



# Improving Student Learning Outcomes Through Project Based Learning Model Assisted by Proteus 8 Professional Application at SMKN 2 Payakumbuh

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**Abstract-** This research aims to enhance students' learning outcomes in the subject of Electronic Circuit Applications by implementing the Project-Based Learning (PjBL) model, supported by the use of the Proteus 8 Professional application at SMK Negeri 2 Payakumbuh. The study is motivated by the low level of student engagement, lack of learning motivation, and the continued use of conventional teaching methods that fail to connect the subject matter with real-world contexts. This research employs a quantitative approach with a one-group pretest-posttest design. The participants of the study were eleventh-grade students enrolled in the Industrial Electronics Engineering program. Data were collected through tests administered before and after the implementation of the learning model. The analysis revealed a significant improvement in student performance following the use of the PjBL model integrated with Proteus 8 Professional. These results suggest that combining project-based learning with digital simulation tools fosters a more engaging, relevant, and effective learning experience, particularly in strengthening students' conceptual understanding and practical abilities in electronics.

**Keywords—** Project Based Learning, Proteus 8 Professional, learning outcomes, electronic circuits, SMK

## INTRODUCTION

Education acts as a fundamental pillar in the development of the quality of human resources as well as being one benchmark of the main benchmarks in assessing the level of progress of a country. [1]. In developing countries such as Indonesia, education not only serves as a means of transmitting knowledge, but also as a development driver of social, economic, and cultural development [2]. Article 31 of the 1945 Constitution of Indonesia guarantees the right of every citizen to access education. Therefore, the state has the responsibility to organize an education system that is fair, equitable and quality education system.[3] Along with the rapid development of digital technology, the Indonesian education system is required to adapt and transform [4]

Information and Communication Technology (ICT) has emerged as a key factor in reshaping the landscape of education, encouraging the transition of learning approaches from those that focus on the role of teachers (teacher-centered) to

approaches that place students as the center of learning (student-centered)[5]. The 21st century learning Model emphasizes the importance of interactivity, the use of technology, and the development of critical and creative thinking skills[6].

However, in practice there are still many educational units that apply conventional learning methods[7]. This has an impact on the low participation and interest in student learning, especially in Vocational High School. One of the problems found in SMK Negeri 2 Payakumbuh the subject of application of electronic circuits is the low active involvement of students in the learning process. Based on the results of observations, only about 30% of students who showed activity in learning activities, with the average summative value has not met the threshold criteria for completeness of learning objectives (KKTP).

In general, the achievement of learners' student learning outcomes is influenced by various factors, both from within the student and the external environment. Internal factors include motivation, interest in learning, individual readiness, and psychological conditions that support the learning process. Meanwhile, external factors include the approach or learning model used by teachers, available Learning, and learning environment conditions. In the context of vocational education, the selection of appropriate models and Learning is very important to bridge the linkage between the mastery of theoretical concepts and applicable practical skills.

The learning model that has been predominantly applied, such as the lecture method and giving individual assignments, is less able to encourage active participation in participants of learners and is not in line with the characteristics of vocational

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subjects that prioritize practice. As an alternative, the PjBL model can be used to overcome these problems[8]. PjBL is a learning model that focuses on the completion of real projects that are relevant to the world of work, so that it can increase the involvement, creativity, and understanding of learners' concepts in more depth[9].

The implementation of PjBL will be more optimal if it is supported by interactive learning and applicable learning media. The Proteus 8 Professional application is a simulation of the electronic circuit simulation of electronic media which is in accordance with the characteristics of electronic engineering subjects. The use of Proteus allows students to design, test, and modify circuits virtually before they are physically applied. These media help improve the efficiency of the learning process, reduce the risk of component damage, and encourage visual and interactive exploration of concepts.

Based on the description of the background in the above background, this study was conducted with the aim to explore the implementation of the Project Based Learning model supported by the application Proteus 8 Professional application in improving student learning outcomes in the subjects of the application of electronic circuits in SMK Negeri 2 Payakumbuh. This study is expected to make a real contribution to the development of innovative technology-based learning strategies in the context of vocational education.

## METHODS

Research This study applies the Action Research approach of Class Action Research (PTK) with the design of one group Pretest-Posttest Design. The main focus of this study is to optimize student learning outcomes through the application of the PjBL model integrated with the Proteus 8 Professional simulation application. The action process is carried out in three cycles, each of which consists of the stages of planning, implementation, observation, and reflection[10]. Reflection in Table 1.

Table 1  
Stages Of Research

Stages	Act	Explanation
O <sub>1</sub>	-	Pre-test before Cycle I
X <sub>1</sub>	PjBL + Proteus 8 Professional	Learning intervention on Cycle I
O <sub>2</sub>	-	Post-test after Cycle I
O <sub>3</sub>	-	Pre-test before Cycle II
X <sub>2</sub>	PjBL + Proteus 8 (improvement)	Learning intervention on Cycle II
O <sub>4</sub>	-	Post-test after Cycle II

The subjects in this study consisted of 35 students of Class XI TEI at SMK Negeri 2 Payakumbuh. The object of research is focused on student learning outcomes in the eyes of the subjects of application Circuits of electronic circuits. The main instruments used are multiple choice tests given at the pretest and posttest stages, and are equipped with observation techniques and documentation techniques as supporting data. The questions used have been through a process of testing the validity and reliability, and analyzed Based on the level of difficulty and discriminating power.

To ensure the validity of the statistical analysis, the data were tested for normality and homogeneity, followed by a paired sample t-test to evaluate the significance of changes in learning outcomes pre- and post-treatment [11]. Apart from In addition, to measure the influence of the learning model the Applied Learning model is applied, the calculation of effect size with the formula using Cohen's d Formula is used. [12]

## RESULTS AND DISCUSSION

This section presents the findings of research related to the application of the PjBL model supported by the Proteus 8 Professional application in the subject of applying Electronic circuits in SMK Negeri 2 Payakumbuh. Research Data obtained through the implementation of pretest and posttest to measure the improvement in student learning outcomes post-intervention learning. In addition, the study also involves the analysis of students' activities during learning, the learning process, as well as the reflection of each cycle of actions as part of evaluating a continuous evaluation. All the results obtained were analyzed descriptively and statistically in order to answer the formulation of the problem and assess the effectiveness of the learning model applied.

### A. Data Description

Based on the analysis results of data analysis, obtained statistical information descriptive statistical information that includes the average value (mean), median, range, and standard deviation. The average score is used to show the general trend of students' learning outcomes [13]. The Median indicates the middle value of all the data obtained[14]. The range is used to determine the distribution of the highest and lowest values[15]. All data is then processed using IBM SPSS Statistics 26 application to be analyzed more accurately.

#### 1. Pretest Results

Present the results of the analysis value of the pretest value of each cycle in a descriptive manner in order to provide figure an initial picture of the level of ability of students before the intervention is carried out. Full details of these results reflection in Table 2.

Table 2  
Pre-test value of Cycle 1 and 2

Statistic	PRE-TEST 1	PRE-TEST 2
Mean	66.05	41.15
Median	66.67	44.44
Range	58.34	77.78
Std.Deviation	18.62	23.43
Minimum Value	33.33	0
Maximum Value	91.67	77.78
Sum	1783.34	1107

Pretest results showed that in the first cycle, the average value of students was 66.05 with a median of 66.67, range of 58.34, and std.dev of 18.62. Meanwhile, in the second cycle, the average was much lower, namely 41.15 with a median of 44.44, a wider range of 77.78, and a std.dev of 23.43. This shows that the initial ability of students in both cycles still varies, especially in the second cycle which has a higher spread of values. The results of the calculation Based on

certain provisions of the value, the frequency of the number of students who answered in Cycle 1 and the percentage is reflected in Table 3

Table 3  
Results of the calculation of the frequency of the number of Pre-test value 1

	Frequency	%	Valid %	Cumulative %
Valid	33.33	2	7.4	7.4
	41.67	3	11.1	18.5
	50	3	11.1	29.6
	58.33	3	11.1	40.7
	66.67	4	14.8	55.6
	75	4	14.8	70.4
	83.33	4	14.8	85.2
	91.67	4	14.8	100
Total	27	100	100	

Based on Table 3 above, the picture on the graph is reflected in Figure 1 below

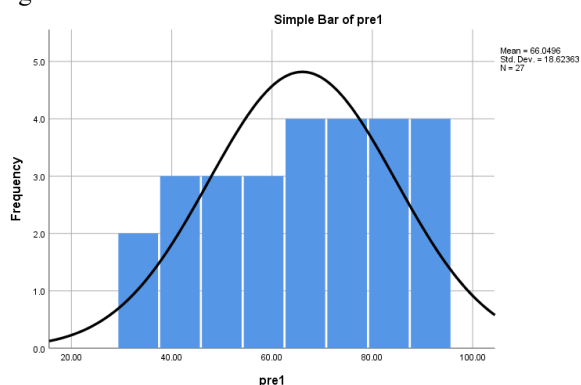


Figure 1 Chart Pre-test 1

Furthermore, the results of the calculation Based on certain provisions of the value, the frequency of the number of students who answered in Cycle 2 and the percentage is reflected in Table 4

Table 4  
The result of the calculation of the frequency of the number of Pre-test values 2

	Frequency	%	Valid %	Cumulative %
Valid	0	1	3.7	3.7
	11.11	4	14.8	18.5
	22.22	4	14.8	33.3
	33.33	4	14.8	48.1
	44.44	4	14.8	63
	55.56	3	11.1	74.1
	66.67	4	14.8	88.9
	77.78	3	11.1	100
Total	27	100	100	

Based on Table 4 above, the picture on the graph is reflected in Figure 2 below

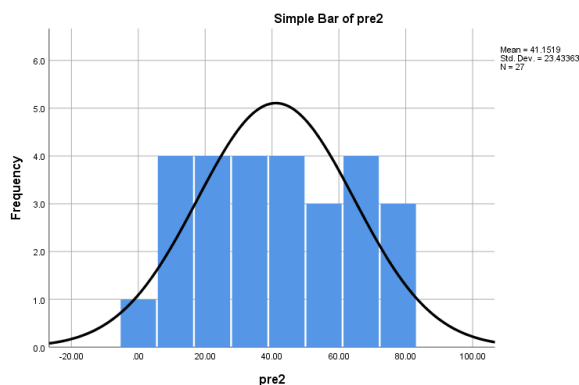


Figure 2 Chart Pre-test 2

## 2. Posttest Results

The following is the result of calculating the post-test value of both cycles. The data is presented descriptively to provide an overview of the participants' final abilities of learners. The full results is reflected in Table 5.

Table 5 Value Post-test Cycle 1 and 2

Statistic	POST-TEST1	POST-TEST2
Mean	80.86	70.78
Median	83.33	66.67
Range	41.67	66.67
Std.Deviation	11.74	20.24
Minimum Value	58.33	33.33
Value	100	100
Maximum Value		
Sum (Sum)*	2183.33	1911.14

After learning is done, there is an increase in learning outcomes in both materials. In the first material, the average posttest rose to 80.86 with a median of 83.33, a range of 41.67, and the std.dev dropped to 11.74, indicating better and evenner student achievement. While in the second material, the posttest value increased to an average of 70.78 with a median of 66.67, a range of 66.67, and a std.dev of 20.24, showing an increase in understanding although the distribution of values is still quite large. Results The calculation results Based on certain provisions of the value, the frequency of the number of students who answered in Cycle 1 and the percentage is reflected in Table 6

Table 6  
Results of the calculation of the frequency of the number of Post-test values 1

	Frequency	%	Valid %	Cumulative %
Valid	58.33	2	7.4	7.4
	66.67	3	11.1	18.5
	75	7	25.9	44.4
	83.33	7	25.9	70.4
	91.67	5	18.5	88.9
	100	3	11.1	100
Total	27	100	100	

Based on Table 6 above, the picture on the graph is reflected in Figure 3 below

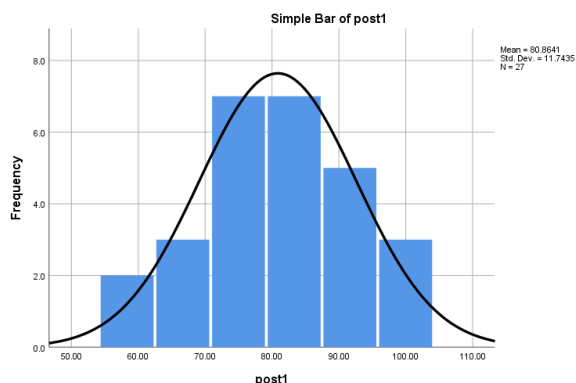


Figure 3 Chart Post-test 1

Furthermore, the results of the calculation Based on certain provisions of the value, the frequency of the number of students who answered in Cycle 2 and the percentage is reflected in Table 7

Table 7  
Results of the calculation of the frequency of the number of Post-test values 2

	Frequency	%	Valid %	Cumulative %
Valid	33.33	1	3.7	3.7
	44.44	4	14.8	18.5
	55.56	5	18.5	37
	66.67	4	14.8	51.9
	77.78	4	14.8	66.7
	88.89	5	18.5	85.2
	100	4	14.8	100
Total		27	100	100

Based on Table 7 above, the picture on the graph is reflected in Figure 4 below

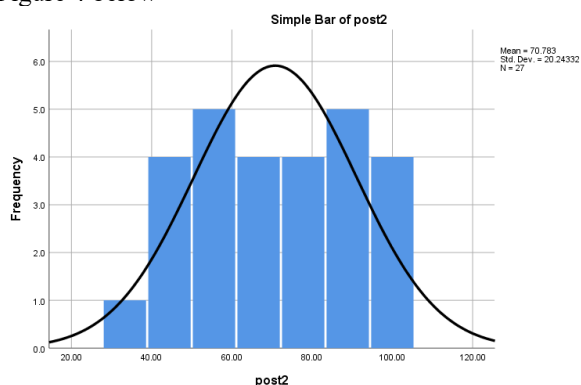


Figure 4 Chart Post-test 2

## B. Data Analysis

### 1. Normality Test

Normality test is used to determine whether the results of the pretest and posttest data are normally distributed or not [16] Researchers conducted a normality test using the Shapiro-Wilk method with the help of the IBM SPSS Statistics 26 application to analyze pretest and posttest data. The following are the test results of the normality test in Table 8.

Table 8 Normality Test  
Kolmogorov-Smirnov<sup>a</sup> Shapiro-Wilk

	Statistic	df	Sig.	Statistic	Df	Sig.
PRETEST2	0.12	27.00	.200*	0.94	27.00	0.13
POSTTEST2	0.15	27.00	0.14	0.93	27.00	0.07
PRE1	0.13	27.00	.200*	0.93	27.00	0.09
POST1	0.14	27.00	0.20	0.94	27.00	0.14

Based on the table of normality test results above using the Kolmogorov-Smirnov and Shapiro-Wilk methods, all pretest and posttest data (both PRETEST2, POSTTEST2, PRE1, and POST1) have significance values (Sig.) greater than 0.05. This shows that the four data are normally distributed normally, so it can be concluded that the data deserves to be analyzed using parametric statistics.

### 2. Homogeneity Test

Homogeneity test Variance homogeneity test was conducted using Levene's Test to determine the similarity of data variance between cycles [17]. The following are the test results of the homogeneity test in Table 9

Table 9  
Homogeneity Test  
Levene Statistic

	Levene Statistic	df1	df2	Sig.	
pretest	Based on Mean	2.156	1	52	0.148
	Based on Median	1.978	1	52	0.166
	Based on Median and with adjusted df	1.978	1	49.675	0.166
	Based on trimmed mean	2.201	1	52	0.144
	posttest	Based on Mean	12.256	1	52
Based on Median		10.090	1	52	0.003
Based on Median and with adjusted df		10.090	1	46.051	0.003
Based on trimmed mean		12.342	1	52	0.001

Based on the results of Levene's Test, the significance value for pretest is 0.148 (Sig. > 0.05), which means that the pretest data between cycles are homogeneous. In contrast, the significance value for the posttest is 0.001 (Sig. < 0.05), so the posttest data is not homogeneous. Furthermore, the difference test between cycles was carried out using analysis of variance (ANOVA). The results are listed in Table 10

Table 10  
ANOVA test

	Sum of Squares	df	Mean Square	F	Sig.	
pretest	Between Groups	8368.6	1	8368.6	18.68	0.00
	Within Groups	23295.3	52	448.0		
	Total	31664.0	53			
posttest	Between Groups	1372.0	1	1372.0	5.01	0.03

Within Groups	14240.2	52	273.9
Total	15612.2	53	

Based on the SPSS output, for pretest data, the value  $F = 18.681$  with  $Sig. = 0.000$ , which indicates a significant difference between Value pretest the students' pretest scores in Cycle 1 and Cycle 2. Since the assumption of the homogeneity assumption is satisfied, the use of ANOVA on the pretest can be acceptable. For posttest data, obtained the value of  $F = 5.010$  with  $Sig. = 0.030$ , which also indicates a significant difference between cycles. However, since the posttest data do not meet the assumption of homogeneity, then these results should be confirmed by alternative analysis which is a more appropriate alternative analysis, such as the Welch ANOVA, or on a t-test using the line "Equal variances not assumed".

### 3. Independent T test

To evaluate the effectiveness of the learning model implementation from Cycle 1 to Cycle 2, a comparative analysis was conducted by comparing the pretest and posttest scores across cycles using an Independent Samples T-Test. This statistical test is used to determine whether there is a significant difference between two independent groups—in this case, the student groups from Cycle 1 and Cycle 2.

Prior to testing for mean differences, a homogeneity of variance assumption was tested using Levene's Test, which helps determine whether the group variances are equal. This step is essential to decide which row of the t-test output should be used for interpreting the results. The outcome of the Independent Samples T-Test is presented in Table 11.

Table 11  
Independent T test

		<i>t</i>		<i>df</i>	<i>Sig. (2-tailed)</i>	
<i>posttest</i>	Equal variances assumed	12.256	0.001	2.238	52.000	0.030
	Equal variances not assumed			2.238	41.720	0.031
<i>pretest</i>	Equal variances assumed	2.156	0.148	4.322	52.000	0.000
	Equal variances not assumed			4.322	49.478	0.000

The results of the Levene test showed that the pretest data between cycles had a significant value of 0.148 ( $Sig. > 0.05$ ), which means the pretest data is considered homogeneous. Therefore, the interpretation is carried out on the line "Equal variances assumed". Based on the results of the Independent Samples T-Test, a significant value of 0.000 was obtained, with an average difference of 24.90, and a 95% confidence interval between 13.34 to 36.46. This shows that there is a significant difference between the pretest value of Cycle 1 and Cycle 2.

Meanwhile, the results of the Levene test for posttest showed a significant value of 0.001 ( $Sig. < 0.05$ ), so that the posttest data between cycles is not considered

homogeneous. So, the interpretation of the test results is carried out on the line "Equal variances not assumed." The results of the T-test showed a significant value of 0.031, which means there is a significant difference between the value of posttest Cycle 1 and Cycle 2. The mean difference between the two groups was 10.08, with a 95% confidence interval between 0.99 to 19.17. These findings indicate that there is an increase in learning outcomes in student learning outcomes from Cycle 1 to Cycle 2.

### 4. Paired T-Test

In this research, a paired sample t-test was utilized with the assistance of IBM SPSS Statistics 26 software. This test was employed to examine whether there was a statistically significant difference between students' pretest and posttest scores following the implementation of the learning model. The hypotheses for this study were defined as follows:

$H_a$  (Alternative Hypothesis): The Project-Based Learning (PjBL) model supported by the Proteus 8 Professional application leads to improved student learning outcomes.

$H_o$  (Null Hypothesis): The Project-Based Learning (PjBL) model supported by the Proteus 8 Professional application does not lead to improved student learning outcomes.

If the calculated t value ( $t_{count}$ ) is greater than the critical t value ( $t_{table}$ ), or if the significance level (p-value) is less than 0.05, then  $H_a$  is accepted and  $H_o$  is rejected. [18] Which means that the Proteus 8 Professional assisted PjBL model is effective in improving student learning outcomes. Conversely, if the  $t_{count} < t_{table}$  or Value significance value  $> 0.05$ , then  $H_a$  is rejected and  $H_o$  is accepted, which means that the model does not provide a significant improvement in learning outcomes. The results of the hypothesis test are presented as follows in Table 12 below

Table 12 Paired T-Test

						<i>t</i>	<i>df</i>	<i>Sig. (2-tailed)</i>	
		Lower	Upper						
Pair 1	PRE1 - POST1	-14.81	10.68	2.05	-19.04	-10.59	-7.21	26	0.000
Pair 2	PRETEST2 - POSTTEST2	-29.63	7.55	1.45	-32.62	-26.64	-20.39	26	0.000

Based on the SPSS output, the test results on the first pair of data (PRE1 - POST1) showed an average difference of -14.81 with the value of t count = -7.21, degrees of freedom (df) 26, and the value of significance ( $Sig. 2-tailed$ ) = 0.000. Meanwhile, in the second pair of data (PRETEST2-POSTTEST2), the average difference of -29.63, with t count = -20.39,  $df = 26$ , and value significance value = 0.000.

Since the entire Value significance value is  $< 0.05$ , it can be concluded that  $H_o$  is rejected and  $H_a$  is accepted. This means, that there is a significant difference between the pretest and posttest results. Thus, the application of the Proteus 8 Professional application-assisted PjBL learning model proved effective in improving student learning outcomes on both materials tested.

### CONCLUSION

Based on the results of research that has been done, it can be concluded that the application of the learning model PjBL assisted by the application with the help of Proteus 8 Professional application has a significant effect on improving

student learning outcomes in the eyes of the subjects of the application. Series of electronic circuits in SMKN 2 Payakumbuh. This is evidenced by the results of pretest and posttest data analysis which showed a significant increase in value, both in the first material and the second material. Normality test results show that the data is normally distributed, so it is worth analyzing using parametric tests. Furthermore, the paired sample t-test showed that the significant value in both pairs of data was below 0.05, which means that there were significant differences in learning outcomes before and after treatment. Thus, the PjBL model assisted by Proteus 8 Professional has proven effective in improving students' understanding and achievement of student learning outcomes in Project-Based Learning.

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