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EFFECTIVENESS OF IMPLEMENTING PROJECT-BASED LEARNING (PjBL) MODEL ON LEARNING OUTCOMES THROUGH MAKING SIMPLE SOLAR POWER PLANTS

Suarti[1], Jusman[2], Muh. Alfandi[3]

[1, 2, & 3] Universitas Islam Negeri Alauddin Makassar
Correspondence e-Mail: suarti.fisika@uin-alauddin.ac.id

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ABSTRACT

The physics learning outcomes of grade XII IPA 1 SMAN 2 Jeneponto 80% students have not reached the minimum completeness criteria, one of the reasons is because the practicum equipment is inadequate so that practicum implementation is rarely carried out, Practicum in physics provides direct experience that can increase understanding of theoretical concepts that support the improvement of student learning outcomes, so the solution offered by researchers is the manufacture of physics teaching aids. This study is to determine the differences in learning outcomes before and after the application of the Project Based Learning learning model through the manufacture of simple solar power plants, and the level of effectiveness of the Project Based Learning learning model through the manufacture of simple solar power plants in improving student learning outcomes. This type of research is pre-experiment with one-group pretest-posttest design. The sample of this study was students of grade XII IPA 1 SMAN 2 Jeneponto, with a total of 30 students. Research instrument multiple-choice test questions. Data analysis techniques are descriptive analysis, inference, and N-Gain test. The results of the descriptive analysis showed that the average learning outcomes of students before being taught with the Project Based Learning learning model were 33,666, in the less category, after being taught with the Project Based Learning learning model was 75,333 in the sufficient category. The results of the hypothesis test using the dependent sample t test Sig. (2-tailed) value = 0.001<0.05, meaning that there are differences in student learning outcomes before and after treatment. Based on the results of the N-gain test, a score of 58.39% was obtained, which means that the application of the Project Based Learning learning model through making simple solar power plant props is quite effective in improving the learning outcomes of grade XII IPA 1 SMAN 2 Jeneponto students.

Keywords: Simple solar power plants; Project-based learning; Learning outcomes

1. INTRODUCTION

The development of globalization has had a positive impact on one of the fields of science and technology (IPTEK). This progress has also affected the education sector, especially in the use of different learning aids and facilities in schools and educational institutions. Teachers use a variety of learning media to support the learning process, following the demands of rapid developments in science and technology. (Subekti, 2017). Educators are faced with the demand to be creative and innovative in implementing learning strategies. This is done so that students can develop skills needed in the 21st century era, such as the ability to think critically, creatively, problem-solving, and decision-making.

Education will undergo significant changes to be more open and take place in two directions, as well as more diverse and multidisciplinary. Education will be closely related to work productivity and competitive competition. In the future life, the information technology and telecommunications sector will become the dominant sector, where those who master technology will become leaders in their environment. Therefore, a big task for schools in facing the era of globalization is to prepare students to face challenges involving rapid change (Heeks et al., 2014). In the learning process, it is very important for positive interactions between teachers and students so that learning becomes fun and not boring. In this context, an appropriate approach is needed. This approach is a point of view or philosophy that is the basis for looking at something, but it is not always easy to prove it (Mulyono, 2016). Therefore, the existence of new alternatives or innovations from educators is needed in carrying out the learning process. One innovative learning model is PjBL (Project-based Learning). PjBL (Project-based Learning) is a structured learning model that involves students in acquiring basic knowledge and life skills through a process of inquiry, authentic questioning, and careful product design and activities. When students are given projects related to energy sources in PjBL, they have the opportunity to improve their thinking skills. PjBL is based on thinking, visualization, and action, which encourages individuals to be creative and take responsibility for their own learning. (Nazirzadeh et al., 2014).

Based on initial observations made by researchers at SMAN 2 Jeneponto The physics learning outcomes of grade XII IPA 1 SMAN 2 Jeneponto students 80% have not reached the minimum completeness criteria, the learning method at the school uses conventional methods by relying on textbooks and LKPD as the main reference in delivering physics material, besides that Practicum equipment is inadequate so that practicum implementation is rarely carried out, Practicum in physics provides direct experience that can increase understanding of theoretical concepts that support for improving student learning outcomes as well as the use of teaching aids at SMAN 2 Jeneponto is still rarely used in the learning process. When laboratory equipment that supports

physics learning is not available in schools, one way that can be done is to use learning aids, therefore researchers intend to apply the PjBL (Project-based Learning) model through making simple solar electric development props that will be applied in the learning process. The use of these teaching aids will help make it easier for students to understand a concept (Afriyanto et al., 2015). Teaching aids are a form of learning media used to describe how an object works (Husnul et al., 2015).

Solar panels have become a popular choice in addressing sustainable energy needs. In the face of the depletion of fossil energy sources and the impact of global warming, solar panels are an attractive alternative to produce clean and environmentally friendly electrical energy. Solar panels have the ability to convert solar energy into energy electricity through an efficient conversion process. In addition, the use of solar panels also provides economic benefits in the long run because of lower operational costs compared to conventional energy sources. Solar power plant props, the value of their usefulness in society is very high. For small-scale students can make street lights in front of their homes with these tools, so there is no need to pay electricity to PLN for street lights with the PLTS. SMAN 2 Jeneponto was chosen by researchers as a place to conduct research because of its geographical location in the coastal area. The coastal area of Jeneponto is an area with sufficient light intensity so it is very suitable for research that requires heat energy from the sun as the most important element in this study.

The purpose of this study is to determine the differences in learning outcomes before and after the application of the Project Based Learning (PjBL) learning model through the manufacture of simple solar power plants for grade XII IPA 1 SMAN 2 Jeneponto students. Knowing the level of effectiveness of the Project Based Learning (PjBL) learning model through the creation of simple solar power plants in improving student learning outcomes.

2. RESEARCH METHOD

This type of research is a pre-experiment with One Group Pretest-Posttest Design research design, which is a research design consisting of pre-test before treatment and post-test after treatment. The design of this study is as follows.

O_1 ———— X ———— O_2

Information:

O_1 : Pre-test to measure student learning outcomes before treatment.

X : The treatment of research subjects is the application of a project-based learning model through the manufacture of simple solar power plants.

O_2 : Post-test to measure student learning outcomes after treatment.

Location The research was carried out at SMA Negeri 2 Jeneponto with the study population being students of grade XII IPA SMAN 2 Jeneponto, as for the sample in this study, namely class XII IPA 1 with purposive sampling techniques, namely sampling techniques with certain considerations (Sugiono, 2014), which is a consideration in sampling is the average learning outcomes of students in class XII Science 1 homogeneous so that it is determined as a research sample that a total of 30 students.

The instruments used in this study were pre-test and post-test learning outcomes consisting of 20 multiple-choice questions. The data analysis technique used is descriptive analysis consisting of mean, maximum value, minimum value, standard deviation and variance. Student learning outcome data is then categorized to determine how high the ability of student learning outcomes, the categorization of learning outcomes is adapted from the educator assessment guide and the 2017 High School Education unit, which refers to the minimum completeness criteria for achieving basic competencies in energy source materials as shown in table 1.

Table 1. Categorization of Student Learning Outcomes

Minimum Completeness Criteria	Value	Predicate
75	0≤x≤74,9	Less
	75,0≤x≤83,9	Enough
	84,0≤x≤92,9	Good
	93,0≤x≤100	Excellent

The next analysis is hypothesis testing with an average difference test to determine whether there is a difference in average learning outcomes before and after the application of the project-based learning model through the manufacture of simple solar power plants, analyzed using a dependent sample t test with the help of SPSS, which has previously been tested prerequisites with normality and homogeneity tests. If there is a difference between the average learning outcomes of pretest and pos-test scores, then calculate the N-Gain Score, which is used to evaluate the effectiveness of using a method or model in research with a pre-test post-test design of one group or research with experimental groups and control groups. The equation for determining the N-Gain Test follows. (Sundayana, 2016)

$$N - Gain\ Score = \frac{Score\ Post\ Test - Score\ Pre\ Test}{The\ score\ is\ ideal - Score\ Pre\ Test}$$

Remarks : The ideal score is the maximum score obtained.

The N-Gain score is determined based on the N-Gain value in percent (%), as shown in table 2.

Table 2. Categories of N-Gain effectiveness interpretation

Percentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Quite Effective
>76	Effective

Source: Hake, R.R, 1999

3. RESULTS AND DISCUSSION

The results of descriptive analysis for physics learning outcomes of grade XII IPA 1 students of SMA Negeri 2 Jeneponto before and after being treated with the PjBL (Project Based Learning) learning model are shown in table 3.

Table 3. Descriptive statistical data of learning outcomes before and after treatment

Descriptive Statistics	Pre-Test Scores	Post-Test Scores
Number of Samples	30	30
Maximum Value	60	95
Minimum Value	15	50
Average	33,666	75,333
Standard deviation	14,535	11,741
Varians	211,272	137,873

Table 3 shows that the standard deviation of pre-test scores is greater than post-test, this shows that the post-test learning outcomes of each student tend to be averaged compared to pre-test scores. The average learning outcomes before and after the implementation of the PjBL (Project Based Learning) learning model through the manufacture of simple solar power plants have increased. The categorization of the average value of pre-test learning outcomes is in the less category while the average value of post-test learning outcomes is in the sufficient category. The frequency distribution of categorization of pre-test and post-test values is shown in Table 4.

Table 4. Frequency distribution table of pre-test and post-test values

Value	Predicate	Frequency distribution	
		Pre-test	Post-test
0≤x≤74,9	Less	30	13
75,0≤x≤83,9	Enough	0	8
84,0≤x≤92,9	Good	0	7
93,0≤x≤100	Excellent	0	2

In table 4 it can be seen that before the treatment (pre-test) there were 30 students classified as less with a percentage of 100%. This means that there are no students who belong to the category of enough, good, or very good. While in the post-test score, as many as 13 students were classified as less category with a percentage of 43.33%, 8 students were classified as sufficient with a percentage of 26.66%, 7 students were classified as good with a percentage of 23.33%, and 2 students were classified as very good category with a percentage of 6.66%.

The results of hypothesis testing with the average difference test using paired sample t test with the help of SPSS, which have previously been tested for prerequisites, namely normality test and homogeneity test can be seen in table 4.

Table 4. Research Hypothesis Test Results

	Paired Differences					t	Df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
PRE-TEST POST-TEST	33.66 75.33	11.102	2.027	-33.979	-25.688	-2.569	29	.001

A study is said to have a proven hypothesis if the significant value is less than 0.05 (sig. < 0.05), where H0 is rejected and H1 is accepted. Based on table 4, it can be seen that the significant value in the hypothesis test using the SPSS Statistic version 25 for Windows program obtained the value of Sig. (2-tailed) = 0.001. So that the hypothesis in this study can be said to be proven because 0.001 < of 0.05. This means that there is a significant difference between student learning outcomes before and after being given treatment in the form of applying the Project Based Learning (PjBL) learning model through making simple Solar Power Plant props for grade XII IPA students of SMAN 2 Jeneponto.

Normalized gain (N-gain score) is a data analysis test that aims to determine the effectiveness of using a method in one group pre-test post-test design research as well as research using experimental groups and control groups. N-Gain score is the difference between post-test

and pre-test scores. N-Gain analysis can be performed using the program SPSS Statistic version 25 for Windows. These results can be seen in table 5.

Table 5. N-Gain Analysis

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
NGain_Score	30	.13	.91	.5839	.16214
NGain_Persen	30	12.50	90.91	58.3995	16.21361
Valid N (listwise)	30				

Based on the calculation results of the N-Gain test, it shows that the average value of N-Gain Score before and after the application of the Project Based Learning (PjBL) learning model through the manufacture of simple Solar Power Plant teaching aids is 58.39% which results are classified into the category of interpretation is quite effective. So it can be concluded that the application of the Project Based Learning (PjBL) learning model through making simple Solar Power Plant teaching aids is quite effective in improving the learning outcomes of grade XII IPA 1 SMAN 2 Jeneponto students for the 2022/2023 academic year.

Student learning outcomes after being taught with the PjBL (Project Based Learning) learning model are higher than student learning outcomes before being taught with the PjBL (Project Based Learning) learning model. This happens because students have been given treatment in the form of applying the Project Based Learning (PjBL) learning model through making simple PLTS, in which students are required to actively participate in groups during project creation. At this stage, students look for their own literacy resources and are given guidance by the teacher if they find obstacles during the project creation process. The above is in line with research conducted by Astriani (Astriani, 2020) entitled Efforts to Develop Student Creativity Through Learning The Project Based Learning model shows that the application of the Project Based Learning (PjBL) learning model can be effective in developing student creativity. The results of this study show that students are able to produce teaching aids with a high level of creativity, this indicates that learning using the PjBL model can make a positive contribution in developing student creativity, Creative students tend to have greater ability in finding innovative solutions to problems. This ability can help them overcome obstacles in learning and achieve deeper understanding. Students who can apply creativity in their problem solving can develop cognitive skills that support the achievement of higher learning outcomes. The application of the learning model from the results of the observation sheet of the implementation of the model of all components is carried out as expected. Students carry out teacher instructions well so that the learning process runs after the PjBL syntax which results in students' understanding of the products they make and concepts that help them answer post-test questions well.

In the learning process, students actively ask teachers about things they don't know such as how to cut cables, how to install cables, analysis of failed products and much more. As a result, their knowledge increases about the product which has an impact on improving their learning outcomes after the post-test. So in addition to student learning outcomes, students' science process skills also improved as in research conducted by (Restu Putra, 2019) with the title Application of Teaching Aid-Based Learning on Material. Static Fluid in Improving Science Process Skills of Class X KB 1 Students of SMK Negeri 2 Makassar shows that the application of teaching aids media-based learning is effective in improving the science process skills of grade X KB 1 students of SMK Negeri 2 Makassar. The results of this study indicate that the use of teaching aids in learning Static Fluid material can make a positive contribution in developing students' science process skills. Student learning outcomes in physics are often measured through science process skills. Their ability to observe, measure, and infer can be an indicator of the achievement of learning objectives.

In this study, learning was carried out using the PjBL (Project Based Learning) learning model. PjBL is used as a method of learning to draw and show students' creativity. PjBL is a learning model that uses a student learning approach to the problem of authenticity (constructivism) (Mihardi et al., 2013). At the end of the project completion process, teachers and students reflect on the activities and results of the project. Project reflection can be done individually though in groups. At the evaluation stage, students are given the opportunity to reflect and express their experiences during completion. At this stage, the teacher also gives feedback to the processes that have been carried out during the completion of the project and the products produced by students. PjBL is very important for the quality of individual behavior and requires a different learning process. PjBL can improve learning achievement, physics attitudes, and science process skills. PjBL is able to improve science process skills, learning outcomes, analytical skills, student attitudes, and creative thinking skills. PjBL is also able to improve thinking skills from low level to higher order thinking such as creative thinking ability (Munawaroh et al., 2012).

This is reinforced by research conducted by Puspasari (2017) in his thesis entitled "Implementation of Project Based Learning to Increase Student Independence and Learning Achievement in Making Innovative Mathematical Teaching Aids" concluded that the project-based learning model is quite effective in terms of group cooperation in making mathematical teaching aids, namely the improvement of groups with better cooperation criteria in the cycle 2 compared to cycle 1 where no group has good cooperation skills.

Other studies have also shown positive results such as in research conducted by Afifah (2019) with the research title Project Based Learning (PjBL) STEM-Based Model to Improve Mastery of

Concepts and Students' Critical Thinking Skills. The results of this study show that STEM-based project-based learning models can improve students' understanding of concepts and critical thinking skills.

4. CONCLUSION

The conclusions obtained after conducting this study are: The results of learning physics students in class XII IPA 1 SMA Negeri 2 Jeneponto before being taught with the PjBL (Project Based Learning) learning model through making simple solar power plants with an average value of 33,666 are in the less category. The results of student physics learning in class XII IPA 1 SMA Negeri 2 Jeneponto after being taught with the PjBL (Project Based Learning) learning model through making simple solar power plants with an average value of 75,333 are in the sufficient category. There are differences in students' physics learning outcomes before and after being taught with the PjBL (Project Based Learning) learning model through the manufacture of simple solar power plants class XII IPA 1 SMA Negeri 2 Jeneponto based on the results of the calculation of the Paired Sample t-Test test with a value of Sig. (2-tailed) = 0.001<0.05. based on the results of the N-gain test, the application of the Project Based Learning (PjBL) learning model was obtained through the manufacture of teaching aids for Power Plants Simple solar is quite effective in improving the learning outcomes of grade XII IPA 1 SMAN 2 Jeneponto students for the 2022/2023 academic year.

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