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THE EFFECT OF PROBLEM-BASED LEARNING MODEL ON STUDENTS' PHYSICS LEARNING OUTCOMES

Kurniawati[1] and Nikitas Kakakios[2]
[1] Univesitas Muhammadiyah Makasar, Indonesia
[2] University of Aegean, Yunani
Corresponding author email: krnwiikurniaa@gmail.com

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Abstract :
The purpose of this study is to measure student learning outcomes using problem-based learning models on students' physics learning outcomes. The research method is using experimental research. The research design used is Posttest-Only Control Design. The sampling technique used in the study was simple random sampling, so one class was obtained as a control class, namely class X mathematics science 2 and one class as an experimental class. With Data Analysis Techniques using Descriptive Analysis and inferential analysis. The results of the study showed that students who were taught with problem-based learning models had high average physics learning outcomes scores, while students who were not taught with this model had average physics learning outcomes scores that were in the low and sufficient categories. This study also found a significant difference in physics learning outcomes between the two groups, indicating that problem-based learning models have a positive effect on students' physics learning outcomes. This study provides a new perspective in measuring the effectiveness of problem-based learning models, especially in improving students' physics learning outcomes, which have not previously been widely studied in the context of physics learning in Indonesia.

Keywords: Learning Outcomes, Physics, Problem Based Learning

INTRODUCTION

Education is the most basic thing and cannot be separated from everyone's life (Nada et al., 2023; Nurmalasari et al., 2013; Zubaidah, 2018). Good education will produce good output because education is the key to all progress and quality development, because with education humans can realize all their potential both as individuals and as citizens (Djalal, 2017; Ineu et al., 2022; Kurniawan et al., 2023). Teachers play an important role in the implementation of educational management, because teachers as facilitators must transfer the knowledge they have to their students, therefore teachers must create comfortable teaching and learning activities for their students (Joni, 2005; Rahmadayanti & Hartoyo, 2022; Subagia, 2014).

Teachers are required to be able to create a conducive learning atmosphere, namely an effective, enjoyable, comfortable learning atmosphere, providing space for students to think actively, creatively, and innovatively in the learning process so that they can generate motivation, creativity, and encourage students to be able to remember the learning material that has been delivered and of course this will have implications for learning outcomes and be able to apply them in everyday life (Muchith, 2016; Wulandari & Vebrianto, 2017). Efforts to improve learning outcomes are largely determined by the quality and motivation of students in the teaching and learning process experienced by students at each level of education (Hardianty & Septian, 2020; Hidayati et al., 2016; Taufik et al., 2010).

One of the learning methods that provides students with the opportunity to solve problems is the problem-based learning model (Hamid et al., 2018; Rohaendi & Laelasari, 2020; Zubaidah, 2018). The problem-based learning model is very useful, because problem-based learning is a form of activity in physics learning that can activate students, develop critical thinking skills in solving problems and have a positive effect on physics (Ineu et al., 2022; Turner & Rapoport, 1977; Wibowo, 2014). Accustoming students to formulating, facing and solving problems is one way to achieve mastery of a concept and can improve learning outcomes (Istikomah & Jana, 2018; Saraswati & Agustika, 2020; Zubaidah, 2018).

Based on interviews with physics teachers at State Senior High School 6 Selayar, it is known that students' physics learning outcomes are not yet satisfactory. This is due to the lack of awareness and sincerity of students in following the lessons. Students tend to be passive, rarely ask questions, and rely more on friends when working on practice questions and exams. Only a small number of students show enthusiasm in learning. As a result, many students do not achieve learning completion, with only 40% of 30 students completing, while the other 60% have to take remedial classes.

Based on research conducted by Ilhaq & Iltizam, (2016) regarding problem-based learning models. Previous research focused on the effectiveness of the Problem Based Learning model in the context of marketing learning at the vocational high school level. The study emphasized increasing learning activities and learning outcomes on materials related to the target market. Meanwhile, the current research focuses on the application of the problem based learning model in the context of physics learning at the high school level. The gap lies in the differences in context and subject matter studied, where previous research focused on marketing aspects in vocational high schools, while the current research explores the application of problem based learning in improving learning outcomes in physics subjects, which have different characteristics and challenges in their teaching. In addition, the current research also seeks to measure the impact of problem based learning more specifically on physics learning outcomes, in contrast to previous research which also emphasized learning activities.

This study offers novelty by exploring the application of Problem Based Learning in the context of physics learning at the high school level which has not been widely studied in depth. While the Problem Based Learning model has been widely used in various disciplines, this study introduces a more specific approach to the subject of physics, which is known to be a challenging and abstract subject for many learners. Another novelty is the focus on how Problem Based Learning can improve learning outcomes, especially in improving critical thinking and problem-solving skills in the context of physics, which is different from previous studies that have mostly examined cognitive aspects in the context of social sciences or marketing. Thus, this study not only contributes to the literature on problem-based learning but also opens new insights on how this model can be effectively integrated into science learning to improve students' physics learning outcomes.

Research is very important to be conducted considering the challenges faced in learning physics, which is often considered difficult and abstract by students. The low physics learning outcomes in many senior high schools, including senior high school 6 Selayar, indicate the need for innovation in teaching methods that can improve student understanding and engagement. The Problem-Based Learning Model offers an approach that can encourage students to think critically, solve problems, and learn more independently, all of which are very relevant in the context of physics learning. Given the importance of physics as a foundation for many fields of science and technology, this research is expected to make a significant contribution to improving the quality of physics education and preparing students with the skills needed to face future challenges. Based on the explanation above, the purpose of this study is to measure student learning outcomes using the problem-based learning model on students' physics learning outcomes.

RESEARCH METHOD

Research Design

This type of research is a true experimental research (Restiani & Sariniwati, 2022; Nikmah et al., 2023; Almonia, 2024). The research design used is Posttest-Only Control Design (Suryonegoro & Hidayah, 2023; . In this design there are two groups, each of which is selected randomly (R). The first group is given treatment (X) and the other group is not. The group given treatment is called the experimental group and the group not given treatment is called the control group. The effect of treatment is (O_1:O^2).

Tabel 1. Posttest-Only Control Design

R	X	O_1
R		O_2

Research Target/Subject

The population in this study were all students of class X at state senior high school 6 Selayar as many as 4 classes, namely X mathematics science 1, X mathematics science 2, X mathematics science 3 and X mathematics science 4. The sampling technique used in the study was simple random sampling (Nadila et al., 2024; Juwita & Mateha, 2024; Jufrin et al., 2024), namely a sampling technique by randomizing classes with the assumption that all classes are homogeneous because both classes are randomized not based on rank (Ilhaq & Iltizam, 2016; Phonna & Arusman, 2018). Based on the results of class randomization, one class was obtained as a control class, namely class X mathematics science 2 and one class as an experimental class, namely class X mathematics science 1 which was given a problem-based learning model.

Instruments, and Data Collection Techniques

The instrument used in this study is by using a learning outcome test. The number of questions is distributed to students in the form of multiple choice questions consisting of 40 numbers. The questions are made based on the cognitive level of students which include remembering (C1), understanding (C2), applying (C3), and analyzing (C4) which are arranged randomly.

Data analysis technique

Data Analysis Techniques using Descriptive Analysis. Descriptive analysis is intended to present or reveal students' science process skills in physics subjects (Ambarwati et al., 2023; Masniari et al., 2023; Sulaiman et al., 2024). Inferential statistical analysis is used to test the research hypothesis that has been tested. Before testing, the basic analysis tests are first carried out, namely the normality and homogeneity tests. The data normality test is intended to determine whether the data used is normally distributed or not (Elvia et al., 2023; Permatasari, 2023; Suantara & Kankani, 2023). Homogeneity Test To determine the t-test formula, which will be selected for hypothesis testing, it is necessary to first test the variance of the two homogeneous samples or not. The science process skills are displayed in the form of an average score. With the assessment categories, namely:

Table 2. Categories of Student Learning Outcomes

Value Interval	Category
0 – 20	Very Low
21 – 40	Low
41 – 60	Fair
61 – 80	High
81 −100	Very High

RESULTS AND DISCUSSION

Descriptive Analysis

Descriptive analysis is a part of statistics that is used to describe or illustrate data without intending to draw conclusions but only to explain groups of data (Amran, 2023; Mansyuarna et al., 2023; Suroso et al., 2024).

Table 3. Statistics of Students' Physics Learning Outcome Scores

Statistics	Statistical Values	
	Control Class	Experimental Class
Number of Samples	33	33
Ideal Score	25	25
Minimum Score	0	0
Highest Score	18	23
Lowest Score	7	12
Score Range	11	11
Mean Score	10,71	19,59
Standard Deviation	2,59	2,65
Variance	6,73	7,02

From the table, it can be seen the difference in physics learning outcomes of students obtained from the experimental class and the control class. In addition, it can also be seen that the physics learning outcomes of students in the experimental class are higher than those in the control class. If the scores of student learning outcomes in the experimental class and the control class of State Senior High School 6 Selayar are categorized on a scale of five, namely very low, low, medium, high, and very high, the results will be obtained as in the following table:

Table 4. Frequency Distribution and Categorization of Students' Physics Learning Outcome Scores

No	Score interval			Category	(*fi*)	
					Control	Experiment
1	0	-	5	Very Low	0	0
2	6	-	10	Low	16	0
3	11	-	15	Fair	16	2
4	16	-	20	High	1	18
5	21	-	25	Very High	0	13
				Amount	33	33

Based on the table above, it can be stated that the physics learning outcomes scores of students who were not taught with problem-based learning models were 16 students in the low category, 16 students in the sufficient category, 1 student in the high category and no students who met the very low and very high categories while the physics learning outcomes scores of students who were taught with problem-based learning models were 2 students in the sufficient category, 18 students in the high category, 13 students in the very high category, and no students in the very low and low categories. So the higher frequency in the control class was in the interval 6-10 and 11-15 with the low and sufficient categories while in the experimental class the higher frequency was in the interval 16-20 with the High category.

Inferential Analysis

Normality test is conducted to determine whether the research population is normally distributed or not. The normality of data is important because with normally distributed data, the data is considered to be able to represent a population. The validity test that is often used is the chi Square method, then the results of the normality test for the control class are obtained as in the following table:

Table 5. Normality testing of control class

No	Interval Class	Interval Limit	Z For Class Limit	Area Z Table	Interval Area	Frequency of Hope (f_0)	Real Frequency (f_h)	Chi-Square Value 2 t(f0− fh) fh
1	7-8	6,5	-1,63	0,4484	0,1461	4,8213	8	2,0957
2	9-10	8,5	-0,85	0,3023	0,2704	8,9232	8	0,0955
3	11-12	10.5	-0,08	0,0319	0,2868	9,4644	9	0,0228
4	13-14	12.5	0,69	0,2549	0,173	5,709	6	0,0148
5	15-16	14.5	1,46	0,4279	0,0592	1,9536	1	0,4655

The calculation results in the control class obtained $x2$ of 3.6895 and the value of $x2$ for α = 0.05 and degrees of freedom (dk) = 3, then the Chi-Square value with the results in table 4. So it can be concluded that the control class is a group of data originating from a normally distributed population.

Table 6. Testing the normality of the experimental class

No	Interval Class	Interval Limit	Z For Class Limit	Area Z Table	Interval Area	Frequency of Hope (f_0)	Real Frequency (f_h)	Chi-Square Value 2 t(f0− fh) fh
1	12-13	11,5	-3,05	0,4989	0,0096	0,3168	1	1,4734
2	14-15	13,5	-2,30	0,4893	0,0511	1,6863	1	0,2793
3	16-17	15,5	-1,54	0,4382	0,153	5,049	5	0,0005
4	18-19	17,5	-0,79	0,2852	0,2732	9,0156	8	0,1144
5		19.5	-0,03	0,0120				

Based on the calculation results in Table 6. in the experimental class, the value of $x2$ is 5.706. While the value of $x2$ for α = 0.05 and degrees of freedom (dk) = 3, then it is searched in the Chi-Squre table shown in table 4 above. So that $hitung$ $tabel$ it can be concluded that the experimental class is a group of data originating from a normally distributed population. The results of the normality test show that the data obtained come from a normally distributed population, so the analysis is continued with a population variance homogeneity test. The homogeneity test is carried out using the F-test. The calculation of the population variance homogeneity test for learning outcomes obtained a calculated F value = 1.04 and an Ftable value = 1.80 (the full calculation can be seen in Appendix C). Since Fcount < Ftable, it can be concluded that the data on physics learning outcomes scores of students in both classes come from a homogeneous population variance. The hypothesis to be tested uses statistics such as the following:

$$H_0 : \mu_1 = \mu_2$$
$$H_1 : \mu_1 \neq \mu_2$$

Information :

$H_0 : \mu_0 = \mu_1$: There is no significant difference between the physics learning outcomes of students who are taught using problem-based learning models and students who are not taught using problem-based learning models.

$H_a : \mu_0 \neq \mu_1$: There is a significant difference between the physics learning outcomes of students who are taught using problem-based learning models and students who are not taught using problem-based learning models.

The testing criteria for the two-party hypothesis test are, Ho is accepted Ha is rejected or -ttable < tcount < ttable while the calculation results using the t-test at the real level □ = 0.05 and dk = 64 obtained tcount = 13.32 while ttable = 1.997. Because the results obtained show -ttable < tcount > ttable = -1.997 < 13.32 > 1.997 the null hypothesis or Ho is rejected and the alternative hypothesis or Ha is accepted, so it can be concluded that there is a difference in the physics learning outcomes of students who are taught using problem-based learning models and those who are not taught using problem-based learning models in class X students of public senior high school 6 Selayar.

The results of the analysis of the scores obtained by students can be categorized into ideal scores using a five-point scale, which shows that the categorization of students' physics learning outcomes scores with the categorization of scores converted into values obtained different results, namely in the experimental class, the average physics learning outcomes of students were in the high category, while in the control class, the average physics learning outcomes of students were in the low and sufficient categories. This shows that there is a difference that shows that the physics learning outcomes of students in the experimental class are higher than the physics learning outcomes of students in the control class..

The next analysis result is the first inferential analysis for the normality test which shows that both classes come from a normally distributed population. The second analysis is the homogeneity test which shows that the physics learning outcomes have homogeneous variance, and the third analysis is the hypothesis test which shows that the average population score of physics learning outcomes of class X mathematics science 1 students who are taught using a problem-based learning model is not the same as the average population score of physics learning outcomes of class X mathematics science 2 students who are not taught using a problem-based learning model which shows the influence of physics learning with a problem-based learning model on physics learning outcomes. This indicates that physics learning using a problem-based learning model is one of the effective physics learning methods used to achieve physics learning outcomes..

The results obtained in this study are in accordance with previous research conducted by Ilhaq & Iltizam, (2016) which shows that by implementing a problem-based learning model to increase activity and learning outcomes are in the effective category in learning. This study has several limitations and implications that need to be considered. The main limitations of this study include the possibility of uncontrolled external variables, such as differences in student backgrounds, other teaching methods being implemented simultaneously, and varying learning environment conditions. In addition, the limited time of the study may have affected the results obtained and the generalization of the findings to various educational contexts. The impacts of this study include an increase in deeper understanding of physics concepts through an approach that encourages students to actively think critically and solve problems independently. However, the implementation of this model requires adequate teacher training and resource support, and may face challenges in adapting existing curricula.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that students who are taught using problem-based learning models show an average score of physics learning outcomes that are relatively high. In contrast, students who are not taught using this model obtain an average score that is in the low to sufficient category. This finding indicates a significant difference in physics learning outcomes between students who use problem-based learning models and those who do not. Thus, this study shows that problem-based learning models have a positive influence on the physics learning outcomes of students at State Senior High School 6 Selayar. For further research, it is recommended that a long-term evaluation be conducted on the application of problem-based learning models in various educational contexts and student levels, as well as further exploration of the supporting and inhibiting factors that influence the effectiveness of this method in improving physics learning outcomes.

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