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Improving Learning Outcomes of Electrical Lighting Installation with Project-Based Learning at SMKN 3 Tondano

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Abstract— This study aims to determine whether there are differences in learning outcomes of psychomotor abilities in designing and installing Electrical Lighting Installations implementing a project-based learning methodology with students using traditional learning models in class XI TITL SMK Negeri 3 Tondano. This study used an experimental method, with a sample of 15 students of XI TITL 1 as the experimental class and 15 students of XI TITL 2 as the control class. Data analysis was carried out by t-test and requirements test, namely normality test using Lilieforce test and the Levene test. The results showed a difference between the learning outcomes of designing and installing electrical lighting installations for groups of students implementing a project-based learning methodology with students using traditional learning models. The average psychomotor ability learning outcomes of students who use project-based learning models are higher than those of conventional learning models. Based on this statement, it can be concluded that there is an effect of project-based learning models to improve students' psychomotor learning outcomes in the material of designing and installing Electrical Lighting Installations in class XI students of SMK Negeri 3 Tondano.

Keywords: project-based learning model, learning outcomes

I. INTRODUCTION

The main factor that can seek to advance the value of a nation is education. Education is the main factor in bridging the value of a nation by providing proper education to individuals or communities to produce quality human resources. The inadequate quality of human resources is an essential issue that might stymie educational advancement. Human resource development must be pursued progressively and continually through a quality education system that includes formal, informal, and non-formal education, extending from primary to higher education (Mulyasa, 2004).

After graduating from junior high school (or its equivalent, vocational high school (SMK) is a secondary education level informal education in Indonesia after graduating from junior high school (or its equivalent). Secondary education is held to continue and expand primary education and prepare students to become members of the community who can hold reciprocal relationships with the social environment and natural culture around and can develop different abilities in the world of work or higher education, for that vocational students must be equipped with adequate basic skills.

In realizing this education, the process requires learning strategies by interacting directly with students to build a relationship in developing students' personalities, both attitudes, behavior, or behavior, and the ability of students to respond to every lesson learned at school. According to (Komalasari, 2011) learning is a system or process of teaching students/learning subjects that are planned or designed, implemented, and evaluated systematically so that subjects/learners can achieve learning objectives effectively and efficiently.

Based on observations of the learning outcomes of students studying Electrical Lighting Installation subjects, they are still low. So to achieve student learning outcomes as expected, It is essential to pay attention. to several factors that influence learning outcomes, including factors within students (internal) and factors consisting of outside students (external) (Syah, 2010).

Initial observations made at SMK Negeri 3 Tondano obtained data that in teaching and learning activities in class XI Electrical Lighting Installation

Engineering in Electrical Lighting Installation subjects, teachers still use conventional learning models. The teacher gives many lectures while the students only listen and take notes on the material delivered by the teacher in the classroom, so the learning atmosphere in the classroom is boring for students. This is what causes students' attractiveness to be reduced to learn, as a result of student learning outcomes become less good (Mokalu et al., 2021). While learning implies interaction between students or students with educators or learning resources in a learning environment (article 1, paragraph 20 of the National Education System).

The paradigm of project-based learning is considered suitable for the learning process of Installing Electrical Lighting Installations. The project-based learning model is a learning model that uses a project as a learning process to train to develop thinking skills, solve problems and make decisions (Kokotsaki et al., 2016). The project-based learning approach was created depending on the degree of thinking growth of the pupils, focusing on educational activities for students to enable them to carry out activities according to their abilities, comfort, and eagerness to study (Datundugon et al., 2021). This project-based learning method necessitates students to learn actively so that student activity is higher, not teachers who are more active in presenting subject matter (Tatu et al., 2021).

II. Method

The research method used is experimental research with a post-test control group design. For the design of this research can be seen in Table 1 (Sugiyono, 2014).

Table 1. Posttest-Only Control Design

Group	Treatment	Post-test
Exsperiment	X	O2
Control	-	O4

For :
X : Project-based learning
O2 : Post-test on class experiment
O4 : Post-test on the control group

In this study, the first thing to do is place the group using project-based learning as the experimental group while the group using conventional learning methods as the control group. Data collection on the results of the learning implementation was carried out after the treatment.

This study was carried out at SMK Negeri 3 Tondano, class XI TITL practice room, located on Jalan Gunung Agung, Minahasa Regency, North Sulawesi Province, West Tondano District. This research was conducted from April to June 2021.

The variables in this study consisted of two variables, namely the dependent variable (Y) and the independent variable (X). Including the following:

1. Variable (X) is a Project-Based Learning Model
2. Variable (Y) is Learning Outcome

Testing the empirical validity of the practice questions is done by calculating the correlation between the item scores and the total score. The test used for the trial measures learning outcomes using product/ practice tests, and the scores produced by the test are continuous beats. Therefore, the correlation technique used is the product-moment correlation with Formula 1.

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{\{N\sum X^2 - (\sum X)^2\{N\sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

For :
r_{xy} : the correlation coefficient between variable X and variable Y
N : number of respondents
$\sum X$: the correct number of item scores
$\sum Y$: total item score
$\sum X^2$: the number of squares of the correct item scores
$\sum Y^2$: sum of squares total score

The question is declared valid if the correlation between the item scores and the total score is significant at the significant level (α = .05); in other words, the question is said to be valid if $r_{count} > r_{table}$ (.514) for n = 15.

The results of the validity test are presented in Table 2, all item questions show $r_{count} > r_{table}$ = .514. Thus, all items are declared valid.

Table 2. Validity Test Results

Item Number	r_{tabel}	$r_{product\ Moment}$	Description
1	.514	.834	Valid
2	.514	.827	Valid
3	.514	.404	Invalid
4	.514	.527	Valid
5	.514	.636	Valid
6	.514	.574	Valid
7	.514	.433	Invalid
8	.514	.522	Valid
9	.514	.709	Valid
10	.514	.687	Valid
11	.514	.606	Valid
12	.514	.651	Valid
13	.514	.616	Valid
14	.514	.875	Valid
15	.514	.688	Valid

Formula 2 used for the test questions in this study is the Alpha coefficient (Cronbach-alpha).

$$r_{ii} = \frac{k}{k-1}\left(1 - \frac{\sum S_t^{\ 2}}{S_t^{\ 2}}\right) \quad (2)$$

For:
r_{ii} = Test Reliability Coefficient
k = Count Grains
S_t^2 = Item Score Variant
S_t^2 = Total Score Variance

Table 3. Reliability Test Results

f_{count}	Coefficient Value	Number of Questions
.903587	.7	15

The question is declared reliable if $r_{count} > .7$ from the calculation results r = .903587, indicating high question reliability because .903587 > .7; thus, the question is valid and reliable for use in this study.

The data obtained in this study were then analyzed using the Software Statistical Package for the Social Science (SPSS) to determine the progress experienced by students.

To carry out further analysis, the data must be tested first to see whether the data is normally distributed or not. The normality test of the data was carried out using the SPSS program with the Shapiro Wilk normality test, with a significant level of = .05. distribution normality test calculation using the following formula:

- Statistical Hypothesis
  H_0 = data is normally distributed
  H_1 = data spread abnormally
- Test criteria
- The level of confidence (ɑ) = .05, n sig > .05, then it is declared normal.

A homogeneity test is used to determine if two or more sets of sample data from the same population have the same variance. The Levene test is used in the homogeneity test with the help of the SPSS 26 program or with Formula 3.

$$W = \frac{(n-k)\sum_{i=1}^{k} n_i(\overline{Z}_\iota - \overline{Z}_\iota)^2}{(k-1)\sum_{i=1}^{k}\sum_{j=1}^{n_i}(Z_{ij} - \overline{Z}_\iota)^2} \quad (3)$$

For :
n = number of observations
k = number of groups
$Z_{ij} = \left|Y_{ij} - \overline{Y}\right|$
$\overline{Y_i}$ = group average to i
$\overline{Z_i}$ = group mean of Z_i
$\overline{Z}$ = overall mean

The test criteria based on the significance level = .05 (5%) is that the null hypothesis is accepted if the sig value > .05, and the null hypothesis is rejected if the sig value < .05.

To test the hypothesis in this study, a t-test statistic was used with Formula 4.

$$t = \frac{\overline{x_1} - \overline{x_2}}{S_{gap}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad (4)$$

Where is the description in Formula 5 (Sugiono, 2014).

$$S_{gap} = \sqrt{\frac{(n1-1)s1^2 + (n2-1)s2^2}{(n1+n2)-2}} \quad (5)$$

For:
n_1 = number of samples from each experimental
n_2 = sample count for the control class
$\overline{x_1}$ = experimental group average
$\overline{x_2}$ = control group average
S_1 = standard deviation of the experimental class
S_2 = control class standard deviation

Management of data in this study using a computer-assisted SPSS program.

Criteria test:
If $t_{count} > t_{table}$, then H_o is accepted
If $t_{count} < t_{table}$, then H_o is rejected

Statistical hypothesis:
$H_0 : \mu_1 = \mu_2 \qquad H_a : \mu_1 \neq \mu_1$

III. Results and Discussion

The information in this research are derived from research conducted at SMK Negeri 3 Tondano in June 2021. It consists of 2 classes, namely class XI TITL 1 as the experimental class with 15 students and XI TITL 2 as the control class with 15 students. In this study, data were taken from learning the psychomotor domain of planning and installing Electrical Lighting Installations. The description of the research data for the two classes can be seen in Table 4.

The data in Table 4 shows that the learning outcomes of psychomotor abilities in planning and installing lighting and electrical installations in the experimental class have a total of 1280 means or an average of 85.4506; the maximum value is 92, the minimum value is 78, the variance is 11.784, and the standard deviation is 3.433. The frequency distribution of the learning outcomes of the experimental class is presented in the form of a frequency distribution table with interval classes using the Sturges rule of 1 + 3.3 log n with log 15 = 1.39 (Sudjana, 2010), and the obtained interval class is 4.97 rounded up to 5, and the class length is 3. The frequency distribution is presented in Table 5, and the histogram is in Figure 1.

Table 4. Summary of Experimental Class Learning Outcomes

Experiment		
N	Valid	15
	Missing	0
Mean		85.310
Std. Deviation		3.433
Variance		11.784
Minimum		78
Maximum		92
Sum		1280

Table 5. Frequency Distribution of Experimental Learning Outcomes

		Freq.	Percent	Valid Percent	Cumulative Percent
Valid	78	1	6.7	6.7	6.7
	81	1	6.7	6.7	13.3
	83	2	13.7	13.3	26.7
	84	4	26.7	26.7	53.3
	86	1	6.7	6.7	60.0
	88	4	26.7	26.7	86.7
	89	1	6.7	6.7	93.3
	92	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

Based on the statistics in Table 5, it is possible to conclude that the experimental class's learning outcomes are above average, as seen in the table above. Figure 1 is a histogram of experimental class learning outcomes data.

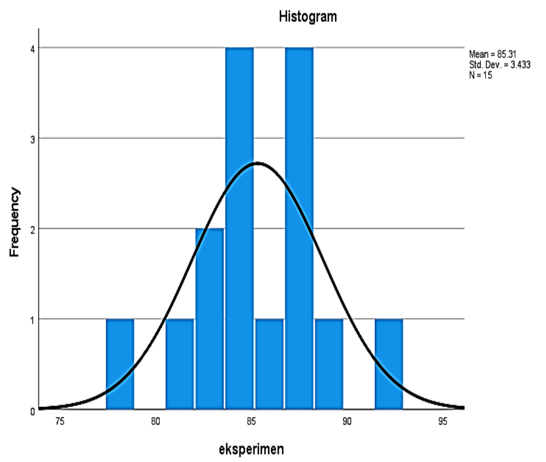

Figure 1. Histogram of Experimental Class Learning Results

Figure 1 shows that students who scored in the interval 75.00 - 80.00 there was one student, the value of 81.00 - 82.00 was one student, the value of 83.00 was two students, the value was 84.00 - 85.00 there were four students, the value of 86.00 – 87.00 is one student, the value of 88.00 is four students, the value of 89.00 is one student, and 90 – 92 is one student.

Table 6. Summary of Control Class Learning Outcomes

Control		
N	Valid	15
	Missing	0
Mean		79.06
Std. Deviation		2.940
Variance		8.646
Minimum		73
Maximum		83
Sum		1186

The data in Table 6 shows that the learning outcomes of psychomotor abilities in planning and installing electrical lighting installations in the experimental class have a total of 1186; mean or average of 79.06; maximum value of 83; minimum score of 73; variance of 8,646; and the standard deviation of 2,940. The frequency distribution of control class learning outcomes is presented in the form of a frequency distribution table with interval classes using the Sturges rule of 1 + 3.3 log n with log 15 = 1.39 (Sudjana, 2010), and the interval class is 4.97 rounded to 5 and length class is 3. The frequency distribution is presented in Table 8, and the histogram is in Figure 2.

Table 7. Frequency Distribution of Control Class Learning Outcomes

		Freq	Percent	Valid Percent	Cumulative Percent
Valid	73	1	6.7	6.7	6.7
	75	1	6.7	6.7	13.3
	77	3	20.0	20.0	33.3
	78	1	6.7	6.7	40.0
	80	4	26.7	26.7	66.7
	81	2	13.3	13.3	80.0
	83	3	20.0	20.0	100.0
	Total	15	100.0	100.0	

If the data in Table 7 is divided into three sections, it can be inferred that the control class learning results are below average, the high learning outcomes are 59% (80 – 83) and low and medium 26.7% (77 – 78) and low. 13.4% (73 – 75). Figure 2 is a histogram of control class learning outcomes.

In Figure 2, it can be seen that students get scores in the interval 72.50 – 75.00 there are two students; the value of 77.50 – 78.00 there are four students, the value of 80.00 is four students, and the value is 81.00 – 83.00 there are five students.

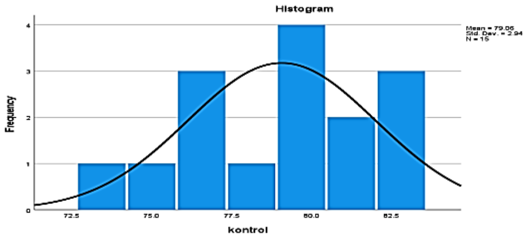

Figure 2. Histogram of Control Class Learning Results

To analyze the test data, the two groups had the requirements of a normality test and a homogeneity test. The processing of this research data uses the computer assistance program SPSS 28.

The experimental class normality test used the same Shapiro-Wilk as the Lilieforce technique. Data is declared normal if n sig > .05. The normality test results using the SPSS 28 computer program can be seen in Table 8.

Table 8. Test of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Stat.	Df	Sig.	Stat.	Df	Sig.
Experiment	141	15	.200	968	15	.833

This is a lower bound of the true significance
Lilliefors significance Correction

From the data in Table 8, it can be seen that the experimental class sig = .833 > .05. Thus, it is possible to deduce from the study data in the experimental class is usually distributed.

The normality test for the control class used the same Shapiro-Wilk as the Lilieforce technique. The data is declared normal if n sig > .05. The results of the normality calculation using the SPSS 28 computer program can be seen in Table 9.

Table 9. Test of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Control	184	15	.181	932	15	.289

This is a lower bound of the true significance
Lilliefors significance Correction

From the data in Table 9, it can be seen that the control class value sig = .289 > .05. Thus, it is possible to deduce that the study data in the control group is usually distributed.

Requirements testing was continued on the homogeneity test. A homogeneity test was conducted to determine whether the data from the two classes were the same (homogeneous). The homogeneity test used the Levene test with the help of the SPSS 28 computer program. The test criteria based on the significance level = .05 (5%) was the null hypothesis was accepted if the sig value > .05, and the hypothesis was rejected if the sig value < .05.

Table 10. Tests of Homogeneity of Variances

		Leyene Statistics	Df 1	Df 2	Sig.
Learning Outcomes	Based on Mean	142	1	28	.710
	Based on Median	164	1	28	.689
	Based on Median and with adjusted df	164	1	26.636	.689
	Based on trimmed mean	165	1	28	.688

The homogeneity test results in Table 10 show that the sig value is .710 > .05. This result means that the tested data from the two groups are homogeneous.

We are testing the hypothesis of this study using the t-test formula to test the following hypothesis. There are differences in learning outcomes for designing and installing Electrical Lighting Installations implementing a project-based learning methodology with those using traditional education in class XI TITL SMK Negeri 3 Tondano. The statistical hypothesis is as seen below.

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

μ_1 = average learning outcomes of students' psychomotor abilities in materials about designing and installing Electrical Lighting Installations taught using a task-oriented learning model.

μ_2 = average the results of learning of students' psychomotor abilities in materials about designing and installing electric lighting installations taught using conventional learning models.

Hypothesis testing in this study uses the computer-aided SPSS program. The test results can be seen in Table 11. The results of the t-test can be seen in the t_{column}. The value of t_{count} is 5.357 > t_{table} = 2.052.

Table 11. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Value	Equal variances assumed	.142	.710	5.357	28	<.001	<.001	6.251	1.167	3.861	8.642
	Equal variances not assumed			5.357	27.355	<.001	<.001	6.251	1.167	3.858	8.644

Thus, there is an influence in comparison to the experimental and control groups where the learning results of the experimental group are higher than the control group's learning outcomes.

Based on the description above, it can be concluded that there is an influence on the learning outcomes of designing and installing electrical lighting installations taught using a model of project-based learning compared with relation to the learning objectives of designing and installing electrical lighting installations taught using traditional learning models. This means that student learning outcomes taught using project-based learning models are higher than student learning outcomes taught using conventional learning models (Bell, 2010).

The research results described above prove the proposed hypothesis; namely, the psychomotor learning outcomes of students in designing and installing Electrical Lighting Installations taught using project-based learning models are higher than students taught using conventional learning models (Guo et al., 2020).

In the data description and data analysis, it has been proven that the learning outcomes for designing and installing Electrical Lighting Installations taught the benefits of employing a project-based learning methodology are greater than the results of learning for designing and installing Electrical Lighting Installations taught using traditional learning models. This shows that, as expressed by (Grey & Antonacopoulou, 2004) expressed, project-based learning is an ideal setting for developing investigative skills that allow us to understand the assumptions and consequences of actions better.

This project-based learning model applied to class XI TITL at SMK Negeri 3 Tondano positively influences the achievement of students' psychomotor ability learning outcomes. Based on the influence of the project-based learning model, student learning activities become fun, wherewith this learning, students can improve their thinking skills in doing the given tasks, such as the statement (Han et al., 2014) that project-based learning is learning that emphasizes the learning process through activities-activities in learning with direct experience, where students need this direct experience to build in-depth knowledge of technology and concepts. During the learning process, using a project-based learning model, the teacher can get to know better students' attitudes and thinking abilities (Sofyan, 2006).

Based on research in the experimental class with a project-based learning model on the material of designing and installing Electrical Lighting Installations at SMK Negeri 3 Tondano, in general, it shows an increase in student psychomotor ability of the results of learning. The high average of students' psychomotor ability of the results of learning regarding the material for designing and installing Electrical Lighting Installations in project-based learning models because students play an active participation in the learning process (Na'imah et al., 2016).

According to the research results handled for three months, the researcher realized that there were limitations in this study. This researcher is only shown for the subject of Electrical Lighting Installation, so it is not generalized to other techniques in the same subject or other subjects.

IV. CONCLUSION

Based on the research and discussion in the previous chapter regarding the effect of project-based learning models on learning outcomes to design and install Electrical Lighting Installations implementing a project-based learning methodology and traditional learning models in class, XI TITL students of SMK Negeri 3 Tondano. Thus, the application of project-based learning models to student psychomotor learning outcomes in designing and installing

Electrical Lighting Installations, where the average student psychomotor ability learning outcomes using project-based learning models is higher than traditional learning models' student learning results.

Project-based learning model can be used as an alternative learning model used in TITL learning. Good time management is the application of each model, especially project-based learning, which will positively impact the learning outcomes to be achieved. TITL teachers should continually improve the quality of their learning by applying various approaches, methods or models in the teaching and learning process so that students are happy to participate in learning.

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