Journal of Educational Research and Evaluation
Volume 4, Number 1 Tahun 2020, pp. 121-132
P-ISSN: 2597-422x E-ISSN: 2549-2675
Open Access: https://ejournal.undiksha.ac.id/index.php/JERE

The Development of *Program Logic Control* (PLC) Trainer Media in Vocational High Schools

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ARTICLEINFO

Article history:
Received 15 February 2020
Received in revised Form 29 March 2020
Accepted 18 April 2020
Available online 29 May 2020

Keywords:
Trainer PLC, IML, Development

ABSTRACT

This study aimed to develop the *Program Logic Control* (PLC) media. The validity, practicalities, and effectiveness, can be used as a media of teaching in schools on subjects IML. The method used was *Research and Development* (R&D) with the 4-D model of developing procedure. The subjects in this study were students of SMK Negeri 5 Batam, the technical data analysis obtained from 5 experts. Analysis of the data used to measure the validity, practicality, and effectiveness by looking at the difference between the average score of learning scores before and after using the *trainer* with *Gain Score* and Standard Deviation. The results of the study met the instructional media qualifications from the assessment of experts with a level of 0.88 stated in the valid category. In practicality based on the teacher's response was 92.00% and on the student, responses were 90.50%. Effectiveness is obtained from the results of the *pretest* with an average score was 59.63%, from the results of the *posttest* with an average score of 79.63%, the N-gain of the average student was 0.37 and the standard deviation from N -gain was 0.52. So, *PLC trainers are* valid, practical, and effective in learning at school. The *PLC* media *trainer* can be used in the learning process at school.

1. Introduction

Quality Human Resources will be able to develop national development. With qualified human resources, Indonesia will be able to compete with other developed countries. This is in line with the opinion of Salafuddin and Ananta (2013: 26) conveying that Human Resources have a very important role and position as an agent and national development goal. Because the role of Human Resources is very important, the role of institutions producing Human Resources, in this case, the school must implement a good quality education program. School is one example of formal education. There are many types of schools that we know, from elementary to upper levels. One type of school is Vocational School (Vocational High School).

Vocational High School (SMK) is one of the formal educational institutions which is demanded to be able to follow technological developments to produce graduates who are competent cognitively, psychomotrically, and affectively. The quality of the teaching and learning process will affect the learning outcomes of students. The quality of the teaching and learning process will have an impact on the learning outcomes of students. Vocational High School (SMK) is a form of a formal education institution that is demanded to be able to follow technological developments to produce graduates who are competent cognitively, psychomotorically, and affectivelly. The introduction of new technology must be carried out in the process of teaching and learning activities in vocational schools so that students can become people who are ready to face the challenges of the world in the technological era. Meanwhile, according to Peraturan Pemerintah Nomor 29 Tahun 1990 Vocational School is education at the secondary education level which prioritizes the development of students' abilities to carry out certain types of work. Vocational secondary education prioritizes in preparing students to enter the workforce as well as developing professional attitudes. Following its shape, the Vocational High School (SMK) organizes educational programs to the types of employment. Vocational Schools have many expertise programs. The expertise program carried out at SMK adjusts to the needs of the existing workforce. The expertise program at the Vocational School level also adjusts to the demands of society and the market. So, it can be said that vocational education is secondary education which prepares students especially to be ready to work in certain fields (Abdul, 2012).

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The purpose of vocational secondary education according to UU No. 20 Tahun 2003, is divided into general objectives and special objectives. The general objectives of vocational secondary education are: (1) increasing the students' faith and piety in God Almighty; (2) developing the potential of students to become noble, healthy, knowledgeable, capable, creative, independent, democratic and responsible citizens; (3) develop the potential of students so that they have national insight, understand and appreciate the cultural diversity of the Indonesian nation. Whereas the specific objectives of vocational secondary education are: (1) preparing students to become productive people, able to work independently, fill existing job openings as secondary level workers according to their competence in the chosen expertise program; (2) preparing students to be able to choose a career, be tenacious and persistent in the competence, adapt in the work environment and develop professional attitudes in the area of expertise they are interested in; (3) equipping students with science, technology and art to be able to develop themselves in the future both independently and through higher education levels; and (4) equipping students with competencies that are following the chosen expertise program.

To achieve these objectives, the learning process must be optimal. Learning is a process of changing behavior better than the training process of adults. According to Sugihartono (2007: 74), learning is a process of behavior change as a result of the interaction of individuals with their environment in meeting their needs. Learning is a process of behavior change thanks to experience and practice. This means that the purpose of the activity is a change in behavior, both concerning knowledge, skills, and attitudes even covering all aspects of the organism or person (Djamarah and Zain, 2010). Learning is not a goal but a process to achieve the goal. Learning is a modification or reinforces behavior through experience (Hamalik, 2008). So, it can be said that the optimal learning process is very much needed to give rise to meaningful knowledge, skills, attitudes, or psychology experiences in children.

Optimal learning is one of the keys and learning processes that can develop children's abilities and can provide experiences to children who can later be implemented in social life. Learning is essentially a process of interaction between children and their environment both between children and children, children with learning resources, and children with educators. Learning activities will be meaningful for children if carried out in a comfortable environment and provide a sense of security for children. Learning is an effort of educators to help students in carrying out learning activities, to achieve satisfying learning outcomes (Isjoni, 2009). Meanwhile, Suparno (1997) states that meaningful learning is a learning process that involves new information related to the understanding structure that is already possessed by a person who is in the learning process. Learning takes place when students try to connect new phenomena into their knowledge structures. That is, the learning material must match the abilities of students and must be relevant to the cognitive structure of students. Therefore, lessons must be linked to concepts that students already have, so that these new concepts are truly absorbed by them. Thus, the intellectual and emotional factors of students are involved in learning activities.

According to Rivai and Nana (2005) in learning some conditions can support the creation of meaningful learning, namely: 1) The material learned must be associated with cognitive structures substantially and regularly. 2) Students have concepts that correspond to the material to be linked. 3) Students must have the will to connect the concept with cognitive structures substantially and regularly as well. To produce learning that can produce quality learning outcomes requires work by the teacher to design a learning process that can certainly help students develop. As well as the teacher must also collaborate aspects in learning. one important aspect of the learning process is the media.

Learning media can be understood as media used in the process and learning objectives. In essence, the learning process is also communication, then the learning media can be understood as a communication medium used in the communication process, learning media have an important role as a means to channel learning messages. According to Anderson (in Bambang Warsita, 2008), the media are divided into two categories, instructional aids, and instructional media. While Hamalik (in Azhar Arsyad, 2013), argues that the use of instructional media in the teaching and learning process can arouse new desires and interests, generate motivation and stimulation of learning activities, and bring psychological influences on students. The use of instructional media in the learning orientation will greatly assist the activeness of the learning process and deliver the message and content of the lesson at that time. In addition to arousing student motivation and interest, learning media can also help students improve understanding, present data attractively, and reliably. This explains that the presence of learning material media can be conveyed more easily and effectively to optimize learning both in terms of learning objectives and psychological students.

In Vocational High School, one of the known media is the type of media trainer. Khosnevis (in Syriac, 2006) trainer is an application simulation process of building a model of a real system or a proposed system, conducting experiments with the model to explain system behavior, study system performance, or to build a new system by desired performance. The media trainer that is often used is the Program Logic

Controller (PLC) trainer. According to the National Electrical Manufacturers (NEMA) (in Hutomo 2011: 3) the definition of Program Logic Controller is a digital electronic device that uses programmed memory so that it can store instructions-instructions from a particular function such as logic, sequential, timer, enumeration, and arithmetic in controlling the machine from the process. The program logic controller-based control system is a unit that is not separate between the input, process, and output used for operations in the field of automatic machining control in the industrial world. This system is based on the controls program in the Program Logic Controller (Sudarto et al., 2019; Obermier et al., 2015).

Sudarto et al., (2019) define the Program logic Controller as follows: 1) Programmable can be programmed (Software based), this implies that the Program Logic Controller has the advantage of being able to be reprogrammed according to the user's wishes. The type of software that will be used depends on the type and type of PLC used where each product has software by its type (Barret, 2008). In general, the programming language used is often called a ledder diagram. ii) Logic Works based on logic created (Park et al., 2006). The logic here usually refers to Boolean logic consisting of AND, OR, and ON or OFF logic gates; 2) Controller (Brain) of a system, this means that PLCs that have been programmed into a central operational unit that can run or control other machines connected with the PLC (Cahyanto, 2014).

Sometimes, the implementation of learning in schools runs less effectively. Especially in SMK Negeri 5 Batam, from observations that have been made, some problems cause learning outcomes that are not maximum among them is very low student motivation, while this lesson requires critical thinking logic, especially when programming itself, so most students already consider this lesson a difficult subject. Another problem, the number of students with learning media in the form of PLC media trainers is still very small, namely the number of PLC media trainers owned by SMK Negeri 5 Batam, as many as 5 units for 40 students, so the usage ratio is 1: 8. This is not as expected. The 2018/2019 school year has also been evaluated to reduce the problem of comparative use of media trainers by dividing the three study groups. Learning outcomes obtained have a slight increase, reaching 55% graduation. In the learning process, the results obtained by students are not optimal as expected, especially the eyes of the Electric Motor Installation course in the basic competency of the Program Logic Controller. This is shown in table 01.

Table 1. Student Learning Evaluation Results.

No.	Academic year	Number of students	Graduation percentage (%)	Percentage of failure (%)
1	2017/2018	40	48	52
2	2018/2019	42	55	45

Source: (SMKN 5 Batam Curriculum/Academic 2017/2018, 2018/2019)

So that these problems can be overcome, the authors are interested in developing the learning media in the form of PLC trainers to support the learning process of electric motor installation training in SMK Negeri 5 Batam. This media trainer is expected to be a solution to improve the effectiveness of student learning at SMK Negeri 5 Batam, especially in the field of electric power installation engineering in subjects Electric Motor and PLC Installation. The purpose and focus of this research are to develop a PLC Trainer media that is validity, practicality, and effectiveness, can be used as learning media in schools on IML subjects.

2. Method

This research is included in research and development. The procedure for developing a Program Logic Controller (PLC) trainer in ship electrical control system subjects uses the 4-D model which is the main stages, definitions, design, development, and disseminate. The 4-D model was chosen in this study because the development model has a systematic procedure, following the problems underlying this research. This PLC media trainer was developed to increase the ability, creativity, and independence of students in learning on electric motor installation subjects. The development of trainer media is carried out with a 4-D research and development model, the stages of development: a) the defining stage, in the form of initial to final analysis, student analysis, concept analysis, task analysis, goal analysis, and results; b) the planning stage (Design), in the form of simulator design; c) Development stage (Development) in the form of validation, practicality, and effectiveness tests using simulators; and d) Disseminate stage in the form of the dissemination stage of the simulator that has been developed.

This simulator has been through the stages of testing the validity, practicality, and effectiveness. In the validity trial, it is done by asking opinions from the validator through a questionnaire. From the

validity trial conducted after several revisions, a valid PLC trainer media results will be used as one of the learning media. Practicality testing is done by asking opinions from the student-teacher and student through a questionnaire. From this practicality test, it is obtained that the simulator is practically used as a learning medium.

Effectiveness testing is done by looking at the comparison between student learning outcomes using a simulator by not using a simulator, the effectiveness of the trials conducted shows that the simulator can improve learning outcomes and can save time, then this simulator is one of the effective learning media for used as a learning media. Testing instrument testing is done by comparing the instruments on the material that has been taught. Technically, the instrument lattice is made as a guideline for selecting test items. The way to find the validity of this item is to use the Corrected Product Moment table with a significant level of 0.30%. If rpbi> rtabel the item is declared valid, and if rpbi <rtabel the item is invalid and declared invalid. Validation test items or formula questions used according to (Saifuddin Azwar, 2014: 154):

$$\gamma_{pbi} = \left(\frac{Mp - Mt)}{St} \right) \sqrt{\frac{p}{q}} \qquad (1)$$

Keterangan:

r pbi = Biserial Correlation Coefficient.
M p = Average score of the subject that answers correctly for items whose validity is sought.
M t = Average Total Score.
S t = Standard deviation of the total score.
p = student proportion who answered right.
q = student proportion that answers incorrectly.

The test criteria are rpbi> rtabel then the test item is declared valid and if rpbi <rtable then the test item is invalid and declared null.

Test reliability functions indicate whether a test is good enough to be used as a reliable data collection tool. To measure the reliability of the test in the study used the Richardson 20 formula (K-R.20) in Arikunto (2009: 103):

$$r_{11} = \left(\frac{n}{n-1} \right) \left(\frac{S^2 - \sum pq}{S^2} \right) \qquad (2)$$

Information:

r tt = overall test reliability.
p = proportion of subjects who answered the item correctly.
q = the proportion of subjects who answered the item incorrectly. (q = 1-p).
Σpq = the number of times the product of p and q.
n = number of test items.
S = standard deviation.

Classification index of reliability problems can be classified as t table 2:

Table 2 . Classification of Reliability Index Questions

No	Distinguishing Power Index	Classification
1	0.90 ≤ r ≤ 1.00	Very high
2	0.70 ≤ r ≤ 0.90	High
3	0.40 ≤ r ≤ 0.70	Average
4	0.20 ≤ r ≤ 0.40	Low
5	0.00 ≤ r ≤ 0.20	Very Low

Source: Arikunto (2009: 75)

Each question analyzed needs to be classified as a question that remains in use, and therefore the reliability of the questions is measured to confirm the problem. The level of difficulty of the problem

according to Arikunto (2009: 207) "is a number that shows the difficulty and ease of a problem". In determining the level of difficulty in the problem used in the equation:

$$P = \frac{B}{Js} \quad (3)$$

Information:
P = Difficulty level.
B = Number of students who answered the questions correctly.
Js = Total number of students who took the test.

Table 3 . Difficulty Classification

No	Difficulty Index	Classification
1	$0{,}00 < r \leq 0{,}20$	Very high
2	$0{,}20 < r \leq 0{,}40$	High
3	$0{,}40 < r \leq 0{,}60$	Average
4	$0{,}60 < r \leq 0{,}80$	Low
5	$0{,}80 < r \leq 1{,}00$	Very Low

Source: Arikunto (2009: 210)

The distinguishing power (D) of the questions is an indicator to distinguish between students who are smart and not smart. The formula to calculate the power of difference is:

$$D = \frac{B_A}{J_A} - \frac{Bn}{J_B} = P_A - P_B \quad (4)$$

Information:
D = Power of distinguishing problems.
JA = Number of participants in the upper group.
JB = Many lower group participants.
BA = Number of top group participants who answered correctly.
BN = Number of participants in the lower group who answered correctly.

Table 4. Distinguishing Power Table

No	Distinguishing Power Index	Classification
1	$0.70 \leq D \leq 1.00$	Very high
2	$0.40 \leq D \leq 0.70$	High
3	$0.20 \leq D \leq 0.40$	Average
4	$0.00 \leq D \leq 0.20$	Low
5	Negatif	Very Low

Source: Arikunto (2009:218)

Analysis of efficacy data conditioned to obtain data on the feasibility of a product to be developed. Data collection techniques using data effectiveness analysis is through tests because the ability of an object to be measured in this study is the result of learning. The design of student learning ability test can be seen in the following table:

Table 5. One Group Pretest-Postest Design

Pre test	Treatment	Posttest
T^1	X	T^2

Source: Sugiyono (2009:75)

Keterangan:
- T^1 = The pretest before the treatment given
- T^2 = The posttest after the treatment given
- X = The treatment towards the study group that used the tool

After that, comparing the pretest and postest score using Gain Score formula in Hake (1999)

$$\text{Gain (g)} = \frac{(S_{Post}) - (S_{Pre})}{S_{Max} - (S_{Pre})}$$

Keterangan:
- g = *Gain Score*
- S_{pre} = *Pretest score*
- S_{post} = *Post test score*

Tabel 6. Kategori *Gain Score*

No	Gain Score	Kategori
1	g > 0,70	High
2	0,30 ≤ g ≤ 0,69	Average
3	g < 0,29	Low

Source: Hake (1999)

3. Result and discussion

Validation Stage

The data validity of the tools and the PLC media trainer guidance carried out using a questionnaire (Questionnaire). The validation test phase of the tool is carried out so that the product being developed can be known for its suitability based on expert judgment. The purpose of validation activities is held to obtain valid status in this study from experts.

Validation test data obtained through the instrument was validation completed by 5 Validator. The input from the expert is used as a material for product revision validation, which was first conducted by experts in learning materials. This validation is carried out by 3 validators who are competent in their fields. The validation of the material expert aims to find out the accuracy and suitability of the material of the product being developed whether it is following learning needs. The validation sheet contains didactic requirements, construction aspects, and technical requirements. Validation is done by 5 Validator, 3 HLI media, and two subject matter experts.

Table 7. Media Validator PLC Trainer validation

No	Rating items	V	Information
	Didactic Requirements		
1	*PLC Trainer* Refers to the curriculum in SMK	1.00	Valid
2	*PLC trainers Support the activities of understanding concepts in learning*	0.90	Valid
3	*PLC trainers Improve the quality of the learning process*.	0.95	Valid
4	*PLC trainers* Consider the character of students in learning	0.80	Valid
5	*PLC trainers guide* students in learning	0.85	Valid
6	*PLC Trainer* Attracts student's interest and attention in learning.	0.85	Valid
	Average	0.89	**Valid**
No	**Rating Items**	**V**	**Information**
	Construction Aspects		
1	*PLC Trainer* Supports the achievement of learning objectives	1,00	Valid
2	*PLC trainer* Contains learning material.	0,90	Valid
3	The use of *PLC trainers* can be used easily by students	0,85	Valid

4	*PLC trainers* can be used for independent learning	0,85	Valid
5	*PLC trainers* Become more interesting learning	0,85	Valid
6	*PLC (Four in One) trainers* can improve student learning motivation	0,80	Valid
	Average	**0,88**	Valid

No	Rating items	V	Information
	Technical Requirements		
1	The appearance of the *PLC (Four in One) Trainer is* attractive	0,85	Valid
2	The PLC simulation display used is interesting	0,85	Valid
3	The *PLC Trainer* component is clear and can be understood by students	0,90	Valid
4	The layout of the components in each trainer is following the trainer's name	0,90	Valid
5	Wiring each component is neatly installed address	0,80	Valid
6	Wiring each component has been installed firmly	0,90	Valid
7	Connection process between the basic PLC trainer, PLC Motor control, PLC *Water level* simulation, PLC Traffic light functioning.	0,95	Valid
	Rata-rata	**0,87**	**Valid**

The results of the data analysis of the validity of the media trainer PLC which is used as a medium of learning on the installation of an electric motor can be seen that the average of 0.89 in didactic terms valid category, aspects of construction was 0.88 with a valid category, and the technical requirements of 0.87 to category valid. Results of the assessment of each aspect of validator can take an average of the overall validity of the tool with the conclusion that the media trainer who developed the said category "Valid".

Data Analysis of Practicality

Practicalities Based on Teacher Response

Practicality test data was obtained from completing the practicality questionnaire of the use of tools as learning media by teachers and students. Practicality data is taken through a questionnaire filled out by the subject teacher, the head of the Electrical Engineering department. The results of the questionnaire by teachers can be seen in Table 8 as follows:

Table 8. Results of Practicality by Teachers

No	Rating Item	G1	G2	G3	∑	percentage	Category
Material							
1	*PLC Trainer* already follows the wishes of the user	**5**	**5**	**5**	**15**	**100,00**	Very Practical
2	The use of *PLC trainers* can arouse student interest in learning	**4**	**4**	**5**	**13**	**86,67**	Very Practical
3	Learning to use a *PLC trainer* makes students understand the material faster	**5**	**5**	**4**	**14**	**93,33**	Very Practical
4	The use of *PLC Trainers* makes learning more interesting	**4**	**5**	**4**	**13**	**86,67**	Very Practical
5	*PLC trainers* can be implemented by the Teacher	**5**	**4**	**4**	**13**	**86,67**	Very Practical
6	*he PLC trainer is* designed according to the learning material	**5**	**4**	**4**	**13**	**86,67**	Very Practical
7	Use of *PLC Trainer* Saves time in presenting material	**5**	**5**	**5**	**15**	**100,00**	Very Practical
8	*PLC trainers* can be independent learning trainees by students	**5**	**5**	**5**	**15**	**100,00**	Very Practical
9	*PLC trainers* have clear instructions	**5**	**4**	**4**	**13**	**86,67**	Very Practical
10	*PLC Trainer* helps Teachers provide learning experiences for students	**5**	**5**	**5**	**15**	**100,00**	Very Practical
11	*Trainer PLC* and teachers develop students' knowledge	**4**	**4**	**5**	**13**	**86,67**	Very Practical
12	The learning process uses a student-	**4**	**4**	**5**	**1**	**86,67**	Very Practical

	centered *PLC trainer*				**3**		
13	With the *PLC Trainer* Learning aids in conveying material	**4**	**5**	**5**	**14**	**93,33**	Very Practical
14	*PLC trainers* Easy to understand by students	**5**	**4**	**5**	**14**	**93,33**	Very Practical
15	As a learning motivation for students	**5**	**5**	**4**	**14**	**93,33**	Very Practical
Average						**92,00**	**Very Practical**

Based on Table 8 on top of the media trainer can be seen that the value of the average score was 92.00%, a product developed is worth very practical.

Practicalities Based on Student Response

The practicality of using the PLC media trainer as a learning medium is also obtained by students' responses about the practicality of using the simulator which can be seen in the table below:

Table 9. Practicality Results Based on Student Responses

No	Aspects Evaluated	V	Category
Ease of Use Media Simulator			
1	By using this PLC trainer, I can find out the learning objectives that I do	Very Practical	Very Practical
2	I can learn the program and maintenance system using this PLC trainer	Very Practical	Very Practical
3	I can follow the learning stages in this PLC trainer	Very Practical	Very Practical
4	*My Emotion PLC Trainer to learn about controlling Basic*	Very Practical	Very Practical
5	*My Emotion PLC Trainer to learn about controlling an electric motor*	Very Practical	Very Practical
6	*PLC trainer (this motivates me to learn about Water Level Simulation*	Very Practical	Very Practical
7	*Trainer PLC motivated me to learn about Traffic Light simulations*	Very Practical	Very Practical
8	I can follow the instructions in ain er PLC	Very Practical	Very Practical
9	Improve my ability to do theory and how to work on the Program system	Very Practical	Very Practical
10	My understanding of the learning process increases	Very Practical	Very Practical
11	I understood the material clearly	Very Practical	Very Practical
Average		**90,82**	Very Practical
The Time Used in the Implementation			
12	I didn't need a long time to learn about Basic PLC	90,00	Very Practical
13	It didn't take me long to learn about the Electric Motor Controlling System	91,00	Very Practical
14	I didn't need a long time to learn about water level simulation	93.50	Very Practical
15	I didn't need a long time to learn about traffic light simulation	86,50	Very Practical
Average		**90,25**	**Very Practical**
Media Attraction			
16	The language used by the PLC Trainer is easy to understand	90,50	Very Practical
17	The information contained in the PLC Trainer is clear	90,50	Very Practical
18	It's been good development of this PLC trainer	91,50	Very Practical
19	PLC Trainer color combination is good	90,00	Very Practical
20	Do you agree with this new PLC trainer	91,00	Very Practical
Average		**90,70**	**Very Practical**

Based on Table 9, it can be seen that the average score of the ease of use of media trainers is 90.82% with the category "very practical", seen from the time spent in implementation that the average score is 90.25% with the category "very practical" ", And seen from the appeal of the media that the

average score is 90.70% with the category" very practical ". So it can be concluded that based on students' responses to the developed trainers very practical.

Effectiveness test

The effectiveness of using the *PLC* media *trainer* as a learning media on the installation of an electric motor is obtained from the achievement of student learning outcomes after using this media. Student learning outcomes are compared before using the media trainer as learning (*pre-test*). Data on learning results are obtained from objective tests which are first tested for validity, reliability, level of difficulty, and the difference.

Testing the validity of the trial instrument is carried out by conducting test questions on electrical power installation engineering students (outside the sample), the number of trials is 44 students. After testing the validity of the item items out of 45 questions given there are 20 valid items namely: 1, 4, 7, 9, 12, 14, 16, 19, 20, 22, 26, 29, 31, 32, 34, 35 , 39, 40, 42, and 45. While 25 items that are not valid are: 2, 3, 5, 6, 8, 10, 11, 13, 15, 17, 18, 21, 23, 24, 25, 27 , 28, 30, 33, 36, 37, 38, 41, 43, and 44. Test reliability is a measure of whether the test can be trusted UU No. 20 *Tahun* 2003. The results of the calculation of the reliability of the questions are known that all reliable questions using Microsoft Excel 2007 and more clearly can be seen in the reliability obtained with a value of 0.88. These results are compared with the r table, seen from the table value of 0.88 be rada in the range of $0.80 \leq r \leq 1.00$. The results of the analysis and based on the score of r, it can be seen that the test has a very high level of test reliability that is 0.88.

The difficulty index is made to see whether the questions that have been made are categorized as very easy, easy, medium, difficult, and very difficult. Based on all the questions that have been tested, the performed analysis and the results that from 45 questions, there are 7 items in the "hard" category, 23 questions in the "medium" category, and 15 items in the "easy" category.

Based on the test of distinguishing test questions on 45 test items it is known that 5 items have a distinguishing score in the "not good" category, 13 items in the "bad" category, 6 items in the "enough" category and 19 items in the "good" category. Then out of 45 questions, there are 25 *invalid questions* and 20 *valid* items used for research.

Retrieval of student learning outcomes data aims to see improvement in student learning outcomes through the use of tools that have been developed. Learning outcomes obtained after the *pretest* and *posttest* using multiple-choice questions as many as 20 items. Test the significance of the difference is done by using a *Gain Score* analysis which consists of two types, namely: *Pretest* (initial test) and *Posttest* (final test), and the average results of the overall *Gain Score* of students.

Tabel 10. *Pretest, Posttest* and *Gain Score Statistic*

Score	Control				
	N	X_{min}	X_{max}	$\bar{x}$	SD
Pretest	40	8	16	59,63	2,37
Posttest	40	10	19	79,63	2,26
N-Gain	40	0,17	0,80	0,52	0,16
Perbandingan % *Posttest* dan *Pretest* = 20 %					
Score Maximal = 20					

Based on Table 10 above, an average pretest score was 59.63, an average posttest score was 79.60 and an average N-gain of a student's total was 0.52. The pretest standard deviation was 2.37, the posttest standard deviation was 2.26 and the standard deviation can be seen from the N-gain was 0.16, then it can be simplified to be displayed as a queue of pretest and posttest learning outcomes. It has proven the valid, practical, and effective learning in learning at school.

Discussion

Based on the research of PLC media trainer development that has been done, firstly, it has been successfully developed a PLC media trainer for learning to install electric motors in SMK Negeri 5 Batam schools that have passed the validity, practicality, and effectiveness test stages. The results of the validity data analysis of the 5 (four) opinions of experts, the media knew the average value, namely: didactic requirements 0.89 with a valid category, construction aspects was 0.86 with a valid category, and technical requirements 0.88 with a valid category. So, when viewed from the results of the overall total average score was 0.948 with a valid category. The results of data analysis seen from the practicality based on the response of 3 (three) teachers get an average score of 92.00% with a very practical category

and the results of data analysis seen from the practicality based on student responses known to the average value, namely: ease of use of media trainers 90.82% with very practical category, the time used in the implementation of 90.25% with a very practical category and the attractiveness of the media 90.70% with a very practical category. So, when viewed from the total results the overall average gets 90.94% with a very practical category. The results of data analysis are seen from the effectiveness test based on the pretest and posttest. It can be seen from the average score of the pretest score of 59.63% and the average posttest score of 79.63%. The overall N-gain of students is 0.52. So, it can be concluded that the trainer is valid, practical, and effective in learning in school.

Media trainer, Khosnevis (Suryani, 2006: 3) that: Trainer is an application simulation process of building a model of a real system or a proposed system, conducting experiments with the model to explain system behavior, study system performance, or to build a new system following the performance desirable (Obermeier et al., 2015). This media is a form of the student learning experience. With real deepening faced by students will lead to a more enjoyable, effective learning process and will certainly produce meaningful learning. With this media, students will be increasingly focused on what they make, of course, this will foster challenges and high learning interest, so learning becomes meaningful. With the PLC media trainer, the learning process consists of the material learned that must be connected to the cognitive structure substantially and regularly. This is following the opinion of Ravai and Nana (2005) which states that According to Rivai and Nana (2005) in learning there are conditions that can support the creation of meaningful learning, namely: 1) the material learned must be associated with cognitive structures substantially and with regularity; 2) students have concepts that correspond to the material to be linked; 3) students must have the will to connect the concept with cognitive structures substantially and regularly as well.

Several research results have proven that the development of PLC media trainers is practical and effective in school learning. Fauza (2020) found that the development carried out had resulted in a valid, practical, and efficient PLC and Electro-pneumatic media trainer product for PLC and Pneumatic subjects at SMK N 1 Bukittinggi. The validity value obtained was 89.7% so that it was categorized as very valid, the practicality value obtained from teachers and students was 93% and 91% so that it was categorized as very practical, and the value of effectiveness obtained was 87% so it was included in the effective category. Arianto (2020) also stated that the PLC microcontroller-based media trainer was already very valid, very practical, and effective to be used as a practicum tool in PLC subjects majoring in Electrical Power Engineering in SMK Negeri 1 Bukittinggi.

Cahyanto (2014) suggested that the development of learning media for Program Logic Control (PLC) courses through five stages, namely analysis begins with the analysis of student needs, the design is the stage of product design consisting of making research instruments, development is the stage of product development starting from making simulations to validated by expert lecturers, implementation is the stage of implementing media products in field trials, evaluation is the end of the procedure for developing learning media for Program Logic Control (PLC) using a 3D virtual plant. This research recommends for the campus that learning media is an important part of learning tools especially in program logic control (PLC) courses so that the Electrical Engineering Education (PTE) laboratory provides mini plant trainers like industry for PLC simulations.

In addition, Sarwono & Ananta (2018) that PLC S7-1200 trainer learning was developed to improve student understanding. This is evidenced by the difference in learning outcomes between the control class that does not use the media trainer and the experimental class that uses the S7-1200 trainer learning media. The increase in the average value that occurred in the experimental class was higher than the increase in the average value that occurred in the control class. Based on the data obtained, the average increase in the pretest and posttest values for the control class was 41.30%, while the experimental class was 45.50%. There is also an increase in students' learning outcomes through the n gain test to experience an increase in the "medium" category of 0.60 for the control class and 0.67 for the experimental class. Furthermore, to maximize it, these teaching aids need to be used independently by students, so that an increase in learning outcomes can be maximized.

4. Conclusion

Based on the research of PLC media trainer development that has been carried out, the first conclusion is that a PLC media trainer has been successfully developed for the learning of electric motor installations at SMK Negeri 5 Batam schools that have passed the validity, practicality, and effectiveness test stages. The results of the validity data analysis of the 5 opinions of experts, the media knew the average value, namely: didactic requirements 0.89 with a valid category, construction aspects 0.86 with a valid category, and technical requirements 0.88 with a valid category. So, when viewed from the results of

the overall total average score was 0.948 with a valid category. The results of data analysis seen from the practicality based on the response of 3 (three) teachers get an average score of 92.00% with a very practical category and the results of data analysis seen from the practicality based on student responses known to the average value namely: ease of use of media trainers 90.82% very practical category, the time used in the implementation of 90.25% with a very practical category and the attractiveness of the media 90.70% with a very practical category. So, when viewed from the total results the overall average gets 90.94% with a very practical category. The results of data analysis are seen from the effectiveness test based on the pretest and posttest. It can be seen from the average score of the pretest score of 59.63% and the average posttest score of 79.63%. If the overall N-gain of students is 0.52

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