The Influence of Electro Pneumatic Trainer Media in the Subject of Industrial Electronics Engineering for Industrial Control System Elements at State Vocational High School 5 Padang

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Abstract - The objective of this study is to determine the impact of electro-pneumatic trainers on the subjects of industrial electronics engineering for industrial control system elements at State Vocational High School (SVHC) 5 Padang. The population and sample of this research comprised 28 students from class XI of Industrial Electronics Engineering (TELIND), with 14 students allocated to the experimental group and 14 students to the control group. The results of the hypothesis test analysis, with a significance level of 5% (2-tailed), yielded a calculated t-value (6.525) > the critical t-value (2.056). Consequently, the null hypothesis (H0) was rejected, and the hypothesis asserting "There is an Influence of Electro Pneumatic Trainer Media on Industrial Electronics Engineering Subjects for Industrial Control System Elements at SVHC 5 Padang" was accepted. This indicates that learning using electro-pneumatic media trainers has a significant effect in enhancing learning outcomes compared to software-based simulation media, with an influence of 8.13%. Thus, it can be inferred that the utilization of electro-pneumatic media trainers during the learning process has contributed to an increase in the average learning outcomes of students.

Keywords— Trainers, Electro Pneumatics, PLC, Industrial Control Systems.

I. Introduction

Learning is an activity that is planned and executed by teachers, involving interaction between educators and learners. It consists of a series of activities closely associated with an environment of information and support systematically designed to facilitate student learning. This environment includes not only the physical space where learning occurs but also the various models, media, and facilities that aid in the dissemination of information [1]. However, Learning can be regarded as a permanent change because it is instilled in students by teachers through techniques such as developing specific skills, altering attitudes, or comprehending scientific laws that operate within a learning environment [2].

The learning process is inseparable from three main elements: media, models, and learning outcomes. Learning media serve as tools or means that support learning activities and enhance students' understanding of information. Teachers can utilize learning media to effectively convey learning messages to students, stimulating their attention, interest, thoughts, and emotions [3]. The primary function of learning media is to serve as a teaching aid, representing the atmosphere, conditions, and learning environment organized and created by the teacher [4].

Learning models are essentially teaching methods presented by the teacher from the beginning to the end in a unique manner. They serve as a container or framework for the implementation of specific approaches, methods, and teaching techniques [5]. Project-based learning (PBL) models are often considered as teaching methods that utilize real-world problems to facilitate students' understanding and absorption of the presented theory [6]. Also, Project-based learning (PBL) is an innovative form of inquiry-based learning centered on the concepts and principles of a subject. It involves utilizing various resources and engaging in continuous inquiry-based learning activities in real-world contexts. The primary objective is to develop comprehensive project work and address multiple interconnected problems within a specified timeframe [7].

The learning outcome pertained to affective skills, which can be defined as advancements in areas concerning emotions and attitudes [8]. Learning outcomes represent the abilities attained by students through learning experiences that influence their behavior. This is considered significant as learning reflects educational experiences from psychological, cognitive, and psychomotor perspectives [9]. Various factors affect students' learning outcomes, encompassing both internal and external aspects. Internally, factors include physical and psychological conditions like intelligence, talents, interests, motivation, and cognitive abilities. Externally, factors are associated with the learning environment, programs, facilities, teachers, and educational staff [10].

Vocational High Schools extensively integrate technology as a learning tool. They also graduate students with skills tailored to their chosen concentration. State Vocational High School

DOI: https://doi.org/10.18782/ijecl

Received : February 2024
Revised : February 2024
Accepted : March 2024
Published : April 2024

(SVHC**)** 5 Padang adopts an independent curriculum and leverages technology for learning. The school offers 8 majors, including electronics engineering. The electronics engineering department features two competencies: Audio Video Engineering (TAV) and Industrial Electronics Engineering (TELIND), the latter being newly established. One fascinating aspect of electronics engineering education lies in the field of control. Control systems encompass the design, development, and utilization of industrial tools. The use of control systems in learning is often implemented in the form of trainers. Trainer is a tool that combines various practical components into a comprehensive instrument, stimulating students' interest in the learning process [11].

One example of a control system trainer is Pneumatics. Pneumatics is a system that utilizes compressed air as its primary source [12]. The compressed air is used to operate the pneumatic system through pipes and components such as pneumatic cylinders, pneumatic valves, air filters, pressure regulators, and etc. Pneumatic systems can be combined with electrical control, termed electro pneumatics. Electro pneumatics refers to the management of pneumatic components through electrical signals [13]. Electro-pneumatics advances pneumatics, utilizing pneumatic energy as the working fluid (driving force), while control devices employ electrical or electronic signals [14].

Based on observations conducted at SVHC 5 Padang, particularly in the electronics engineering department, several issues have been identified. One of the issues at SVHC 5 Padang is the failure to achieve the desired learning outcomes, especially in the industrial control system elements. This is due to the novelty of these industrial control system elements and the lack of supportive media to maximize the learning process. Currently, the teaching of these elements relies on PowerPoint presentations, lectures, and supplementary videos. When practical learning takes place, students use software to simulate pneumatic and PLC control, leading to reduced engagement in the learning process.

Based on the above, the need for tangible learning media such as trainers that can replicate pneumatic working processes resembling real-world industrial conditions is apparent. To address this issue, a learning media in the form of a trainer kit was developed, namely an electro pneumatic trainer with an OMRON PLC type CP1E, which is the result of previous research. It is unknown whether this trainer media has an impact on improving student learning outcomes. Therefore, the researcher is influenced to observe and investigate the effect of industrial control system learning with the assistance of the existing electro pneumatic trainer media.

This research was conducted at SVHC 5 Padang, located at Jalan Beringin Raya No.4, Lolong Belanti, Kec. Padang Utara, Kota Padang, West Sumatra. The population and sample of this study were students of class XI Industrial Electronics Engineering (TELIND). A total of 14 students were grouped into the experimental class and another 14 students were categorized into the control class, making a total of 28 students in both the experimental and control classes.

II. Methods

In this study, the research utilized a type of experimental design known as Quasi-Experimental Design. Quasi-Experimental Design is an evolution of true experimental design. While this design includes a control group, it may not fully control external variables that affect the implementation of the experiment [15].

This research applies the Posttest Only control design model, comprising two classes: the experimental class receiving treatment with electro-pneumatic trainer media, and the control class without treatment. Both classes utilize the Project Based Learning learning model. The layout of the Posttest Only control design is provided below.

TABLE I
POSTTEST ONLY CONTROL DESIGN

Class type	**Treatment**	**Final test**
Experimental Class	X	O_1
Control Class		O_2

where:

X : Provision of treatment with electro-pneumatic trainer media

O_1 : Final test for the experimental class after treatment

O_2 : Final test for the control class without treatment

In this research, two procedures were carried out as part of the experiment, first providing treatment to students in the experimental class in the form of electro-pneumatic trainer media, secondly conducting practical assessments using a rubric to determine students' abilities.

The data collection technique in this study was conducted through observation sheets and documentation, with the observation sheet taking the form of a posttest to assess students' abilities after receiving treatment. The treatment administered involved the use of electro-pneumatic trainer media.

Data analysis was performed using two methods: Descriptive Analysis and Inductive Analysis. After analyzing the data, the improvement in learning outcomes using electro-pneumatic trainer media can be determined with the formula.

A. *Descriptive Data Analysis*

Descriptive Analysis was conducted to record and summarize data, aiming to describe important aspects within a dataset, such as mean, variance, and standard deviation.

1) *Mean*

$$\overline{x} = \frac{\sum x_i}{n} \quad (1)$$

where:

$\overline{x}$ = mean value

$\sum$xi = total score

n = number of respondents

2) *Variance*

$$S^2 = \frac{\sum(x_i-\overline{x})^2}{(n-1)} \quad (2)$$

where:

S^2 = variance

$\overline{x}$ = mean value

xi = total of each term

n = number of respondents

3) *Standard deviation*

$$S = \sqrt{\frac{\sum(x_i-\overline{x})^2}{(n-1)}} \quad (3)$$

where:

S = Standard deviation
$\overline{x}$ = mean value
xi = total of each term
n = number of respondents

B. Inductive Data Analysis

Inductive Analysis included tests for normality, homogeneity, and hypothesis testing.

1) Normality testing: To ascertain whether the research data follows a normal distribution, a normality test is conducted. If the data conforms to a normal distribution, the t-test can be applied. Data is deemed normally distributed if the significance level exceeds 0.05. Conversely, it is considered non-normally distributed if the significance level is less than 0.05.

2) *Homogeneity testing:* The homogeneity test is conducted to determine whether the data in each variable is homogeneous. If the result of the homogeneity test shows a significance value < 0.05, then the data variance among groups is not the same. Conversely, if the significance value is > 0.05, then the data variance among groups is considered to be the same.

3) *Hypothesis testing:* Hypothesis testing is conducted to determine whether the hypothesis in the research is accepted or rejected. It aims to ascertain whether there is a difference in the average scores between the experimental class and the control class. If t-value > critical t-value, the hypothesis is accepted; conversely, if t-value < critical t-value, the hypothesis is rejected.

C. Determining the Influence Percentage

Determining the extent of influence is essential for assessing the impact of students' learning outcomes on a particular factor. This can be calculated using a formula.

$$influence = \frac{\bar{X}_1 - \bar{X}_2}{\bar{X}_2} \times 100\% \quad (4)$$

where:

$\bar{X}_1$ = Average of experimental class scores
$\bar{X}_2$ = Average of control class scores

III. Results and Discussions

The research was carried out at SVHC 5 Padang from October 9th to November 10th, 2023, involving students from class XI TELIND as research subjects. They were divided into an experimental class and a control class, totaling 28 students in one class, utilizing random sampling techniques. Therefore, 14 students from class XI TELIND were allocated to the experimental class and another 14 students to the control class. In the control class, learning occurred through simulation using software, while in the experimental class, students were provided with electro-pneumatic trainer media. The variables under investigation included learning outcomes in industrial electronics engineering subjects with industrial control system elements and the achievement of applying control circuits.

The research was carried out across three sessions in both experimental groups. During these sessions, the curriculum covered basic pneumatic principles progressing to electro-pneumatics with PLC materials. However, there was a disparity in the learning media utilized between the two groups. The results obtained from this research encompass field study findings to gather posttest data at the conclusion of each session or following instruction in the Industrial Electronics Engineering subject. This investigation aims to assess the impact of implementing electro-pneumatic trainer media within the Industrial Electronics Engineering domain, particularly concerning industrial control system elements, at SVHC 5 Padang.

A. Descriptive Data Analysis

This analysis is conducted to present the overall data status obtained from both samples in the study. Research data is acquired based on the post-test scores obtained at each meeting from both samples, each consisting of 14 individuals per class. After the treatment, which involved the use of electro-pneumatic trainer media in the experimental class and simulation media in the control class, there were differences in the post-test results between the two samples. The average differences in post-test scores at each meeting between the experimental and control classes are displayed in Table 2:

TABLE III
THE AVERAGE LEARNING OUTCOMES OF THE TWO SAMPLES

Activities	Experimental Class	Control Class
Session 1	84	78.07
Session 2	82.35	73.86
Session 3	79.57	75.5
Average	81.97	75.80

Based on the table above, the average post-test scores of students over three sessions indicate that the average learning outcomes of industrial electronics engineering in the experimental class are higher than those in the control class. Therefore, a comparison diagram of the post-test scores of both sample classes can be illustrated on Fig. 1.

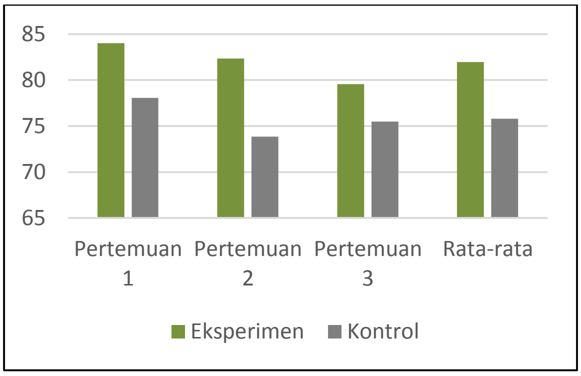

Fig. 1 Comparison graph of scores of the two sample classes

Based on the calculations made on the research data from the experimental and control classes, it was found that the mean or average score in the experimental class is greater than that of the control class, namely 81.98 for the experimental class compared to 75.81 for the control class. Furthermore, the standard deviation in the experimental class is 2.827 and in the control class is 2.123. Additionally, the variance in the experimental class is 7.991, while in the control class it is 4.508. Further detailed description is shown in Table 3 obtained using the SPSS program.

TABLE IIIII
RESULTS OF CONSTRUCT VALIDITY TEST

Information	Experimental Class	Control Class
Max Score	87	78
Minimum Score	78	70
Sum	1148	1061
Average	81,98	75,81
Standard Deviation	2,827	2,123
Varians	7,991	4,508

B. *Inductive Data Analysis*

1) Normality testing: The normality test is conducted to determine whether the sample is from a normally distributed population. The normality test is performed with the help of the SPSS application, as shown in Table 4 below.

TABLE IV
OUTPUT NORMALITY TEST

	Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Learning Outcomes	Post-Test Experiment	.162	14	.200*	.942	14	.440
	Post-Test Control	.158	14	.200*	.890	14	.082

Based on the normality tests of the experimental and control classes using the Kolmogorov-Smirnov and Shapiro-Wilk tests, significance levels (Sig.) greater than 0.05 were obtained for both classes. Hence, it can be concluded that the sample data are normally distributed.

2) *Homogeneity testing:* Homogeneity testing is used to determine whether the learning outcome data obtained from the population have homogeneous (equal) or heterogeneous variance levels. Homogeneity testing is conducted using the SPSS application. The condition to determine homogeneous variance is to observe a significance value (Sig.) greater than 0.05.

TABLE V
OUTPUT HOMOGENEITY TEST

		Levene Statistic	df1	df2	Sig.
Learning Outcomes	Based on Mean	2.118	1	26	.158

Based on the table above, the significance value (Sig.) is greater than 0.05 based on the mean. Therefore, it can be concluded that the data variance is homogeneous or equal.

3) *Hypothesis testing:* To conduct hypothesis testing for the research, the t-test formula and t-test in the SPSS application are used. The t-test is performed to examine the difference in the average learning outcomes between the two research classes, namely the experimental class and the control class, in the subject of industrial electronics engineering for industrial control system elements with the achievement of applying PLC control circuits using electro-pneumatic components. The results of hypothesis testing using the t-test formula are outlined as follows:

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\left(\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2}\right)}} = \frac{81{,}98 - 75{,}81}{\sqrt{\left(\frac{7{,}991}{14} + \frac{4{,}508}{14}\right)}} = 6{,}525 \quad (5)$$

Based on the t-test calculation using the formula, the obtained t-value or t-calculated is 6.525. For a more detailed view of the t-test results, please refer to Table 6, which was obtained using processed data from the SPSS application.

TABLE VI
OUTPUT T-TEST

Class	N	$\bar{x}$	t_{value}	$Critical\ t_{value}$
Experiment	14	81,89	6,525	2,056
Control	14	75,81		

Based on the t-test calculation using the formula and the t-test conducted using the SPSS application, the obtained t-value or t-calculated is 6.525. Referring to the t-table with a significance level of α = 0.05 and degree of freedom (df) = 14+14-2 = 26, the t-table or critical t-value obtained is 2.056. Therefore, to conduct hypothesis testing, a comparison is made between t-calculated and critical t-value, which is 6.525 > 2.056, indicating that the null hypothesis is rejected. To facilitate the explanation of hypothesis testing based on t-value and critical t-value, it is reflected in the curve in Figure 2 below:

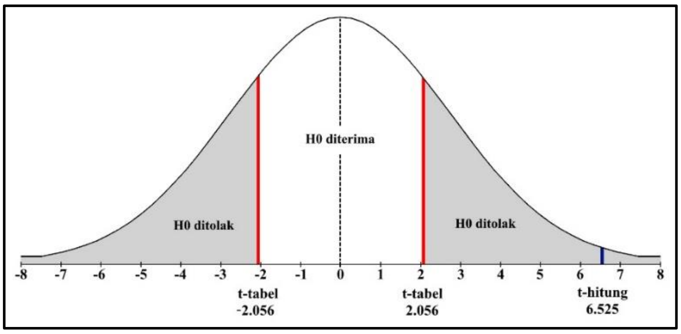

Fig. 2 Comparison graph of scores of the two sample classes

Based on the hypothesis testing curve, it can be seen that the calculated t-value falls within the region of hypothesis acceptance because the calculated t-value is greater than the critical t-value, thus the null hypothesis is rejected. The rejection of the null hypothesis leads to the acceptance of the alternative hypothesis in the research. Therefore, it can be concluded that there is an influence of electro-pneumatic trainer media on the Industrial Electronics Engineering subject for industrial control system elements at SVHC 5 Padang.

C. *Determining the Influence Percentage*

Based on the descriptive analysis data obtained, the average posttest scores in the experimental class are 81.98 and 75.81 in the control class. Therefore, the magnitude of the influence is:

$$influence = \frac{\bar{X}_1 - \bar{X}_2}{\bar{X}_2} \times 100\% \quad (6)$$

$$influence = \frac{81{,}98 - 75{,}81}{75{,}81} \times 100\ \% \quad (7)$$

$$influence = 8{,}13\ \% \quad (8)$$

The research titled "The Influence of Electro-Pneumatic Trainer Media in Industrial Electronics Engineering Subjects for Industrial Control System Elements at SVHC 5 Padang" is based on the limitations of learning media in the learning process and the use of simulation-based software media, which tends to make students easily bored as they only see the results of projects or practices on the monitor screen. Therefore, SVHC 5 Padang initiated the creation of learning media in the form of a trainer, namely an electro-pneumatic trainer. The trainer is one option in instructional learning media that can effectively represent the components and equipment used in the industrial world. This allows students to gain direct experience during the learning process involving the development of knowledge and technical skills [16]. Learning with the assistance of electro-pneumatic trainer media is expected to enhance students' abilities in Industrial Electronics Engineering learning and make learners more interested because the trainer is designed to resemble real-world conditions in the industry, allowing students to interact more with the equipment in front of them.

Based on the data analysis, it can be concluded that using electro-pneumatic trainer media results in an improvement in learning outcomes by 8.13% compared to the learning process assisted by simulation media with software. This has been proven by the difference in the average learning outcomes between the two sample classes, as indicated by hypothesis testing. The obtained t-value > critical t-value (6.525 > 2.056) leads to the rejection of the null hypothesis. Based on the information provided in the research background regarding the test scores of the 11th-grade Industrial Electronics Engineering subject in 2022, it is revealed that the average student learning outcomes are still below the Learning Objective Achievement Criteria. Therefore, it can be concluded that the influence of electro-pneumatic trainer media in the learning process has helped improve the average student learning outcomes. Thus, the problem has been successfully addressed. Hence, the formulated hypothesis "There is an Influence of Electro Pneumatic Trainer Media in Industrial Electronics Engineering Subjects for Industrial Control System Elements at SVHC 5 Padang" is accepted.

IV. Conclusions

Based on the research conducted at SVHC 5 Padang, the following conclusions were drawn: There is a significant influence on students' learning outcomes at SVHC 5 Padang in learning Industrial Control System elements when applying PLC control circuits with electro-pneumatic components, as evidenced by data analysis and hypothesis testing. The use of electro-pneumatic trainer media, supported by hypothesis testing with a significance level of 5%, resulted in t-value (6.525) > critical t-value (2.056). Consequently, it can be concluded that the hypothesis stating "There is an Influence of Electro Pneumatic Trainer Media in Industrial Electronics Engineering Subjects for Industrial Control System Elements at SVHC 5 Padang" is accepted. This implies that learning using electro-pneumatic trainer media positively impacts learning outcomes compared to software-based simulation media. And the students' learning outcomes at SVHC 5 Padang in learning Industrial Control System elements by applying PLC control circuits with electro-pneumatic components using trainers as learning media demonstrate significant differences. The average post-test score for the experimental class using trainers is 81.98. In contrast, the control class using software-based simulation media has an average post-test score of 75.81. Thus, there is an 8.13% increase in learning outcomes.

V. Limitations and Future work

Based on the research findings, the researcher suggests the following Future studies should expand upon this research by incorporating additional variables that may influence the use of trainer-based learning media, such as 21st-century learning. It is hoped that in the future, training sessions will be conducted for both teachers and State Vocational High School students to enhance their interest in and understanding of the industrial world. Through these training sessions, students and teachers will gain a deeper understanding of technological advancements in the industrial field.

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