 2023/2024 academic year, out of 38 students, only 10 students or around 26% got scores above the KKM.

Furthermore, according to the results of interviews with class teachers, it was revealed that class VB students had low problem solving abilities, especially in learning mathematics, especially in materials that had formulas such as geometry. This geometry problem is related to the identification of various shapes, both flat shapes and spatial shapes. In the interview the teacher revealed the students' difficulties when understanding geometry problems. The reason is because the methods used by teachers in learning are still conventional and not varied. Furthermore, students do not understand basic concepts and students have weak mastery of multiplication and division. This causes students to be less trained in solving mathematical problems. Then the results of interviews with students revealed the same thing about their difficulty in understanding the problems presented.

Therefore, to overcome this problem, a learning model is needed that can activate students and encourage students to be able to explore problems so that they can better understand the problems they are facing. *Problem Based Learning* is a model that is suitable for overcoming these problems because based on its characteristics, it is *Problem Based Learning* namely that learning is focused on problem solving which requires students to be responsible for finding solutions to the problems given and in this case the teacher acts as a facilitator or mentor who provides support to students in the problem solving process (Yandhari et al., 2019) . The problem solving process using *Problem Based Learning* can improve elementary school students' problem solving abilities (Maharani et al., 2020) . *Problem Based Learning* is one of the learning models recommended for use in elementary schools in mathematics to help and

support the problem solving process (Suminar et al., 2024) . *Problem Based Learning* challenges students to solve problems and learn independently (Yulistiana & Setyawan, 2020) .

Spatial reasoning was further defined by Clements and Battista (1992) as the ability to understand and manipulate spatial objects as well as their shape relationships and transformations. In this opinion, it is stated that spatial reasoning is an important component of mathematics learning. Spatial abilities are needed to understand geometric concepts, such as points, lines, planes and space. This ability is also needed to solve mathematical problems involving geometry, such as calculating the area and volume of geometric shapes. Geometry and spatial reasoning are two things that are interrelated. Geometry is very important to learn because it helps us understand our physical environment, while spatial reasoning is a necessary ability for creative thinking in mathematics (Clements & Battista, 1992) .

skills are important in learning mathematics, especially in flat-sided geometry material (Septia et al., 2018) . Spatial reasoning is very important in helping students develop geometric concepts (Aini & Suryowati, 2022) . Spatial reasoning can be applied to problem solving in mathematics lessons (Burte et al., 2017) . The spatial reasoning intended in this research is the spatial reasoning component which includes visualization, rotation and spatial orientation. Visualization is the ability to imagine and manipulate objects in three-dimensional space, for example imagining cubes and blocks from various points of view. Rotation is the ability to rotate geometric shapes precisely, rotating cubes and blocks. Orientation is being able to identify the position of cubes and blocks in space.

This research supports previous research, namely research from (Amaliah et al., 2019) , Application of the Problem-Based Learning Model to Improve the Mathematical Problem Solving Ability of Class V Elementary School Students, concluding that there was an increase in students' mathematical problem solving ability as seen from cycle I 65 .63% to 93.75% in cycle II. The research results (Rifa et al., 2019) concluded that the application of the *Problem Based Learning model* can improve students' mathematical problem solving abilities in social arithmetic material in class X MA Annizhomiyyah students. Research (Sapoetra & Hardini, 2020) , the effectiveness of the *problem based learning model* in terms of mathematical problem solving abilities in elementary schools, concluded that the *problem based learning model* is effective for improving students' problem solving skills in mathematics subjects.

Based on the results of this research, there are differences with this research, namely in terms of material, class, level of education and its basis because this research is about the use of *Problem Based Learning* based on spatial reasoning in order to improve the geometric problem solving abilities of elementary school VB class students. The use of *Problem Based Learning* based on spatial reasoning can be a reference for teachers in implementing learning models to improve elementary school students' geometric problem solving abilities. The use of *Problem Based Learning* based on spatial reasoning in geometry material makes it easier for teachers to teach geometry to students and students understand the learning more easily. Therefore, the researcher will conduct classroom action research in the VB class at SDN Cimanggis 02. The researcher raised the title of the research, namely "Improving Geometry Problem Solving Ability through *Problem Based Learning* Based on Spatial Reasoning in Elementary Schools". This research was conducted with the aim of seeing whether learning geometry using *Problem Based Learning* based on spatial reasoning can improve elementary school students' geometric problem solving abilities and what the process of learning geometry using the *Problem Based Learning learning model* based on spatial reasoning is.

METHOD

Types and Designs

The type of research used in this research is classroom action research. The classroom action research chosen was the Kemmis & McTaggart design in the form of a spiral cycle.

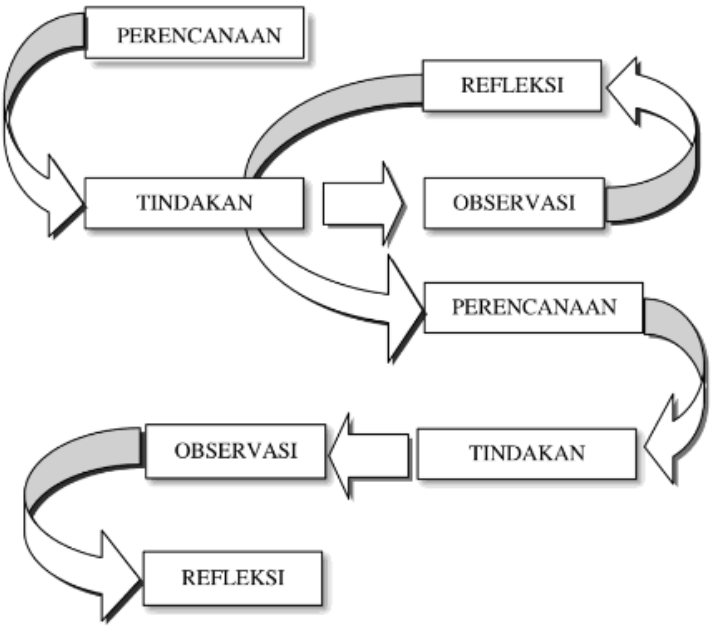

Figure 1. Kemmis & McTaggart model PTK design

This research is reflective in nature and will be carried out by researchers to improve the teaching and learning process in the classroom. All problems in the classroom are the responsibility of the researcher and researchers can carry out innovations that are deemed necessary as an effort to improve the teaching and learning process in the classroom. This research was carried out in three cycles, each cycle consisting of four stages, namely planning, action, observation and reflection. Cycles I-III consisted of three meetings (two action implementation meetings and one geometric problem solving ability test meeting). This research was carried out on March 21-April 30 2024 at SD N Cimanggis 02 with subjects of 38 students with heterogeneous abilities.

Data and Data Sources

Data from this action research consists of two types, namely qualitative data and quantitative data. Qualitative data includes data from observations of teacher and student activities in learning, while quantitative data includes test results to improve geometric problem solving abilities.

The data sources for this research are divided into two, namely first, data from observations during the mathematics learning process using the *Problem Based Learning learning model* based on spatial reasoning in cube and block building material in the VB class at SD N Cimanggis 02 which was obtained through observation instruments for

teacher and student activities. Second, namely data from research regarding increasing geometric problem solving abilities in cube and block geometric material in class VB obtained from geometric problem solving ability test instruments carried out at the end of each cycle.

Data collection technique

The data collection technique used in this research is through observation of teacher and student activities in learning, field notes, geometric problem solving ability tests and documentation.

This research uses several instruments to collect data regarding improving geometric problem-solving abilities through problem-based learning with spatial reasoning in elementary schools. The first instrument is a geometric problem-solving ability test, which includes questions to measure students' conceptual understanding, spatial reasoning, and problem-solving process abilities. The indicators measured include problem identification, planning for resolution, implementation of plans, and evaluation of results. Observation sheets are used to observe the learning process in class, including student participation, use of spatial reasoning, problem-solving strategies, and student responses to learning methods. Questionnaires were given to students after learning to collect data regarding learning motivation, concept understanding, spatial reasoning skills, and satisfaction with learning methods. Interviews were conducted with several students and teachers to obtain in-depth qualitative data about the experiences and obstacles faced during learning. Documentation in the form of field notes, photos, and videos during the learning process is used to record student activities and interactions, as well as support findings from observations and interviews. These instruments are used in a complementary manner to provide a comprehensive picture of the effectiveness of spatial reasoning-based problem-based learning in improving geometric problem-solving abilities in elementary schools.

The following is table 1 regarding qualitative data in the form of data recaps from observations of teacher and student activities in cycle I, cycle II and cycle III and table 2 regarding data recaps of geometric problem solving ability test results for cycle I, cycle II and cycle III.

Table 1. Recap of data from observations of teacher and student activities in Cycle I – Cycle III

Observation Aspect	**% which are expected**	**% achieved**		
		Cycle I	**Cycle II**	**Cycle III**
Teacher Activities	≥ 75%	73%	80%	93%
Student Activities	≥ 75%	70%	80%	90%

Table 2. Recap of geometric problem solving ability test results data cycle I – Cycle III

Category	Cycle I	Cycle II	Cycle III
Good	0%	26%	55%
Currently	63%	53%	37%
Low	37%	21%	8%
The highest score	79	100	100
Lowest Value	42	35	41
Average	65.7	70	85.3

Data analysis

The data analysis techniques used in this research are qualitative data analysis techniques and quantitative data analysis techniques. Qualitative data was obtained from teacher and student activity observation sheets, interviews, field notes and documentation. Quantitative data analysis techniques are activities to collect and add up data from research results based on variables from respondents to solve problems. Quantitative data was obtained from students through geometric problem solving ability tests. To analyze the success rate or percentage of student success after each round of the learning process, this is done by providing an evaluation in the form of written test questions at the end of each cycle. The data obtained from the test instrument was analyzed using descriptive statistics, namely adding up the overall scores obtained by students and converting them in the range 0-100. The analysis results are presented in tables and graphs. The following is a table of 3 categories of students' geometric problem solving abilities.

Table 3. Geometry problem solving ability category

Value Interval	Category
$80 \leq x \leq 100$	Tall
$60 \leq x < 80$	Currently
$x \leq 60$	Low

Source: (Davita & Pujiastuti, 2020)

Students' geometric problem solving abilities were analyzed using the components of problem solving abilities from Polya (1973) which are presented in table 2 below.

Table 4. Components of problem solving abilities (Polya, 1973)

Component	Indicator

Understand the problem	Students can state what they know and ask in the question.
Planning strategies/problem solving	Students have a problem solving plan and students are able to develop strategies to solve problems.
Apply strategy/problem solving	Students are able to implement the strategies that have been created and are able to solve problems.
Re-correct/evaluate	Students can re-correct their answers.

Source: (Priansa, 2017)

Calculation of the percentage of students' problem solving abilities is by adding up the achievement scores divided by the maximum achieved. If all the specified indicators have met completeness, reaching a minimum class average of 75% and a maximum of 100%, it can be interpreted that students' geometric problem solving abilities have increased.

RESULTS AND DISCUSSION

This research data analysis shows that problem-based learning based on spatial reasoning significantly improves students' geometric problem-solving abilities in elementary schools. From the analysis of qualitative data obtained through observation sheets, interviews, and documentation, it can be seen that student participation in learning has increased. Students are more active in discussing and collaborating with classmates to solve given geometry problems, which can be seen from increased verbal and non-verbal interactions during learning sessions. In addition, students begin to use spatial reasoning more effectively in solving geometric problems. They are able to visualize geometric shapes and manipulate them mentally to find solutions.

Interviews also revealed that students began to develop and use a variety of more systematic problem-solving strategies. They can identify problems more clearly, design resolution plans, and critically evaluate results. Student responses to problem-based learning methods are also very positive; they feel more motivated and challenged to learn geometry. Teachers reported an increase in student engagement and the quality of discussions in class. The questionnaire also showed that most students felt more motivated to learn geometry, their understanding of geometric concepts increased, and their spatial reasoning skills improved. Most students expressed satisfaction with the learning methods applied. Data triangulation demonstrated consistency between qualitative and quantitative findings. The increase in student participation, use of spatial reasoning, and problem-solving strategies observed through qualitative data is supported by significant increases in test scores and positive questionnaire responses. This conclusion shows that problem-based learning based on spatial reasoning effectively improves students' geometric problem-solving abilities in elementary schools. Thus, this research concludes that problem-based learning methods that integrate spatial reasoning not only significantly improve students' geometric problem-solving abilities, but also increase students' motivation and involvement in learning.

Students' geometric problem solving abilities measured using test at the end of each cycle. The test given is in the form of a description of 4 questions. Students are required to

answer each question using the problem solving ability components from Polya (1973), namely understanding the problem, making a problem solving plan, implementing the plan and evaluating (Polya, 1973) . The results of students' geometric problem solving abilities in each cycle can be seen in Figure 1.

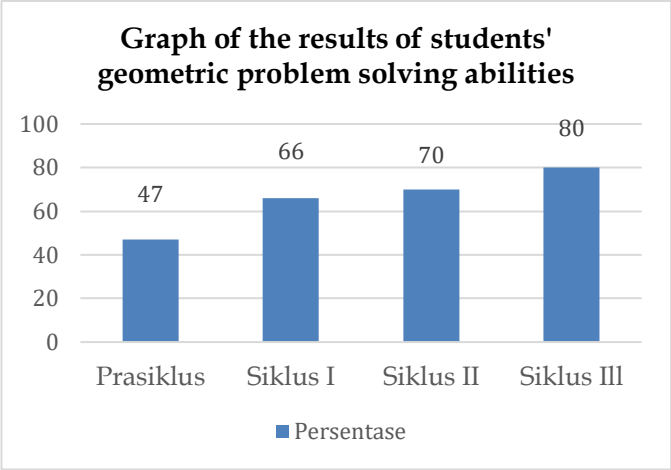

Figure 1. Graph of the results of students' geometric problem solving abilities

Figure 1 shows that students' geometric problem solving abilities increased significantly. Based on this figure, the average results of students' geometric problem solving abilities from pre-cycle to cycle III have increased, namely pre-cycle by 47%, increasing to 66% in cycle I, 70% in cycle II and 80% in cycle III. Meanwhile, the data recap results of geometric problem solving abilities from pre-cycle to cycle III are summarized in table 3 below.

Table 3. Recap of data on geometric problem solving abilities

No	Category	Precycle	%	Cycle I	%	Cycle II	%	Cycle III	%
1	Good	0	0	0	0	10	26	21	55
2	Currently	0	0	24	63	20	53	14	37
3	Low	38	100	14	37	8	21	3	8
	Amount	38	100	38	100	38	100	38	100

The summary table of data on geometric problem solving abilities shows that there has been an increase in students' geometric problem solving abilities in each cycle. In general, students have not been able to implement the components of problem solving abilities as shown in table 2, even in the pre-cycle all students are not guided by the Polya components because they are not used to it even though the teacher has taught it simply but the students' habit is to immediately implement strategies without understanding the problem, planning and evaluating. in writing.

The geometric problem solving ability of students in class VB is still relatively low as evidenced by the pre-cycle results which illustrate the low ability to solve geometric problems, but after carrying out the first cycle, namely by carrying out actions applying the *Problem Based Learning model* based on spatial reasoning, the geometric problem solving ability began to increase, namely 63% have moderate geometric problem solving abilities, namely 24 students and 37% are still low, namely 14 students. Furthermore, in cycle II, 26% had good geometric

problem solving abilities, namely around 10 students, 53% had moderate abilities, namely 20 students and the remaining 21% or 8 students still had low geometric problem solving abilities.

Based on the data from cycle II, they have not reached the KKM limit of 75, so they continue to cycle III. The results from cycle III show that 55% or 21 students have the ability to solve geometric problems in the good category with a score of ≥ 80, 37% or 14 students are in the medium category with obtaining scores between 60-80 and 8% is still low or around 3 students with ≤ 60. From the results of cycle III it was found that 80% of students had scores above the KKM, for this reason this research was stopped until cycle III.

The discussion of the results of this research focuses on evaluating the effectiveness of problem-based learning with spatial reasoning in improving students' geometric problem-solving abilities in elementary schools. Based on the results of data analysis, both qualitative and quantitative, there are several key findings that are worthy of discussion. First, the increase in student participation during problem-based learning shows that this method is effective in actively involving students in the learning process. Students who are more active in discussing and collaborating with classmates in solving geometry problems show that they not only understand concepts individually but are also able to work in groups. This improvement is important because collaboration and discussion can help students develop critical and creative thinking skills that are essential in problem-solving. Second, students' more effective use of spatial reasoning in solving geometric problems is a significant finding. Spatial reasoning is the ability to visualize and mentally manipulate objects, which is a key skill in understanding geometric concepts. By integrating spatial reasoning in problem-based learning, students can more easily understand geometric shapes and relationships, which in turn improves their ability to solve geometric problems. This is consistent with educational theory which states that visualization and mental manipulation are important aspects in learning geometry.

Third, the more systematic problem-solving strategies developed by students show that problem-based learning helps them in developing metacognitive skills. The ability to identify problems, design a resolution plan, execute the plan, and evaluate results are important metacognitive skills. Students who are able to develop and use this strategy tend to be more successful in solving problems because they have a structured and systematic approach to dealing with problems. Fourth, students' positive response to the problem-based learning method shows that this approach can increase students' motivation and involvement in learning. Students who feel challenged and motivated to learn tend to have better achievements. High motivation is also associated with increased interest and desire to learn further, which is important for continuous learning.

The quantitative results support the qualitative findings by showing a significant increase in students' geometric problem-solving abilities after implementing problem-based learning. The increase in the average score from the pre-test to the post-test shows that this method is effective in improving problem-solving skills. The paired t-test shows a significant difference between the pre-test and post-test scores, which confirms that problem-based learning has a real positive impact on students' abilities. A questionnaire given to students showed that most students felt problem-based learning helped them understand geometric concepts better and improved their spatial reasoning skills. Student satisfaction with this method also shows that problem-based learning is well-received and can be implemented effectively in the classroom.

Overall, the findings of this study indicate that problem-based learning with spatial reasoning is an effective approach to improving geometric problem-solving abilities in elementary schools. This method not only improves students' cognitive and metacognitive skills but also increases their motivation and engagement in learning. Therefore, it is recommended that this method be applied more widely in geometry learning in elementary schools to achieve optimal results in mathematics learning.

Problem Based Learning learning model used has the characteristics, namely (1) learning begins with giving a problem, (2) students in groups actively formulate the problem, and (3) study and search for material related to the problem themselves and report the solution (Ali N, 2008) . This model is suitable for helping students improve problem solving abilities. *Problem Based Learning* is a learning model recommended for mathematics learning in elementary schools to support students' higher level thinking abilities through investigation and problem solving (Zainal, 2022) . *Problem Based Learning* is a learning model that uses various students' thinking abilities, both individual and group, and is relevant to students' lives and makes learning more meaningful (Permatasari Sintya, 2023) .

Problem Based Learning is linked to spatial reasoning in this research because geometric concepts require spatial abilities to understand them, in this case regarding the nets of cubes and blocks, elements of cubes and blocks as well as the area and volume of cubes and blocks. *Problem Based Learning* based on spatial reasoning is predicted to improve students' geometric problem solving abilities. Clements & Battista (1992) stated that geometry and spatial reasoning are two interrelated things. Geometry is very important to learn because it helps us understand our physical environment, while spatial reasoning is a necessary ability for creative thinking in mathematics (Clements & Battista, 1992) .

The comparison of research findings with previous research such as that conducted by Maharani & Montessori (2020), namely cycle 1 was 68 and cycle 2 was 79. The results of this research show an increase in the problem solving abilities of elementary school students using the *Problem-Based Learning* model , there is a percentage increased problem solving abilities students amounted to 11%, while this research showed that the average problem solving ability of students was initially 66% to 70% and increased again to 80%. The significance of the findings of this research is that the application of the *Problem-Based Learning learning model* based on spatial reasoning can significantly improve problem solving abilities *student* geometry .

CONCLUSION

This research shows that before the intervention, students' geometric problem solving abilities were very low, as evidenced by the pre-cycle results. After implementing the Problem Based Learning learning model based on spatial reasoning, students' geometric problem solving abilities increased. This research involved three cycles of action that were proven effective in improving this ability. The application of this model makes students more active because it involves collaboration and group discussion, thereby broadening their horizons through the exchange of ideas and spatial reasoning which includes imagination, orientation and mental manipulation of cubes and blocks. This hones critical thinking and improves students' spatial intuition.

It is hoped that the results of this research can inspire teachers to develop more effective and meaningful geometry learning. It is also hoped that other innovative learning models will emerge that teachers can apply in the learning process, especially mathematics learning in elementary schools, in order to equip students with critical, creative and logical thinking skills.

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