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Improving Problem Solving Abilities in Mathematics Subjects Using Problem-Based Learning (PBL)

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ABSTRACT

This research aims to determine the application of the problem-based learning (PBL) model to improve students' problem-solving abilities in Mathematics subjects in class. This research is classroom action research carried out in 2 cycles. The research subjects were students of the class. The research procedure consists of 4 stages in each cycle: planning, implementing actions, observing, and reflecting. The biology learning process uses the problem-based learning (PBL) learning method. The indicator of learning outcomes in this research is an increase in students' ability to solve problems in mathematics subjects. The results of the research showed that students' problem-solving skills increased in each cycle; in cycle II, there were nine people in the 90 - 100 (excellent) range, 16 people in the 80 - 89 (good) range, and seven people in the 80 - 89 (good) range. Value range 70 – 79 (medium). These findings underscore the potential of the PBL model to effectively enhance students' capacity to solve mathematical problems, offering a more engaging and effective learning experience.

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1. INTRODUCTION

In principle, excellent and challenging learning is a learning process that solves many problems that exist in life to be drawn to learning so that students can experience and feel firsthand how to analyze and find solutions to overcome these problems (Gallagher, 2023; Perusso & Leal, 2022; Salvador et al., 2023). However, this is not the case; it turns out that students who take part in the learning process of mathematics, especially in class XII IPA 2 SMAN 1 Cigalontang Tasikmalaya Regency, look very unenthusiastic in participating in mathematics learning because, according to their assumption that mathematics lessons are lessons that are very difficult to understand especially requiring high numeracy skills and memorizing formulas of multiplication, subtraction, division, and addition.

This is one of the learning problems that teachers often find when teaching mathematics subjects. The interest and enthusiasm of students' learning still need to be higher, which can reduce the quality of learning carried out by the teacher. Especially with the teacher's habit of teaching using the lecture method to students in class. Many problems exist in the implementation of learning that are related to the teacher's ability to apply inappropriate teaching methods, the education curriculum that is too rigid, ineffective school management, and the lack of motivation of students in learning so that students cannot solve their problems (Aksit et al., 2016; Asigigan & Samur, 2021).

This can be seen in the field, which shows that students lack high learning ability. Many students feel lazy and bored with participating in math learning, especially in class XII IPA 2 SMAN 1 Cigalontang Tasikmalaya Regency. Students often need help understanding the math lessons delivered by the teacher well. Students need strong motivation to learn. Students still consider learning activities unpleasant and choose other activities outside the learning context, such as watching television, playing with gadgets, and talking when the teacher explains in front of the class. This can be seen from the results of the pre-cycle; out of 32 students, only two students, or 6.25%, can be said to be able to solve problems in learning mathematics.

One step the teacher can take as a guide for students is choosing a suitable learning model. Using an inappropriate learning model can lead to boredom and a lack of understanding of the teaching material, ultimately reducing students' motivation to learn (Dewaele & Le, 2020; Ibrahim et al., 2017; Susilana et al., 2022). Thus, an effective learning model is needed, making students more active in the learning process. One of the learning models that can be used is the Problem Based Learning (PBL) model. Problem Based Learning (PBL) is an innovative learning model that can provide active learning conditions to students, involving students to solve a problem through the stages of the scientific method so that students can learn knowledge related to the problem and at the same time have the skills to solve problems (Hung et al., 2008; Suryanti & Supeni, 2019; Vasquez & Lara, 2020).

According to John Dewey, as cited in Bayrak & Gürses (2020), there are six steps in Problem-Based Learning (PBL), which he later referred to as the problem-solving method. The first step is formulating the problem, where learners identify the problem that needs to be addressed. Next, they analyze the situation, critically examining it from multiple perspectives. After that, learners formulate hypotheses, proposing various potential solutions based on their existing knowledge. The subsequent step is collecting data, where learners seek and describe the necessary information to solve the problem. Then, they move on to testing the hypothesis, drawing conclusions based on the acceptance or rejection of the proposed theory. Finally, learners formulate recommendations for problem-solving by outlining

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recommendations that can be made based on the results of hypothesis testing and the conclusions drawn.

Problem solving as an effort to find a way out of a difficulty in order to achieve a goal that is not immediately achievable (Sari et al., 2021; Watzlawic et al., 2011). To gain the ability to solve problems, one must have a lot of experience in solving various problems. Various research results show that children who are given a lot of problem solving practice have higher scores than children with less practice (Alfares, 2021; Simanjuntak et al., 2021).

Problem-solving is a fundamental skill that students must acquire, and its importance is evident in the competency-based curriculum framework. This curriculum emphasizes students' need to develop problem-solving abilities, integrating them into various subject areas. The indicators of effective problem-solving include several key steps: first, understanding the problem by translating verbal descriptions into mathematical terms and identifying the known and unknown elements. Next, in the planning stage, students select relevant variables, interpret the problem through visuals or diagrams, and create a mathematical model. When solving the problem, students apply appropriate concepts or rules, perform accurate calculations, and determine the solution. Finally, reevaluation involves testing the solution against the model and identifying more efficient or optimal outcomes (Thorndahl & Stentoft, 2020).

This study aims to investigate the implementation of the Problem-Based Learning (PBL) model as a strategy to enhance students' motivation and problem-solving skills in mathematics, particularly among students in class XII IPA 2 at SMAN 1 Cigalontang, Tasikmalaya Regency. By exploring how PBL can address the challenges of low student engagement and understanding in mathematics, this research aims to provide insights into innovative learning models' effectiveness in fostering academic achievement and critical thinking abilities. Ultimately, the goal is to improve students' ability to solve complex problems and increase their overall enthusiasm for learning mathematics.

2. METHODOLOGY

This research is a type of Classroom Action Research (CAR). Classroom action research is an observation of learning activities in the form of actions deliberately raised and occurring in a class together (Cohen et al., 2017). Classroom action research is a theoretical concept and a practical problem-solving strategy (McNiff, 2013). It involves taking real action, reflecting on the results, and using these insights to improve the quality of the subject being studied. In this case, the research was conducted with a specific goal: to enhance students' problem-solving abilities in mathematics through the application of Problem-Based Learning (PBL).

In its implementation, this classroom action research was carried out in collaboration between researchers as teachers and colleagues as observers. In this case, the researcher collaborates with colleagues to make it easier to conduct research and obtain more accurate data because observers in classroom learning activities can observe researchers. The subjects in this classroom action research are students in class XII IPA 2 totaling 32 students consisting of 11 males and 21 females. Meanwhile, the object of this classroom action research is the level of mathematical problem solving ability of students in class XII IPA 2 until applying the Problem Based Learning (PBL) model.

This classroom action research began with initial observation activities by giving initial tests (pre-cycle) to students regarding students' abilities in solving various problems in story problems in mathematics subjects. It turned out that students' problem-solving skills were

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still low in this type of research, namely classroom action research. The flow of the classroom action research cycle can be seen more clearly in Figure 1 below.

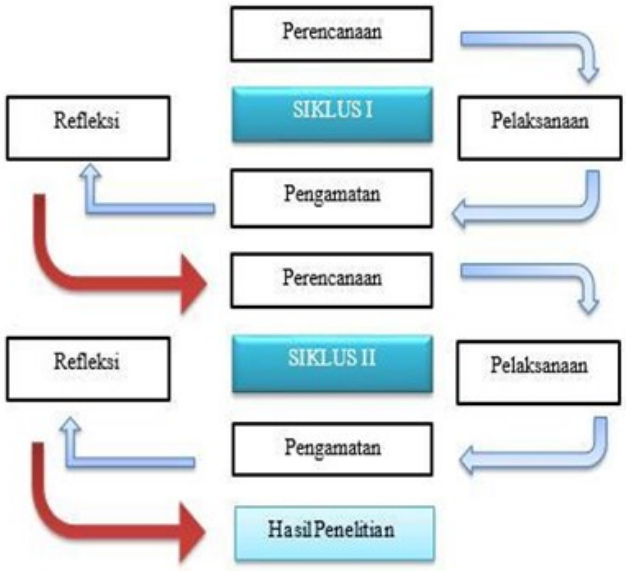

Figure 1. Scheme of Procedures for Implementing Classroom Action Research (Sanjaya, 2013)

3. RESULT AND DISCUSSION

Before carrying out classroom action research by applying problem-based learning (PBL), researchers first made initial observations to conduct pre-cycle activities to identify problems during the ongoing mathematics learning process in class XII IPA 2 SMAN 1 Cigalontang Tasikmalaya Regency. The observations were carried out with a focus on the teacher's teaching, the students' activeness, and their mathematics learning outcomes. The active participation of the students in these observations was a key aspect, highlighting their role in the research process.

Tabel 1. Description of Students' Ability Levels in Pre-Cycle Activities

Criteria	Ability Level	Many Students	Percentage of Number of Students
90 – 100	Very high	0	0
80 – 89	High	0	0
70 – 79	Currently	2	6,26
60 – 69	Low	3	9,37
0 – 59	Very Low	27	84,37
Amount		32	100

Based on the analysis in the table above, students' ability to solve problems in pre-cycle activities is still low. This can be seen from the number of students given the initial test who only got a score between 70 and 79, with two people in the medium category or around 6.26% of the total number of 32 students. This indicates that students' abilities are still meager, and action needs to be taken.

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To be able to clarify the results of the calculation of the table above, it can be seen in the following figure:

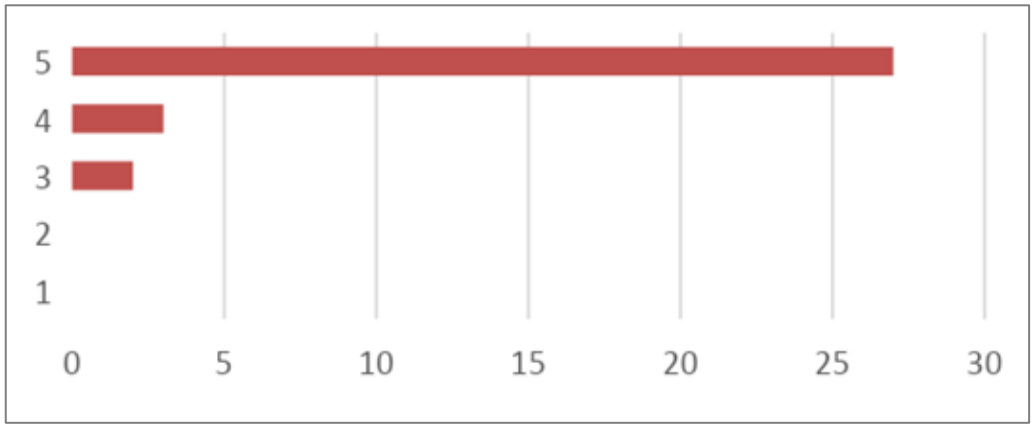

Figure 2. Description of Students' Ability Levels in Pre-Cycle Activities

3.1 Cycle I

Problems in cycle I were obtained based on the results obtained from the initial test. The test was given to students of class Problem Based Learning (PBL).

To be able to find out the tests carried out in cycle I activities can be seen in the table below:

Tabel 2. Description of Students' Ability Levels in Cycle I Activities

Criteria	Ability Level	Many Students	Percentage of Number of Students
90 – 100	Very high	0	0
80 – 89	High	5	15,63
70 – 79	Currently	8	25
60 – 69	Low	8	25
0 – 59	Very Low	11	34,37
Amount		32	100

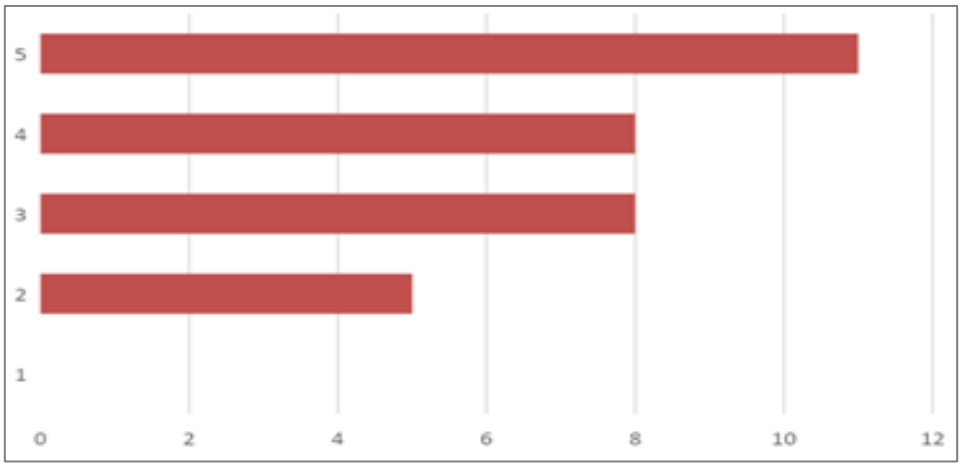

Figure 3. Description of Students' Ability Levels in Cycle I Activities

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Based on the results of data calculations in the table above, it can be seen that five students got a score in the range of 80 - 89 in the high category or around 15.63%, students who got a score in the range of 70 - 79 in the medium category are 8. people or around 25%, eight students got scores in the range 60 – 69 or around 25%, and students who got scores in the range 0 – 59 in the deficient category were 11 people or around 34.37%.

These results indicate a promising improvement in student performance, especially when compared to pre-cycle activities or before the introduction of problem-based learning (PBL). This suggests that there is still room for further enhancement, as depicted in the following figure 3.

After carrying out learning actions consisting of two meetings in cycle I, the research identified the problems found during the learning. Based on the results of the observations and the researcher's observations during the lesson, several things were obtained that the researcher needed to pay attention to so that they could become materials for improvement for the next cycle, namely:

a. Researchers have yet to be able to manage and carry out teaching and learning activities optimally. This is based on the results of observations of teacher activities in the implementation of teaching and learning activities in cycle I;
b. Students still need to be able to optimally follow lessons using the learning model problem-based learning (PBL), where students are more active and discover the concepts being studied for themselves with limited assistance from the teacher. Most students still need clarification about solving problems or finding mathematical concepts using problem-solving steps. These students' difficulties include not planning problem-solving, finding a pattern that matches the situation, and needing help to carry out the solution. Problems, in this case, linking, arranging, and defining the concepts studied to solve problems;
c. The students' problem-solving ability scores are still low, only reaching a learning completion level of 6.25%. Thus, it can be concluded that the class is not yet complete in solving problems classically, namely that not more than 75% of students have a moderate level of problem-solving ability.

3.2 Cycle II

At the level of action implementation, the researcher, in the role of a teacher, implements learning activities using problem-based learning (PBL). The actions in cycle II are consistent with those in cycle I, with several improvements to the activities at each stage. The learning process seamlessly continues with the next material on the probability of compound events, using PBL in accordance with the RPP in cycle II.

To be able to find out the tests carried out in cycle II activities can be seen in the table below.

Tabel 3. Description of Students' Ability Levels in Cycle II Activities

Criteria	Ability Level	Many Students	Percentage of Number of Students
90 – 100	Very high	9	28,12
80 – 89	High	16	50
70 – 79	Currently	7	21,88
60 – 69	Low	0	0

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Criteria	Ability Level	Many Students	Percentage of Number of Students
0 – 59	Very Low	0	0
Amount		32	100

Based on the results of data calculations in the table above, it can be seen that nine students got a score in the range of 90 - 100 in the very high category or around 28.12%, students who got a score in the range of 80 - 89 in the high category are numbered. Sixteen people, or around 50%, seven students got scores in the range 70 – 79, or around 21.88%, and no students got scores in the range 60 – 69 and 0 – 59 in the low categories.

This shows a perfect improvement when compared to cycle I activities, namely by implementing problem-based learning (PBL), which is planned carefully and thoroughly so that the learning activities given to students can run effectively and efficiently so that all students can understand and follow the learning well which in the end can have good problem-solving skills regarding mathematics learning in the material of probability of occurrence compound.

Furthermore, to be able to clarify the data above, the researcher displays the data in the following figure 4.

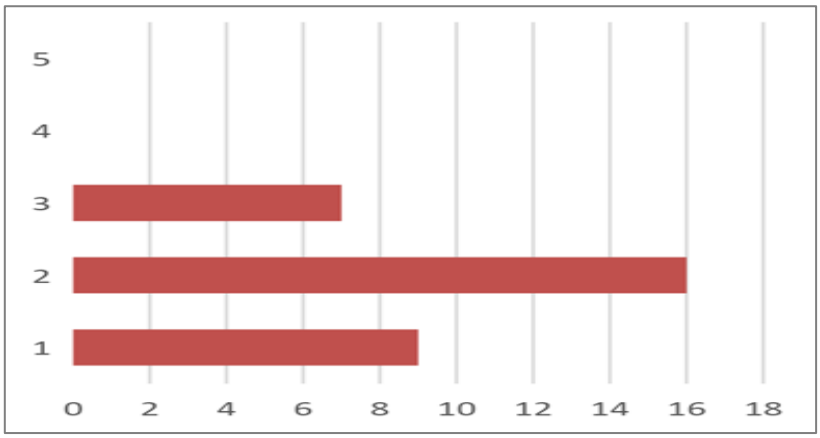

Figure 4. Description of Students' Ability Levels in Cycle I Activities

3.3 Discussion

Based on the results of research in cycles I and II, it can be said that the learning process using the problem-based learning (PBL) model can improve students' abilities in problem-solving in class XII IPA 2 SMAN 1 Cigalontang Tasikmalaya Regency. The discussion of the results of this research is based on observations accompanied by reflections on actions at the end of each cycle.

The results of observations of student activities during problem-based learning (PBL) show that students are making significant strides in their problem-solving abilities. When given assignments and exercises in mathematics, students demonstrate their improved problem-solving skills, including tackling problems presented by the teacher.

Then, students present the results of the data obtained in front of the class. In this context, students present their abilities in solving problems with their respective creativity. Even though in the implementation of cycle I, some students were still in the score range between 0 - 59 and 60 - 69 in the very low and low categories. This is because students are still not

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used to solving various mathematical problems using the material on the probability of compound events.

When working on various story questions related to material on the probability of multiple events, students still experience difficulties and do not show seriousness, so many students still have a score below the minimum passing score (MPS) of 79. Likewise, teachers' ability to provide learning has yet to be appropriately implemented. Moreover, teachers are more likely to use lecture teaching methods, which make students feel bored and fed up with participating in mathematics learning in class XII IPA 2.

Furthermore, in the implementation of cycle I activities, there were still many students who wanted to avoid asking questions when explaining the material to the teacher, and most of the other students were still less active in asking or answering questions from the teacher. Likewise, many students still feel awkward and shy when working on the questions given by the teacher. In more detail, the results of observations made by observers on students obtained the following findings: a) the average activity of students in learning mathematics does not meet the indicators, and students who ask the teacher or answer questions from the teacher are still deficient; b) Students are still awkward and nervous when making presentations in front of the class.

From this reflection, the researcher then continues learning to cycle II. The situation of increasing student activity was seen when students in cycle I had not asked the teacher many questions and answered questions from the teacher related to mathematics learning material. In cycle II, students are active and willing to ask more questions about material they do not understand. When the teacher gives them the next test, many students show their ability to solve the problems provided by the teacher. In implementing cycle II activities, students looked even more enthusiastic than in cycle I activities. In cycle II, they showed excellent results compared to cycle II.

In the learning process in cycle II, the teacher tries to improve his performance further by applying problem-based learning (PBL). In cycle II, the researcher acting as a teacher encouraged students to improve their ability to solve problems in mathematics lessons by applying problem-based learning (PBL) in class XII IPA 2 at SMAN 1 Cigalontang, Tasikmalaya Regency. Implementing problem-based learning (PBL) in mathematics learning can improve students' mathematical problem-solving abilities, especially in the material on the probability of compound events. Students' problem-solving abilities can increase with PBL because presenting problems in learning will stimulate students' thinking, analysis, and critical thinking (Arifin et al., 2020; Mustofa & Hidayah, 2020; Rehmat & Hartley, 2020). PBL is relevant to indicators of problem-solving (Kori, 2023; Lapuz & Fulgencio, 2020; Sholihah & Lastariwati, 2020).

4. CONCLUSION

Based on the results of the research and discussion, the researcher concluded that the application of problem-based learning (PBL) in the class showed an improvement in students' ability to solve mathematical problems, particularly in the Statistics material. This improvement enabled students to achieve the required learning mastery in mathematics, which was aligned with the previously established minimum passing criteria. The class action research began with a pre-cycle phase to assess the initial level of students' problem-solving abilities. During this phase, a small number of students demonstrated moderate proficiency, while the majority were categorized as having very low proficiency in problem-solving.

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Following the implementation of PBL, there was a noticeable increase in students' abilities. A group of students achieved high proficiency, while others showed moderate and low proficiency. Despite this progress, there remained a portion of the class that did not meet the standard for classical learning mastery, which prompted the continuation of the process into a second cycle. The outcomes from the first cycle were used to guide further actions and refine the learning strategies in the second cycle, with the goal of enhancing students' problem-solving skills through the continued use of PBL.

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