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Implementation of Problem-Based Learning Model and Its Effect on Students' Physics Learning Outcomes

Ayu Swasti Dayuni Soamole[1)], Kaharuddin Arafah[2*)], Subaer[3)]

[1,2,3)]*Physics Education Study Program, Universitas Negeri Makassar, Makassar, 90222, Indonesia*

**corresponding author: kahar.arafah@unm.ac.id*

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Abstract – *This study aims to implement a problem-based learning model and to measure its effect on students' physics learning outcomes. This research is a pre-experiment using a one-group pretest-posttest research design. The population in this study were all students in class XI MIPA at SMA Negeri 1 Wangi-Wangi for the 2022/2023 academic year, while the sample was 35 students who were selected using the Slovin method. The results of the descriptive analysis showed that the average score of students' physics learning outcomes before using the problem-based learning model was 7.26. Conversely, after using the problem-based learning model, the average score of students' physics learning outcomes was 12.14. The results of the N-gain test analysis showed N = 0.36, which indicated that there was an increase in students' physics learning outcomes after using the problem-based learning model. Therefore, this study concluded that the problem-based learning model is effective in improving the physics learning outcomes of class XI MIPA students at SMA Negeri 1 Wangi-Wangi.*

Keywords: *learning outcomes; physics concept; problem-based learning*

I. INTRODUCTION

The development of knowledge and technology in the 21st century is increasing, requiring qualified human resources to deal with it (Nasar & Kurniati, 2020). The rapid advancement of science, technology, and society requires people to have the necessary skills (Ratini et al., 2018). The world of education in the 21st century faces enormous challenges. Education in the 21st century must be able to prepare generations of Indonesians to welcome the advancement of information and communication technology in social life (Rawung et al., 2021). Developments in education teach all people to solve problems that are their responsibility as Indonesian citizens. Education is regulated by a system in Indonesia, namely the Indonesian National Education System (Yustiana et al., 2022).

Appropriate curriculum development will be able to increase the effectiveness of future needs in the knowledge era and efforts to improve the skills and competencies of students (Rawung et al., 2021). The tutoring and learning process is a process that requires the role of the teacher and the students (Azhary et al., 2020). The teacher factor is very influential in the continuity of the learning process (Yustiana, 2022). One of the problems faced by the world of education is the weak learning process, and students are less directed to develop thinking skills that aim to lead students to changes in behavior (Prihatiningtyas & Sholihah, 2020). Changes in individual behavior as a result of learning are shown in various aspects, such as changes in understanding, knowledge, perceptions, and motivation (Harjati, 2023).

Many teachers still teach in teacher centers rather than student learning centers. Teaching in a teacher center is usually implemented through lecture methods, but the lecture method is not well used in communicating the material (Arofiq, 2019). Based on the results of preliminary observations conducted at SMA Negeri 1 Wangi-Wangi, the students think that physics lessons are very difficult to understand because there are too many formulas that must be memorized, and the delivery of certain topics in physics lessons still uses teacher-centered learning. This causes students' inability to solve problems, and learning that is still dominated by the teacher will make students feel bored (Muliandari, 2019). Teachers are required to be more creative and innovative in choosing teaching models and media that will be used when teaching in class (Ismatulloh & Ropikoh, 2022). The existence of good communication between teachers and students will achieve the goals of success in the learning process and help students understand the material being studied (Kartika et al., 2022). Learning outcomes are influenced by factors like study space and the teacher's teaching (Nurnaifah et al., 2023).

Much research has been performed regarding problem-based learning by assessing the students' results and increases in learners' success (e.g., Asdar et al., 2020, 2019; Arofiq, 2019; BatdÄ, 2014; Nurazmi & Bancong, 2021). Problem-based learning as a pedagogical strategy appeals to many educators because it offers an instructional framework that supports learning (Yew & Goh, 2016). Problem-based learning is defined as learning that involves problems (Nasar & Kurniati, 2020). Problem-based learning requires students to conduct investigations to solve problems (Widura et al., 2021; Nurazmi & Bancong, 2021). Problem-based learning begins after the teacher provides problem scenarios to students taken from daily life problems (Jamal et al., 2019). Problem-based learning provides opportunities for all students to be active in the learning process (Rombe et al., 2021).

Problem-based learning is designed to help learners develop their thinking, problem-solving, and intellectual skills (Sulistyani, 2018). Problem-solving skills are an integral part of school physics lessons and also help students adapt to their environment (Wilujeng & Suliyanah, 2022). Skills in higher-order thinking which is defined as the ability to think in a more complex and comprehensive manner with a view to obtaining a solution to a problem (Lespita et al., 2023). The concept of problem-based learning is to uncover an issue situation, seek information, and discuss and apply new knowledge to the issue (Hussin et al., 2019). The stages of problem-based learning are (1) orientation of students to the problem, (2) organization of students for learning, (3) leading individual or group experiences, (4) development and presentation of the work, (5) process evaluation and assessment (Yulianti & Gunawan, 2019).

The use of the problem-based learning model requires proactive student participation in learning activities (Asdar et al., 2020). The characteristics of the problem-based learning model are related to real-life problems and emphasize investigation activities in solving these problems (Prihatiningtyas & Sholihah, 2020). Problem-based learning has a direct positive impact on students' academic performance, retention of knowledge, conceptual development, and attitudes toward learning (Merritt et al., 2017). It is hopeful that through teaching with a problem-based learning model, students will be able to solve problems while learning.

Therefore, the purpose of this research is to implement a problem-based learning model and measure its effect on learning outcomes. The research question is

1) What is the score of the students' physics learning outcomes before and after the implementation of the problem-based learning model in class XI at SMA Negeri 1 Wangi-Wangi?
2) Does the implementation of the problem-based learning model significantly improve students' physics learning outcomes in class XI at SMA Negeri 1 Wangi-Wangi?

II. METHODS

This research is pre-experiment research. This research was done in the odd semester of the academic year 2022/2023 at SMA Negeri 1 Wangi-Wangi, Wakatobi District, Southeast Sulawesi Province. The population of this research was all students enrolled in class XI MIPA of SMA Negeri 1 Wangi-Wangi in number of 180 students. The sample consisted of 35 students of class XI.3 MIPA. This research used a pre-experimental design with a one-group-pretest-posttest form as follows:

$$O_1 \;\; X \;\; O_2$$

Description:
O_1 = Pre-test results
O_2 = Post-test results
X = Treatment

(Sugiyono, 2016)

The procedures used in this research included a preparatory phase, an implementation phase, and a final phase. The data collecting method used was a test, which is a series of questions that correspond to the elements of learning outcomes. In this case, two tests were used, namely pre-tests and post-tests.

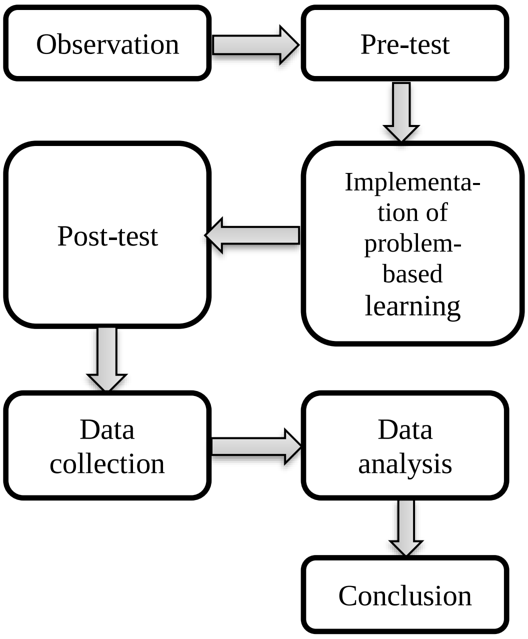

Figure 1. A flow chart of the research procedure

The instrument used in this research is a multiple-choice test according to the basic competencies. The instrument is used to examine the learning achievement of the students using the model of problem-based learning. The data from this research were processed and analyzed with descriptive analysis and the N-Gain test. Descriptive analysis was used to describe the assessments of SMA 1 Wangi-Wangi, who were taught using the problem-based learning model. This method serves to analyze the data by describing the collected data based on the retrieved variables (Sugiyono, 2017). The descriptive analysis includes 1) average score; 2) variance; 3) standard deviation; 4) categorization of descriptive statistics.

The following is a table of descriptive statistical assessment categorization guidelines put forward by Riduwan (2018).

Table 1. Guidelines for categorization of descriptive statistics

Value interval criteria	Rating category
81% - 100%	Very high
61% - 80%	High
41% - 60%	Medium
21% - 40%	Low
0% - 20%	Very low

The N-Gain test is used to calculate the enhancement of student learning achievement pre and post-using the problem-based learning model. If there is a substantial difference between the average pre-test and post-test scores, the improvement in student performance using the N-gain formula can be calculated:

$$g = \frac{S_1 - S_0}{S_{maks} - S_0} \qquad 1)$$

Description:
S_1 total = Post-test total score
S_0 total = Pre-test total score
S_{max} = Maximum score

The classification of normalized gain scores follows the classification put forward by Wahyu et al. (2018) as follows.

Table 2. Normalizid gain criteria

N-Gain score	Criteria
$0,00 < N - gain < 0,30$	Low
$0,30 \leq N - gain \leq 0,70$	Medium
$N - gain > 0,70$	High

III. RESULTS AND DISCUSSION

The research findings in this study are data from the pretest and posttest results after implementing the problem-based learning model in class XI SMA Negeri Wangi-Wangi. This research was conducted in 6 meetings on the subject of elasticity of materials. The results of descriptive analysis of the physics learning outcomes test scores of students in class XI MIPA 3 SMA Negeri 1 Wangi-Wangi can be seen in the Table 3.

Table 3. Descriptive statistics of physics learning outcomes score of students

Statistic	**Statistic score**	
	Pre-test	**Post-test**
Subject	35	35
Maximum ideal score	23	23
Minimum ideal score	0	0
Maximum empirical score	10	18
Minimum empirical score	5	9
Average score	7.26	12.14
Standard deviation	2.15	2.43
Variance	4.65	5.90

Based on the pre-test results, it was found that the students' physics learning achievement of class XI MIPA at SMA Negeri 1 Wangi-Wangi before using the problem-based learning model showed that the highest score achieved was 10, the lowest score was 5, and the average score achieved was 7.26 with a standard deviation of 2.15. Conversely, based on the post-test results, it was found that the students' physics learning achievement of class XI MIPA at SMA Negeri 1 Wangi-Wangi after using the problem-based learning model showed that the highest score achieved was 18, the lowest score was 9, and the average score achieved was 12.14, with a standard deviation of 2.43.

Table 4. Categorization of pre-test and post-test scores of students' physics learning outcomes

No	Score interval	Category	Percentage (%)	
			Pre-test	Post-test
1	20-24	Very high	0	0
2	15-19	High	0	28
3	10-14	Medium	9	63
4	5-9	Low	91	9
5	0-4	Very low	0	0
Total			100	100

Table 4 demonstrates the scores for physics learning outcomes before and after using the problem-based learning model. As seen in the pre-test, there were 3 students in the medium category with a percentage of 9%, and 32 students in the low category with a percentage of 91%. This shows that the learning achievement of physics before learning using a problem-based learning model is in the low category. Conversely, in the post-test, there were 10 students in the high category interval with a percentage of 28%, 22 students were in the medium category with a percentage of 63%, and 3 students were in the low category with a percentage of 9%. This shows that the learning outcomes of physics after learning using problem-based learning models are in the medium category.

To determine the significance of increasing student learning outcomes, the N-Gain formula is used. The distribution and percentage of the N-Gain average based on the gain index criteria are shown in Table 5 below:

Table 5. Distribution and percentage of normalized gain of students

Normalized gain score	Criteria	Percentage (%)	N-Gain
$(g) < 0.3$	Low	43	
$0.3 \leq (g) < 0.7$	Medium	54	0.36
$(g) \geq 0.7$	High	5	
Total		100	

Table 5 shows that 43% of students are in the low criteria, 54% of students are in the medium criteria, and 3% of students are in the high criteria. It can also be seen that students of class XI MIPA SMA Negeri 1 Wangi-Wangi have an average score of normalized gain of 0.36 with criteria in the medium category. It means that there is an improvement in student learning achievement after teaching using a problem-based learning model.

This research is a pre-experiment research conducted in several stages, namely the pre-test stage, implementation of the problem-based learning model, and the final stage by giving a post-test to students of class XI MIPA 3 SMA Negeri 1 Wangi-Wangi. This research uses a problem-based learning model, which has several learning steps that are carried out during learning activities in the classroom. The learning steps are orienting students to the problem, organizing student for learning, guiding individual and group investigations, developing and presenting work, and analyzing and evaluating the problem-solving process.

The implementation of all learning steps in this study has been carried out well. This can be seen from the results before and after using the problem-based learning model in descriptive statistical analysis and the N-Gain test, which there is an increase after using the problem-based learning model. After carrying out these stages, the research data were obtained. Based on the descriptive statistical analysis, it was found that the average score of the students' physics learning outcome in class XI MIPA at SMA Negeri 1 Wangi-Wangi before and after being taught using a problem-based learning model is 7.26 and

12.14 conversely. This shows that there is an increase in student learning outcomes after being used using a problem-based learning model with the N-Gain score of 0.36 (moderate).

This research is in line with the study of Ismatulloh and Ropikoh (2022), which shows that the average score of student learning outcomes in the experimental class taught using problem-based learning methods is higher than students in the control class who are taught using conventional methods. In addition, students' interest and motivation in learning physics increased after using a problem-based learning model, where previously, students often felt lazy and bored quickly. However, after implementing this model, students feel happy and challenged in solving the problems given by the teacher.

The results of this study were also supported by previous research by Kurniawan et al., 2015, which revealed that there is a significant difference (based on statistics) between physics learning outcomes through the application of a problem-based learning model assisted by physics comics and conventional learning for students in class VIII at junior high school. Students' physics learning outcomes are higher by using a problem-based learning model compared to using conventional learning.

Confirmed by the results of research by Hasmiati et al., 2018, which showed that the Problem-based learning model can promote students' creative thinking skills in the classroom. Therefore, based on the results of this study and previous studies, it is hoped that this problem-based learning model can be an alternative and can be used by teachers in teaching physics in the classroom.

IV. CONCLUSION AND SUGGESTION

Based on the results of data analysis, it can be concluded that the problem-based learning model is effective in improving student learning outcomes in class XI MIPA at SMAN 1 Wangi-Wangi with an N-gain of 0.36 (medium). The average score of the students' physics learning outcome in class XI MIPA at SMA Negeri 1 Wangi-Wangi before and after being taught using a problem-based learning model is 7.26 and 12.14 conversely.

This study has several limitations, such as the small number of samples and no comparison class. Therefore, we suggest future researchers to apply a problem-based learning model to a large number of samples. In addition, to support the results obtained in this study, further research is needed to compare the effectiveness of this model with other learning models.

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