THE EFFECTIVENESS OF USING PLC TRAINER PANEL SYSTEM IN THE PRACTICE LEARNING OF OPERATING ELECTROMAGNETIC CONTROL SYSTEM IN VOCATIONAL HIGH SCHOOL

Abdul Muis Mappalotteng, Fathahillah, and Pattasang
Technology and Vocational Education, Postgraduate, State University of Makassar
abdulmuism@unm.ac.id, pattafaiz@gmail.com

ABSTRACT

The aims of this study were; to determine the effectiveness of using PLC Trainer panel System (PLC TPS) as the media in practice learning of operating electromagnetic control systems in Vocational High School in Makassar; to evaluate the learners' response regarding the practice learning of operating electromagnetic system control through the use of PLC Trainer Panel System as the instructional media in vocational high schools in Makassar; to evaluate the learners' activities during the practice of operating electromagnetic control system through the use of PLC Trainer Panel System as the instructional media in vocational high school in Makassar. This study was a quasi experimental study. The subjects of this study were 30 students. The results of the study showed that the learning outcomes of the students who were taught using PLC TPS as instructional media fell under moderate, good and very good category, while those who were taught without using PLC TPS fell under poor, moderate, and good category; the response of students who were taught using PLC TPS media fell under agree and strongly agree category, while those who were taught without using PLC TPS media fell under somewhat agree, agree and strongly agree category; and the activeness of the students who were taught by using PLC TPS fell under very active category, while the activeness of students who were taught without using PLC TPS fell under less active category.

Keywords: PLC TPS, learning outcomes, students' response, learning activeness

INTRODUCTION

Learning process in the educational unit was organized in such way so that it provided a learning process that was interactive, inspiring, fun, challenging, motivating the students to be more active in the learning process and also provided enough space for students to foster and develop their innovation, creativity, and independence in accordance with their talents, interests, and their physical and psychological development. PP 32 Article 19, paragraph 1. Every educational unit has to plan, implement, assess the outcomes, and supervise the learning process in order to achieve an effective and efficient learning process.

In connection with the matter above, then the learning process should be conducted in an interactive, inspiring, fun, challenging, motivating the students be more active in the learning process and also provided enough space for students to foster and develop their innovation, creativity, and independence in accordance with their talents, interests, and their physical and psychological development. There was a high expectation for the Vocational High School to prepare and produce qualified human resources, but it had not been achieved yet. The fact was that the quality of many vocational high school graduates was still far from expectations.

The opinion above was in line with the reality found on the field. There were many students whose learning outcomes had not met the Minimum Mastery Criteria of 75. This was most likely happened due to the students' lack of responses and activeness. In addition, in the conventional practice learning, which used wiring diagram, utilized too many cable and so that if an error occurred then it would be difficult to detect the cause of the error. On

the other hand, when PLC TPS was used, it would be easier to detect the error. The implementation of PLC TPS system could save the use of wires and provide easier troubleshooting if errors should happen. Besides, by using PLC TPS the students could conduct a circuit simulation. Similarly, based on the evaluation conducted by supervisor-teacher of students who were undergoing their field industrial practice, it was found that students had a hard time to adapt in the industries that already employed the PLC compared with the students who already used PLC Trainer at school.

The intended use of PLC TPS as the instructional media was to improve the students' practice learning outcomes. Thus, the author conducted this scientific study to determine whether the prevailing perception among the public regarding the use of PLC TPS was right or not.

This study was going to examine the effectiveness of using of PLC Trainer panel System (*PLC TPS*) as the media in the practice learning of operating electromagnetic control systems in Vocational High School in Makassar. The subjects of the study were the effectiveness of the media, the students' response and activeness during the use of PLC TPS as the instructional media in operating electromagnetic system control.

METHOD

This study was a Quasi Experimental study. The design used was *Control-Group Pretest-Posttest Design*. In this study, the data collection methods used were; (1) pretest, (2) Observation Sheet, (3) questionnaire about the students' responses and activities, and (4) Posttest. The criteria for the questionnaire result were set as follows:

$$N = \frac{highest\ value - lowest\ value}{number\ of\ criteria}$$

There were two types of variables used in this study, namely, independent and dependent variable. The independent variables was the effectiveness of the use of PLC TPS while the dependent variable was the learning outcomes, the students' response and activities.

The study was conducted at SMK Gunung Sari 1 Makassar and SMK LPP UMI 1 Makassar. The subjects of the study were the electric department students of grade XI in the second semester (IV) academic year of 2015/2016 who were studying how to operate electromagnetic control system. The sample consisted of two classes with the total number of 30 students. Fifteen (15) students of SMK Gunung Sari 1 Makassar who were taught using PLC TPS media which classified as experimental class, while fifteen (students) of SMK LPP UMI 1 who were taught using conventional instructional media were classified as the control class.

This study consisted of three stages, namely, preparation, implementation and reporting stage. At the preparation stage, there were several things that need to be prepared i.e., the objectives and need analysis. The implementation stage was conducted in 4 meetings, both for experimental and control class. In the experimental class, PLC TPS media was used as the instructional media (treatment) while in the control class, the conventional learning models was applied (non-treatment).

The reporting stage was done to examine the differences in learning outcome between the experimental and control class. The end of the study was done by giving post-test to the students in both experimental and control class.

T-test was used to determine the equality of samples that must meet the prerequisites for parametric statistics. The data analyzed should have normal and and uniform distribution. The tests used in this study should be tested for its feasibility before being used to collect the data. The

feasibility study conducted on the test included validity and reliability test.

RESULT AND DISCUSSION

This section would explain about the general idea of the effectiveness of using PLC TPS in the practice learning of operating electromagnetic control system in Vocational High School in Makassar. Furthermore, t-test analysis would be carried out to determine the effectiveness, response and activeness of students regarding the learning outcomes from using PLC TPS in operating electromagnetic control system

A. Description of Research Results

This study used data collected from the *pretest* and *post-test* results. The pretest was conducted in both experimental and control class before the implementation of TPS PLC-based learning activities. The post-test was conducted after the implementation of TPS PLC-based learning activities (experimental class) or after the implementation of magnetic contactor or conventional method in the learning activities for control class (non-treatment).

The learning outcomes here referred to cognitive domains (the students were given 30 multiple choice questions) and psychomotor domains (the students were ordered to complete a circuit that used Ladder diagram as part of their performance).

Both the students' *pretest* and *post-test* results from the experimental and control class could be seen in the appendix.

1. Data Description of Instrument Validation by Validator

The data description was presented in Table 4.1

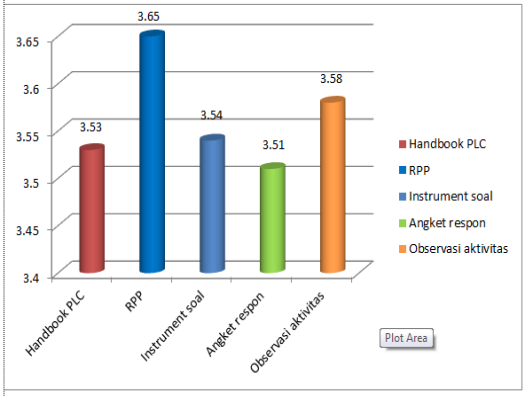
Table 4.1 Analysis validation results of the learning instructional

No.	Types of learning instructional	Validation result	Description
1.	Basic PLC Handbook	3.53	Very valid
2.	Lesson Plan	3.65	Very valid
3.	Pretest and Post-test questions for the students	3.54	Very valid
4.	Students' questionnaire response	3.51	Very valid
5.	observation of Students' activities	3.58	Very valid
	Total	17.56	
	Average	3.56	Very valid

Source: Validator' analysis result in appendix 2

Based on the analysis of learning instructional as shown in table 4.1 above, it could be seen that the average value for validation by both validator was 3.56 (very valid). In addition, the validation result for Basic PLC Handbook was 3.53 (very valid), lesson plan was 3.65 (very valid), pretest and post-test question was 3.54 (very valid), students' questionnaire responses was 3.51 (very valid), and observation of students' activities was 3.58 (very valid).

For more details, the average validation assessment on the learning instructional used in the practice learning of operating electromagnetic control system can be seen in figure 4.1 below.



Gambar 4.1 Analisi Perangat Pembelajaran

Similarly, the results of validation assessment on learning instructional by validator generally showed that the learning instructional to be used to collect data fell under very valid category. In other word, those instruments have met the criteria and fit for used even there were minor revisions needed.

2. Data on the Tryout Result of Research Instrument

a. The accumulation of Data on the Research Instrument Test

The accumulation of answer from 20 students on the tryout of instrument (40 items) could be seen in Table 4.2 below.

Table 4.2 Data Accumulation of the Tryout Result of Research Instrument

No	Type of data	Total	Score	Description
1	Total question	40		
2	The number of test participant	20		
3	Minimum Mastery Criteria		75	Passed
4	Total correct answer	552.00	1,226.65	
5	Lowest score	10.00	22.22	Failed
6	Highest score	33.00	73.33	Failed
7	Average	27.60	61.33	Failed
8	standard deviation	6.90	15.33	

Source: Appendix 4

Based on table 4.2 above, it could be seen that the lowest score obtained was 22.22 while the highest score was 73.33 with the average score of 61.33. Based on this result, it could be concluded that data fell under Fail category because it had not met the required Minimum Mastery Criteria of 75 set by the school.

b. Test Item Validity

Recapitulation of the students' answers toward the tryout of the instrument had generated the data on item validity, as outlined in appendix 5.1.1 part a

From the table above, it could be seen that from 40 items, based on the criterion validity i.e., $r_{calc} > r_{tab}$ (0.444), then the items which considered as valid item were 30 items. The items was then sorted and used as the items for pretest and post test.

As for the remaining items (10 items) that its $r_{calc} < r_{tab}$ (0.444) were rejected because it considered as invalid items.

c. Test Reliability

If the value of Cronbach's Alpha was bigger than 0.60 then the construction of questions/ items were deemed reliable. The test reliability results could be seen in the table of appendix 5.1.1 appendix part b. The reliability of the items fell under high-reliability category because the Cronbach's Alpha value was bigger than 0.90. Thus, the items were deemed feasible and could be used in the *pretest* and *post-test*.

3. Description of the Research Result Data

a. Data on The Students' Learning Outcome

The students' learning outcome could be obtained after the researcher conducted two tests, namely *pretest* and *post-test*. Based on the students' learning outcome, there was significant different in the range of score between the experimental class (taught using PLC TPS media) and control class (without using PLC TPS) in the practice learning of operating electromagnetic control system. The average score of pretest in the experimental class was 40.26, while in the control class was 34.06. After giving different treatment for these two class, the average score of posttest in the experimental class was 82.27, while in the control class was 68.80. These data showed that the average score of the experimental class was higher than the control class.

Distribution of the pretest score; there were 13% or 2 students whose score fell under good category in the experimental class while in control class there was none, and there were 87% or 13 students whose score fell under poor category in experimental class while in the control class all the students (100% or 15 students) belong to this category. Based on these results, it could be assumed that both students in the experimental and control class had relatively similar skills on the learning practice of operating electromagnetic control system.

The distribution of the post-test score in experimental class were 6 students (40%), 8 students (57%) and 1 student (7%) whose score fell under the category of very good, good, and fair, respectively. There was no one in the experimental class whose score fell under poor category. Whereas the distribution of post-test score in the control class were 6 students (40%), 5 students (33%) and 4 students (27%) whose score fell under the category of good, fair and poor, respectively. There was no one in the control class whose score fell under very good category.

b. Data on the Students' Response

Data on the students' responses toward the use of PLC TPS in the practice learning of operating electromagnetic control systems was obtained from the analysis results of questionnaire given to the students both in experimental and control class, after different treatment for both classes applied.

The average score of the students' response in the experimental and control class were 87.73 and 72.73, respectively. From these results, it could be seen that the average score in the experimental class was higher than in the control class

The distribution of students' response in the experimental class were 2 students (13%) who strongly agree and 13 students (87%) who agree with the use of PLC TPS. Whereas in the control class, 5 students (33%) were agree and 10 students (67%) were somewhat disagree with the use of conventional instructional media .

c. Data on the Students' activeness

The students were highly involved (very active) during the practice learning of PLC TPS-based in operating the Electromagnetic Control System. This conclusion was based on assessment conducted by the two supervisors for 4 meetings in the experimental class. The average score of the students' activeness was 3.70 which fell under very active category.

Effectiveness of Using PLC TPS in the Practice Learning of Operating the Electromagnetic Control System

Based on the Minimum Mastery Criteria set by the school, the students' learning mastery on each subject, for Productive subjects, was 75. The analysis results of students' learning mastery from *posttest* result in the experimental and control class could be seen in Table 4.8.

Table 4.8 Analysis of Students' Mastery Learning

Score	Category	Experimental class		Control class	
		Freq	%	Freq	%
75 – 100	Passed	14	93	5	33
0 -74	Failed	1	7	10	67
Total		15	100	15	100

Based on Table 4.8, it could be seen that in the experimental class there was only 1 student (7%) who failed while for the control class there were 10 students (67%). Thus, it could be concluded that learning outcome of the students in the experimental class was higher (93% or 14 students passed the Minimum Mastery Criteria) than students in control class (33% or 5 students passed the Minimum Mastery Criteria).

4. Inferential analysis

a. Test of Normality

Data on test of normality was calculated using *SPSS 20.0* namely Kolmogorov-Smirnov test.

Table 4.9 Test Normality

Level	Test of normality	Experimental class			Control class		
		Pretest	Posttest	Response	Pretest	Posttest	Response
0.05	Kolmogorov-Smirnov	0.076	0.097	0.056	0.20	0.196	0.186
Conclusion	Asymp. Sig. (2 tailed)> 0.05	normal distribution			normal distribution		

Source: data analysis in Appendix 5.1.2.b, 5.1.3.b and 5.2.b

Based on data obtained from the Kolmogorov-Smirnov test in Table 4.9, it could be concluded that the data was normally distributed because it had the significance bigger than $\alpha = 0.05$. It indicated that the data obtained from the test results and the questionnaire in the experimental and control class was derived from normally distributed population. Thus, parametric statistical test could be used in this study.

b. Test of Homogenity

Test of homogeneity was used to determine whether the data obtained from the *pretest* and *posttest*, as well as the questionnaire from the experimental and control class were homogeneous or not. The data distribution was said to be homogeneous if the level of significance was bigger than 0.05, and vice versa.

1) Test of Homogeneity on Pretest Dat

Table 4.10 Test of Homogeneity Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Pretest score	Based on Mean	.883	1	28	.355
	Based on median	.510	1	28	.481
	Based on median and with adjusted df	.510	1	21.309	.483
	Based on trimmed mean	.741	1	28	.397

Source: Data Analysis on appendix 5.1.2.c

From the test of homogeneity of pretest data, it could be seen that the significance value obtained was 0.355. The significance level obtained was bigger than

α = 0.05. Thus it could be concluded that the data on pretest result from the experimental and control class had the same variance (homogeneous).

2) Test of Homogeneity on Post-test Data

Tabel 4.11 Test of Homogeneity Results
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Post-test score	Based on Mean	3.852	1	28	**.060**
	Based on median	3.496	1	28	.072
	Based on median and with adjusted df	3.496	1	26.129	.073
	Based on trimmed mean	3.969	1	28	.056

Source: Data Analysis on appendix 5.1.3.c

From the test of homogeneity of post-test data, it could be seen that the significance value obtained was 0.060. The significance level obtained was bigger than α = 0.05. Thus it could be concluded that the data on post-test result from the experimental and control class had the same variance (homogeneous).

3) Test of Homogeneity on Students' response

Tabel 4.12 Test of Homogeneity Results
Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Score of students' Responses	Based on Mean	.795	1	28	**.380**
	Based on median	.484	1	28	.493
	Based on median and with adjusted df	.484	1		.493
	Based on trimmed mean	.686	1	28	.415

Source: Data Analysis on appendix 5.2.c

Based on the Table 4.12 it could be seen that the significance value obtained was .380. The significance level obtained was bigger than α = 0.05. Thus, it could be concluded that the response of the students in the experimental and control class had the same variance (homogeneous).

c. Hypothesis testing

Referring to the test of normality and homogeneity results, then a statistical tests was conducted to test the hypothesis. Hypothesis testing used in this study was a Parametric Statistics testing using *independent sample t-test*.

1) Hypothesis Testing Results of the Students'Learning Outcomes

Once the data was proved to be normal and homogeneous, then, *t-test* was conducted on the pretest results to determine the initial ability of students from experimental and control class. The t-test analysis results could be seen in Table 4.13.

Table 4.13 Hypothesis Testing Results of the students' Pretest

α	Class	N	Me	t_{calc}	t_{tab}	Sig

			an			.
0.05	Experimental	15	40.26	1,589	0.514	0.123
	Control	15	34.07			

Source: Data Analysis on appendix 5.1.2.a and 5.1.2.d

From table 4.13 above, it could be seen that the Sig. (2-tailed) was 0.123 which was bigger than 0.05. Thus, H_0 was accepted. In other words, the initial ability of the students in the experimental and control class was the same and thus allowed both classes to be compared for the purpose of this study.

Table 4.14 below would show the students' learning outcome (*Post-test*) after receiving different treatment in delivery of learning material.

Table 4.14 Hypothesis Testing Results of the students' Post-test

α	Class	N	Mean	t_{calc}	t_{tab}	Sig.
0.05	Experimental	15	82.27	3.200	0.514	0.003
	Control	15	68.80			

Source: Data Analysis on appendix 5.1.3.a and 5.1.3.d

From table 4.14 above, it could be seen that t_{calc} value was 3.200 with significance level of 0.003 or lower than 0.05. Thus, H_0 was rejected and H_1 was accepted. It was then concluded that there were differences in the learning outcomes between the students who were taught to operate the electromagnetic control system using PLC TPS with those who did not.

The analysis result above showed that the use of PLC TPS was effective to improve the learning outcomes of students in operating the electromagnetic control system at SMK in Makassar.

The effectiveness of using PLC TPS could also be seen from the average score achieved by the students in the experimental class which was 82.27 or above the Minimum Mastery Criteria while the average score in the control class was 68.80 or below the Minimum Mastery Criteria.

2) Hypothesis Testing on the Students' Response

The analysis results of *t-test* concerning the students' responses toward the learning activities could be seen in Table 4:15. The table showed that t_{calc} was 4.558 with significance level of 0.000 of lower than 0.05 (H_0 was rejected). This result was also supported by the average score of the students' response in the experimental class which was 87.73 or bigger than the control class which was 72.73.

Table 4.15 Hypothesis Test Results of the Students' Response toward the learning activities in the Experimental and Control Class

α	Class	N	Mean	t_{cal}	t_{tab}	Sig.
0.05	Experimental	15	87.73	4.558	0.514	0.000
	Control	15	72.73			

Source: Data Analysis on appendix 5.2.d

Based on the results above, it could be seen that there were differences in response between the students who were taught to operate the electromagnetic control system using PLC TPS with those who did not.

B. DISCUSSION

Adaptive learning subjects of operating the electromagnetic control system is a practice-oriented competence subject. Therefore, before the practical work, the students were required to understand various components as well as control circuits, power and wiring diagrams with its complex wired structure since it used too many cables. Thus, to

overcome this problem PLC-based operating electromagnetic control system was proposed.

The effectiveness of learning was the standard achievement of learning objective with the predetermined standard. Practical learning of PLC-based operating electromagnetic control system provided the opportunity for students to experience the real and active learning. Besides, the students were also trained to modify a control system without reinstallation so that to save the time and provide an easier process. Then, if something went wrong, the cause of error could be searched and monitored directly using PLC computer program, *PLC programming tools*.

Monitoring of *Ladder Diagram* PLC could also be done visually by using a *programming device*. For example, to detect whether a relay was working or not, the relay status (ON or OFF) could be checked in the program. So if there were problems, for example a relay did not work, then the contact which caused the relay to stop working could immediately be found. The students' involvement in the practice learning of PLC-based operating electromagnetic control system was also one of the indicators of learning effectiveness. The students' not only received the materials from the teacher but also tried to explore and develop their self-potential by cooperating with other students to modify a control circuit into a series of business and industry- oriented ladder circuit.

The students' mastery learning in each subject was determined based on Minimum Mastery Criteria (KKM) set by the school, which for productive subjects was 75. Before the different treatment was given to the experimental and control class, a pretest was conducted. From the pretest it was found the initial ability of students from both classes was quite similar. However, after both classes were given different treatment (using PLC TPS for experimental class and without PLC TPS for control class), the average score of the experimental class was higher than the KKM while the average score of the control class was lower than the KKM.. Similarly, in the statistical test (t-test) which compared the value of the two classes, the result obtained for experimental class was higher than the control class.

This learning outcome was also supported by the students' responses toward the practice of operating electromagnetic control system which fell under the category of agree and strongly agree. It was because the students were happy following the learning activities, the tasks given were easier, the students were ready to answer questions, they became more focus, used critical thinking and more eager to the lesson. Thus, it could be said that the used of PLC TPS was effective in improving the students' response. In line with it, Siregar & Nara (2014: 54) state that the dynamics of learning will greatly affect the students' response. By varying the learning activities, it was expected that the learning activities became more meaningful and optimal.

Furthermore, the use of PLC TPS could also help the students to be more active during the teaching learning activities since it was no longer a teacher-oriented but student-oriented approach. In this approach, the teacher served as a mediator and facilitator. Thus, the teaching learning activities was designed in such way so that it would engage the students more, namely students' interaction with the teachers, fellow students, as well as with the surrounding environment. Similarly, from the average score given by the two observers during 4 meetings, the activeness of students in experimental class fell under very active category while the for the students in control class fell under less active category.

Based on the results of students' response and learning activities then it could be concluded that the use of PLC TPS in the practice learning of operating the electromagnetic control systems was effective to be used in the vocational high schools in Makassar.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions that could be drawn based on the research results and discussion were

1. The result of using PLC TPS as practices learning instructional media in operating electromagnetic control systems in the vocational high school in Makassar met the criteria of effectiveness that had been set and it was supported by the students' learning achievement the met the KKM
2. The response of students toward the use of TPS PLC in the practice learning of operating the electromagnetic control system fell under agree and strongly agree category.
3. The activities of the students in the experimental class fell under very active, while for the students in the control class fell under less active category.

Based on the research result and conclusions, then the researchers would like to make some recommendations as follow:

1. Teachers should consider the implementation of adaptive learning subjects in operating the electromagnetic control system using PLC TPS as the alternative of teaching learning activities since it could not only improve the students' learning outcomes (cognitive and psikomorik) but also improve their attitude quality (affective)
2. Since there was an indication of students' differences response on the learning outcome toward the use of TPS PLC as the instructional media, then the teachers were recommended to consider the media being used.
3. To maintain the students' activeness during the practice learning in operating electromagnetic control system, then the teachers were recommended to always update the latest information about PLC.
4. The school and government were expected to increase both in terms of quantity and trainer of several types of PLC for the purposes of teaching learning activities in the vocational high school.
5. The World Business Industry (DUDI) were expected to be actively involved both as speakers and as user of vocational high school graduates which would result in a positive synergy between the school and the business/ industry.

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