

# **Developing DC Motor Control Module Using PLC as PLC Learning Media in Electrical Engineering UNESA, Indonesia**

**Puput Wanarti Rusimamto, Munoto, Muchlas Samani, Ekohariadi, Endryansyah, Dadang Suprayitno**

Faculty of Engineering, Universitas Negeri Surabaya, Indonesia  
[puputwanarti@unesa.ac.id](mailto:puputwanarti@unesa.ac.id)

**Ahad Ali**

A. Leon Linton Department of Mechanical Engineering, Lawrence Technological University  
Southfield, MI 48075, USA  
[aali@ltu.edu](mailto:aali@ltu.edu)

## **Abstract**

To improve the understanding and programming of PLC Unesa Electrical Engineering Education students, learning media are needed in the form of modules and trainers that discuss PLC about basic instructions, ladder diagram programs and DC motor control with PLC control. The use of DC motors is very common, one of the advantages of DC motors is that they are relatively easy to obtain and are easily regulated to rotate speed. The method used is the development of the four D model. The development process that is used only reaches the 3rd D stage, namely the development stage or develop from 4 stages namely define, design, develop, and disseminate. The subjects of this study were Electrical Engineering Education students at Surabaya State University who programed PLC courses. The modules that have been made are then validated by PLC experts, instructional media experts and linguists. Learning media in the form of modules and trainers are implemented to Electrical Engineering Unesa students to improve PLC programming skills. The module quality results obtained an average total value of 89.95% which means it can be categorized as very valid. For the results of student responses obtained an average total of 78.44% with a good category which means the learning module can be used as a reference for PLC courses.

## **Keywords:**

modules, DC motor settings, PLC programming, Electrical Engineering Education students

## **1. Introduction**

Programmable Logic Controller (PLC) is a compulsory subject for S1 Electrical Engineering Education study program students. One of the goals of Unesa Electrical Engineering Education is to produce competent teachers in the field of electrical engineering [1]. Among them as subject teachers on instrumentation expertise and process automation competencies. PLC learning requires the active role of students. The low ability of students' thinking is due to the fact that PLC learning has tended to only sharpen aspects of remembering and understanding. Then we need an alternative method that is able to develop programming skills in learning PLC [2]. One of them is through practicum or demonstration activities, because practicum or demonstration activities help students to understand an event, see an event in more detail than before and after that remember the event.

In order to improve the understanding and programming of PLC Unesa Electrical Engineering Education students, it is necessary to have learning media in the form of modules and trainers that discuss PLC about basic instructions, ladder diagram programs and DC motor control with PLC control.

## **2. Literature Review**

### **2.1. PLC Modul**

Modules are learning tools or tools that contain material, methods, limitations, and ways of evaluating that are designed systematically and attractively to achieve the competencies/subcompetencies expected in accordance with their level of complexity [3]. The module created is titled DC Motor Control with PLC Control. The contents of this

module consist of a brief theory, questions and solutions which are divided into 4 learning activities namely PLC control system, PLC programming technique, making a program with CX Programmer, setting a DC motor.

To produce modules that are able to increase motivation and effectiveness in use, module development must pay attention to the characteristics of the module as follows: the first is (1) Self Instructional. Through this module students are able to learn themselves, not dependent on other parties. The PLC module is equipped with (a) introduction consisting of descriptions, prerequisites, instructions for using the module, competencies and indicators, final objectives, assessment of prerequisite capabilities. (b) Learning activities consisting of competencies and indicators, description of material, summary, assignments, formative tests and worksheets. (2) Self Contained. What is meant by self contained is that all learning material from one competency or sub-competency learned is contained in one module as a whole. The purpose of this concept is to provide opportunities for training participants to study learning material thoroughly, because the material is packaged into a single unit that is beneficial. (3) Stand Alone. Stand alone is a module that is developed does not depend on other teaching materials or does not have to be used together with other teaching materials. By using modules, students do not need other teaching materials to learn and or do assignments on the module. (4) Adaptive. Adaptive modules are if the contents of learning materials and software can be used up to a certain period of time. (5) User Friendly. Modules should also meet the user friendly rules. Every instruction and information exposure that appears is helpful and friendly to the wearer, including the user's ease in responding, accessing as desired. The use of language that is simple, easy to understand and uses terms that are commonly used is one form of user friendly [3] [4].

## **2.2. PLC trainer**

Hasan [5] suggests that the trainer is a set of equipment in the laboratory that is used as an educational medium which is a combination of work models and mock-ups. The mock-up model is a simplification of the basic arrangement of a more complicated process or system. The appearance of the media trainer will clarify the presentation of ideas, describe or decorate facts that might be quickly forgotten if not visualized. The trainer is intended to support student learning in applying the knowledge/concepts acquired in real objects.

According to [6] media trainers as learning media have advantages and disadvantages. The advantages of media trainers as learning media include: (1) not all systems can be presented in mathematical models, so simulation is the right alternative. (2) can experiment without any risk to the real system, with simulation allows to experiment with the system without having to bear the risk of the system running. (3) the simulation can estimate the performance of the system under certain conditions and provide the best alternative design in accordance with the desired specifications. (4) simulation allows to carry out long-term studies in a relatively short time. (5) can use various data inputs. (6) the nature is concrete and more realistic in raising the main problem when compared to verbal language.

In addition to some of the advantages mentioned above, media trainers as learning media also have several shortcomings, including: (1) quality and trainer analysis depending on the maker of learning trainers (2) only estimating the characteristics of the system based on certain inputs. (3) only displays sensory perception, limited size can only be seen by a group of students [7].

In the automation system, the PLC is the "heart" control system. With the program stored in the memory of the PLC, in its execution, the PLC can monitor the state of the system through a signal from the input equipment, then based on the program logic determines the action circuit for controlling the output equipment outside [8] [9].

PLCs can be used to control simple tasks that are repetitive, or interconnected with others using computers through a type of communication network to integrate complex process controls [10]. PLC control systems are widely used in various fields including controlling traffic lights, elevators, conveyors, goods packaging systems, electronic equipment assembly systems, building security systems, electric power generation systems, robots, food processing [11].

PLC control must be carried out through the following systematic steps. (1) choose a PLC with specifications suitable for the control system, (2) install a communication system, (3) make a control program, (4) transfer the program into the PLC, (5) install the unit, (6) connect I/O wiring , (7) testing the program and (8) running the program.

## **3. Methodology**

This type of research is classified as development research. The development model in this study refers to the 4-D (four D model) model of Thiagarajan [12] which consists of four stages, namely define, design, develop, and disseminate. In the process of applying the development model used in this study only to the 3rd stage of D, namely the stage of development or develop. In summary, the four-D model is described in Figure 1.

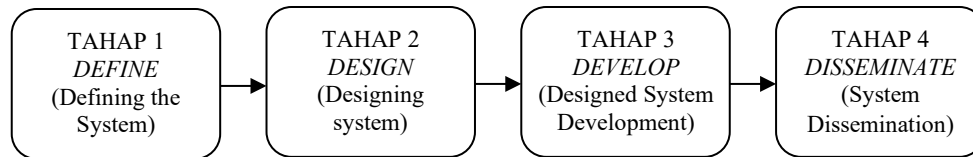


Figure 1. Tahapan penelitian pengembangan media pembelajaran

### 3.1. Define

The purpose of this stage is to determine and define everything that is needed in making modules that are in accordance with the college curriculum so that they can assist lecturers or students in learning. The activities carried out in this stage are as follows.

#### 3.1.1. Front-End Analysis

According to [12] this analysis aims to raise and determine the basic problems faced and then made the background in the research. Based on the identification, further learning tools are developed which are adapted to the current curriculum signs, the learning theory used, and the challenges and demands of the future. According to the results of a survey conducted during the course, Electrical Engineering students, especially electrical engineering education study programs, are still weak in understanding the control system, especially the control system that uses PLC, so the need for learning media in the form of modules and training kits that discuss PLC.

#### 3.1.2. Material Analysis

Material analysis aims to establish the material that will be used as the basis for making learning media which will later be included in the sub-competency of the subject matter of regulatory engineering, while the material is divided into 4 learning activities namely PLC control system, PLC basic instruction, programming with CX Programmer and applications use of PLC to drive DC motors.

#### 3.1.3. Task Analysis

Task analysis is the identification of the main skills needed in learning in accordance with the college curriculum. Task analysis aims to find out the general learning objectives outline about the knowledge and skills that students will learn in applying CPM2A PLC.

### 3.2. Design

The purpose of the Design Phase is to produce learning tools that are in accordance with the college curriculum. Activities carried out in this phase include several stages which will be described as follows.

#### 3.2.1. Media Selection

Media selection activities are adapted to the subject of regulatory techniques and also the material to be taught. In this course, a tool is used in the form of white board, markers, erasers, PLC training kits and a set of computers and print media in the form of modules.

#### 3.2.2. Format Selection

Select appropriate learning tools and are expected to help learning activities namely Semester Learning Plans (RPS) and Modules. RPS is a detailed description of basic competencies, learning outcomes, and indicators of learning outcomes, learning materials and activities, learning scope, time allocation, learning material sources, and assessment [1][13]. This description is described in the form of learning steps to achieve the basic competencies of learning outcomes. The module is a learning tool that contains instructions, information and direction so that students can know what competencies are obtained after completing the module. In the module there are directives and materials and assignments and tests.

#### 3.2.3. Preliminary Design

Activities at this stage focus on writing modules and designing training kits, and reading references related and relevant to the adoption of the modules to be developed.

### 3.3. Development

The development phase aims to produce modules that have been validated to lecturers or experts and revised so that they are suitable for limited trials. The development phase consists of the expert assessment phase and the field trial stage.

Expert judgment is a technique for obtaining advice or input for revising the module and trainer of DC motor control with PLC control. This suggestion can be obtained from competent experts, so that the right and effective learning tools are produced. In addition to providing suggestions, experts will assess learning devices according to existing indicators. In this stage several expert lecturers were taken to study modules for the field of learning and engineering. The validation results are then analyzed and revised according to the validator's suggestion.

In the development test researchers conducted field trials, which were conducted to obtain responses, reactions, and comments from students to the learning module. In this stage it is obtained from the results of student responses.

## 4. Result and Discussion

### 4.1. Validation Result

The validator's assessment of the learning module refers to the module indicators. The results of the module quality evaluation by the validator are shown in Figure 2.

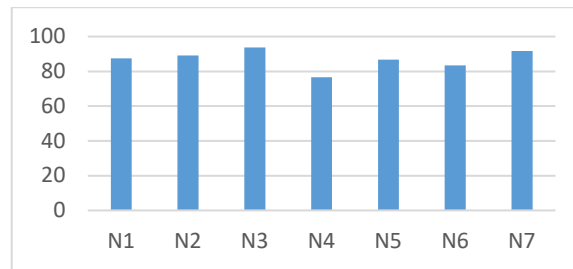


Figure 2. The validator module's quality assessment bar chart

Information: N = Rated aspect, N<sub>1</sub>= Module purpose, N<sub>2</sub>= Substance of the modul, N<sub>3</sub>= Module format, N<sub>4</sub> = Language used, N<sub>5</sub>= Illustrations contained in the module, N<sub>6</sub>=Module evaluation, N<sub>7</sub>= Reference,  $\bar{x}$  = Total average

$$\bar{x} = \frac{N_1 + N_2 + N_3 + N_4 + N_5 + N_6 + N_7}{n} \quad (1)$$

$$\bar{x} = \frac{87,49 + 89,16 + 93,74 + 76,66 + 86,66 + 83,33 + 91,66}{7} = 89,95 \quad (2)$$

Figure 2 shows a diagram of the results of the module quality evaluation by the validator. Based on the results of the module evaluation, the total average result was 89.95%, which was categorized as very valid so that it could be used as a learning reference. But it still needs improvement for the next researcher so that the resulting module can be better.

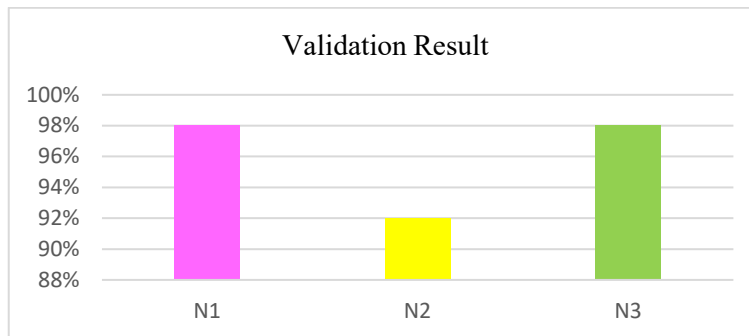


Figure 3. The bar diagram of the completeness of the module components by the validator

Information: N<sub>1</sub> = validator 1, N<sub>2</sub> = validator 2, N<sub>3</sub> = validator 3

Figure 3. shows a diagram of the results of the evaluation of the completeness of the practical module components by the validator. Based on the results of the calculation of the module component assessment, the total average result is

96% so that it can be used as a learning reference. But it still needs improvement for the next researcher so that the resulting module can be better.

#### 4.2. Student Response Result

Student response data were obtained using student response questionnaires. In this study the student response questionnaire instrument was filled with 12 students.

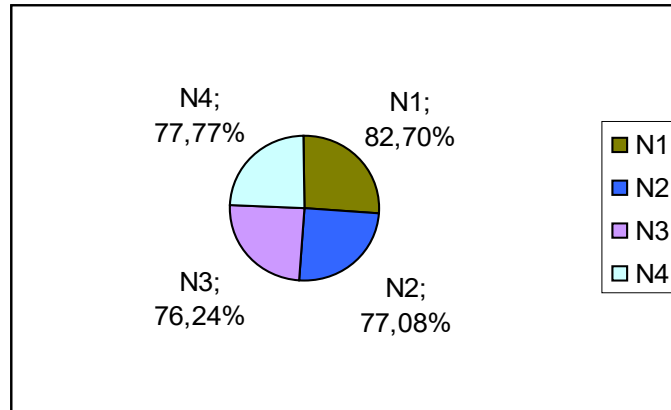


Figure 4. Percentage diagram of student response questionnaire against the module

N = Rated aspect, N<sub>1</sub>= Formulation of the module format, N<sub>2</sub>= Substance of the module, N<sub>3</sub>= Language module, N<sub>4</sub>= Illustrations contained in the module.

$\bar{x}$  = Total average

$$x = \frac{N_1 + N_2 + N_3 + N_4}{n} \quad (3)$$

$$x = \frac{82,7\% + 77,08\% + 76,24\% + 77,77\%}{4} = 78,44\% \quad (4)$$

The results of the average total percentage of student responses to module material amounted to 78.44%, which means that the practice module received a good response and can be used as a reference for learning.

#### 4.3. Discussion

This DC motor control module with PLC control has been completed and validated by 3 related experts, namely engineering experts and linguists. After revising the validators, and the average assessment by the validators is 89.95%, which means that it is of good value, the learning module is suitable for use and tested on 12 students of the Surabaya State University Electrical Engineering Education who program the Regulatory Technique.

From the results of the validator's assessment of the DC motor control module with PLC control there are several aspects assessed, among others: (1) the objectives are categorized as good with an average value of 87.49% because the modules made are in accordance with the validator criteria. (2) the concept/substance obtains an average value of 89.16% with a very valid category, because the module created is in accordance with the criteria of the validator. (3) the format is categorized as good with an average value of 93.74% with a very valid category, because the module that is created is in accordance with the criteria of the validator. (4) the language can get an average value of 76.66% with a very valid category, because the module that is created is in accordance with the criteria of the validator. (5) the illustration gets an average value of 86.66% with a valid category, because the module created is in accordance with the criteria of the validator. (a6) evaluation gets an average value of 83.33% with a very valid category, because the module that is made is in accordance with the criteria of the validator. (7) the bibliography gets an average value of 91.66% with a very valid category, because the module created is in accordance with the criteria of the validator.

One response indicator of the DC motor control module with PLC control is that students as subjects of learning give positive responses. This study found that the DC motor control module with PLC control used received a positive response from the majority of students.

From the results of the student response questionnaire about the module, the format on the module got 82.7%, the concept on the module got 77.08%, the language used in the module got 76.24%, and the picture in the module 77.77%

for the good category it can be concluded that the module developed by the author was suitable to be used as a reference for learning.

## 5. Conclusion

Based on the data obtained from the results of the research that has been done, it can be concluded that (1) the results of the module quality assessment obtained from the validator get an average of 89.95% can be stated to be very valid / feasible to use for the engineering courses in the Department of Electrical Engineering Unesa. (2) The results obtained from the assessment of student response questionnaires obtained an average percentage of 78.44% which means getting a good response and can be used as a reference for learning.

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## Biographies

**Puput Wanarti Rusimamto**, Lecturer in Electrical Engineering in Universitas Negeri Surabaya. Currently taking a vocational education doctoral program, and completing a dissertation on critical tinkering and creativity of PLC programming capabilities.

**Munoto**, Lecturer in Electrical Engineering and Postgraduate in Universitas Negeri Surabaya. Completing the doctoral program in 1996, received the title of 64th Professor of Universitas Negeri Surabaya. With the Decree of the Professor of "Electrical Engineering Education" in 2008. He became a professor at the age of 56 years 2 months. He was inaugurated on January 15, 2010. With his speech, "Portfolio Assessment for Learning in Electrical Engineering Education". He is from the Faculty of Engineering, Universitas Negeri Surabaya.

**Muchlas Samani**, Lecturer in Mechanical Engineering and Postgraduate in Universitas Negeri Surabaya. Inaugurated as the 26th Professor of Universitas Negeri Surabaya. With the Decree of the Professor "Compressor Pump" in 1998. He became a professor at the age of 46 years 1 month. He was inaugurated on December 14, 1998. With his speech, "Vocational Education Towards the Millennium III". He is from the Faculty of Engineering, Universitas Negeri Surabaya.

**Ekohariadi**, Lecturer in Informatics Engineering and Postgraduate in Universitas Negeri Surabaya. Inaugurated as the 69th Professor of Universitas Negeri Surabaya. With the Decree of the Professor "Evaluation of Electrical

Engineering Education" in 2009. He became a professor at the age of 49 years 8 months. He was inaugurated on September 22, 2010. With his speech namely "Study of the New Student Admissions System Test of Universitas Negeri Surabaya". He is from the Faculty of Engineering, Universitas Negeri Surabaya.

**Endryansyah**, Lecturer in Electrical Engineering in Universitas Negeri Surabaya. Complete the 2001 master program with a thesis entitled Induction Motor Speed Control System with Fuzzy Stator Current Estimation.

**Dadang Suprayitno**, Lecturer in Civil Engineering in Universitas Negeri Surabaya. From 2013 to 2016, he played an active role in the research activities of the higher education research and technology ministry. Doctorate graduated in 2013, with the title dissertation Modeling of Sidoarjo-Surabaya Mass Public Transportation.

**Ahad Ali** is an Associate Professor, and Director of Master of Engineering in Manufacturing Systems and Master of Science in Industrial Engineering in the A. Leon Linton Department of Mechanical Engineering at the Lawrence Technological University, Michigan, USA. He earned B.S. in Mechanical Engineering from Khulna University of Engineering and Technology, Bangladesh, Masters in Systems and Engineering Management from Nanyang Technological University, Singapore and PhD in Industrial Engineering from University of Wisconsin-Milwaukee. He has published journal and conference papers. Dr Ali has completed research projects with Chrysler, Ford, New Center Stamping, Whelan Co., Progressive Metal Manufacturing Company, Whitlam Label Company, DTE Energy, Delphi Automotive System, GE Medical Systems, Harley-Davidson Motor Company, International Truck and Engine Corporation (ITEC), National/Panasonic Electronics, and Rockwell Automation. His research interests include manufacturing, simulation, optimization, reliability, scheduling, manufacturing, and lean. He is member of IEOM, INFORMS, SME and IEEE.