Zen Programmable Relay PLC Training Kit to Improve Programming Skill of Electrical Engineering Education Students

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Abstract. This research is a development research that aims to produce a ZEN Programmable Relay PLC module and training kit to improve the programming skills of Electrical Engineering Education students. The method used is the development of the four D model. The development process carried out only in 3 stages, namely define, design and develop. Then test the validity of the module and training kit. The results of the validator's assessment of the module with an average value of 80.06% and an assessment of the training kit of 86.33%. Furthermore, practicality and effectiveness tests were carried out by conducting performance tests on each Learning Activity (KB). Based on the test results, it can be concluded that the ZEN Programmable Relay PLC module and training kit is categorized as valid and can be used as a reference for PLC course practicum.

Keywords: Module, training kit, PLC, ZEN programmable relay, programming skill

1 Introduction

The Department of Electrical Engineering at Unesa consists of two study programs, namely the S1 Electrical Engineering Education Study Program and the S1 Electrical Engineering Study Program. Each study program has its own graduate profile and learning achievement. Profile of Electrical Engineering Education graduates are educators, researchers and education managers. The competencies expected as educators include being open, critical, innovative, and confident in carrying out their duties as a teacher in the field of electrical engineering and electronics engineering studies and mastering the standard content of electrical engineering and electronics engineering subjects which are included in the national education standards and enrichment. [1]. Meanwhile, the learning outcomes of graduates according to the qualification level of the KKNI include being able to work, be responsible and have a commitment as educators who think openly, critically, innovatively, and confidently in carrying out their duties as teachers in the field of electrical engineering and electronics engineering studies in accordance with the quality standards set. has been established and able to develop and integrate science and technology concepts/theories in the field of Electrical Engineering Education [1]. From the expected competencies and learning outcomes according to the IQF qualification level, teachers must have the abilities and skills according to the demands of the 21st century which must have 4 competencies of critical thinking, communication, collaboration, and creativity and innovation [2][3]. For this reason, the Electrical Engineering Education Study Program must equip prospective educators to keep pace with changes that occur rapidly and they must have the knowledge, skills, and support to

become 21st century educators. One of the knowledge and skills that must be possessed by prospective SMK educators from the PTE S1 study program is Programmable Logic Controller (PLC) competence. The PLCs in the Unesa Electrical Engineering control system laboratory are Omron PLC type C28H, Zen Programmable Relay, CPM2A, CP1E and CP2H.

To make it easier to learn Omron PLC in general, it is necessary to start with something easy and then learn more complex ones [4]. Something easy in this case is to use ZEN Programmable Relay, before using Omron PLC series CPM1 or CPM2 (Sysmac series). Therefore, a Zen Programmable Relay PLC module and trainer was created to facilitate PLC learning in the Electrical Engineering department of Unesa. Meanwhile the C28H PLC module and training kit have been made and used in learning.

Zen Programmable Relay is another PLC product from omron, Zen provides a product with 10 programmable I/O channels consisting of 6 inputs and 4 outputs and 20 I/O channels consisting of 12 inputs and 8 outputs. This controller can also be expanded in number with additional hardware. Zen products have 2 forms, namely: the LCD type which is equipped with an LCD display and operation buttons, and the LED type which does not use an LCD and the operation buttons are only LED indicators [5]. The Zen Programmable Relay is shown in Figure 1.

Figure 1. Zen Programmable Relay.
https://id.misumi-ec.com/vona2/detail/222004923385/

The Zen Programmable Relay has been successfully used in experiments conducted by Rampradesh for the application of conveyor belt tracking and monitoring systems. The system can detect faults on and off within 5 seconds. PLC used type ZEN-10C1DR-D-V2 Programmable Relay [6].

One of the software used in programming ladder diagrams for Omron brand PLCs is Zen support software. This software is simple enough that it is easy to understand for beginners who want to learn how to program a ladder diagram for a PLC. In addition, ZEN support software is also equipped with a simulation feature so it is very suitable for students who are just learning PLC. In this study using Zen support software version 3.0. This software is different from the software used by other types of PLC [4][5]. Omron has a Zen PLC programmable relay with special software for the creation and simulation of ladder diagrams, as shown in Figures 2 and 3 below.

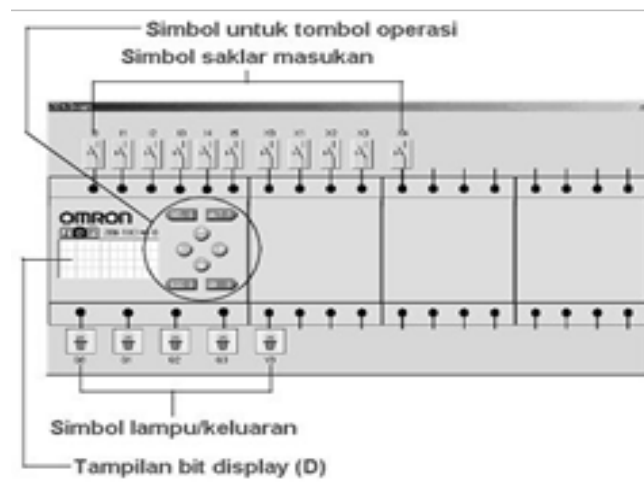**Figure 2**. Display of Zen support software (Omron)

Figure 3. Display of ladder diagram simulation (Omron)

This research uses Zen Programmable Relay as a PLC Training kit to Improve Programming Ability of Electrical Engineering Education Students [7][8][9].

2   Research Method

This research is a development research. In this research the development of this device used a development model from Thiagarajan, Semuel, called the 4-D (four D model) which consists of 4 stages, namely: define, design, develop and desiminate. This model was chosen because the development steps are easy to understand [10]. In brief, the four-D model is described in Figure 4 below.
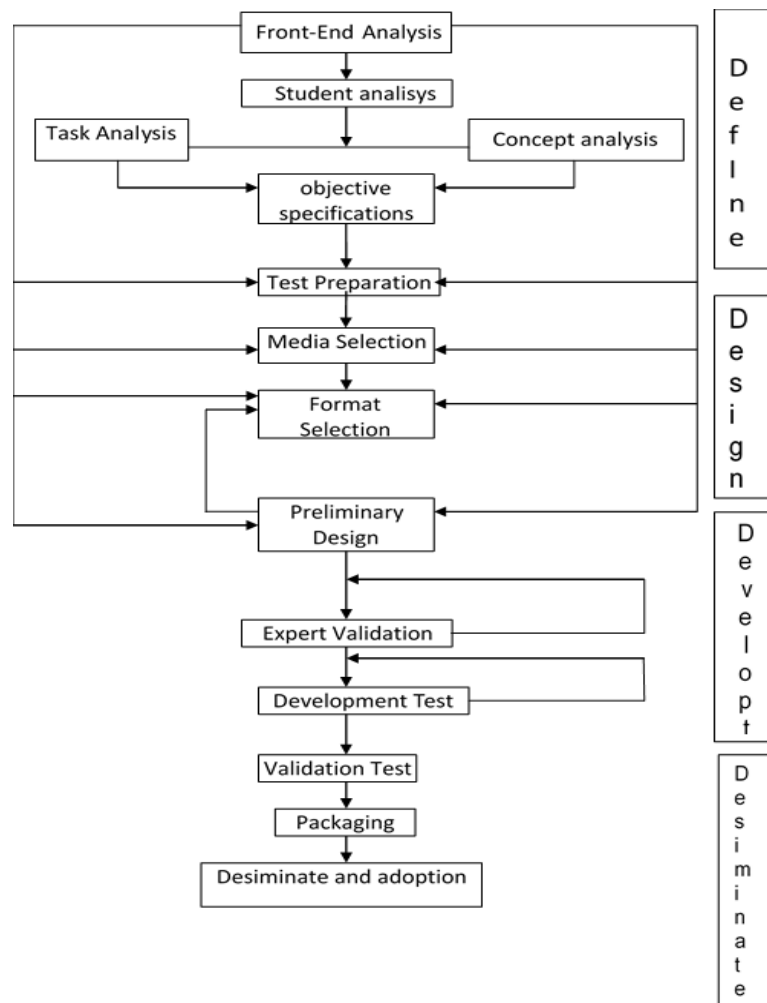
Figure 4. 4-D Learning Device Development Model
(Thiagarajan, Samuel, 1974)

After the module and trainer have been created, the next step is to validate the module and trainer to language experts, PLC experts and learning. The results of the validation were analyzed and then tested on 30 students to determine student responses and performance tests.

3 Results and Discussion

The process of making the Zen Programmable Relay application module and trainer according to the research design and the instructions for making the module referring to the Ministry of National Education and Rahdiyanta [11]. The module arrangement is in accordance with the format consisting of the title page, introduction, table of contents, module position map, terminology, introduction, learning activities, evaluation, bibliography. While the making of the trainer is shown in Figure 5.
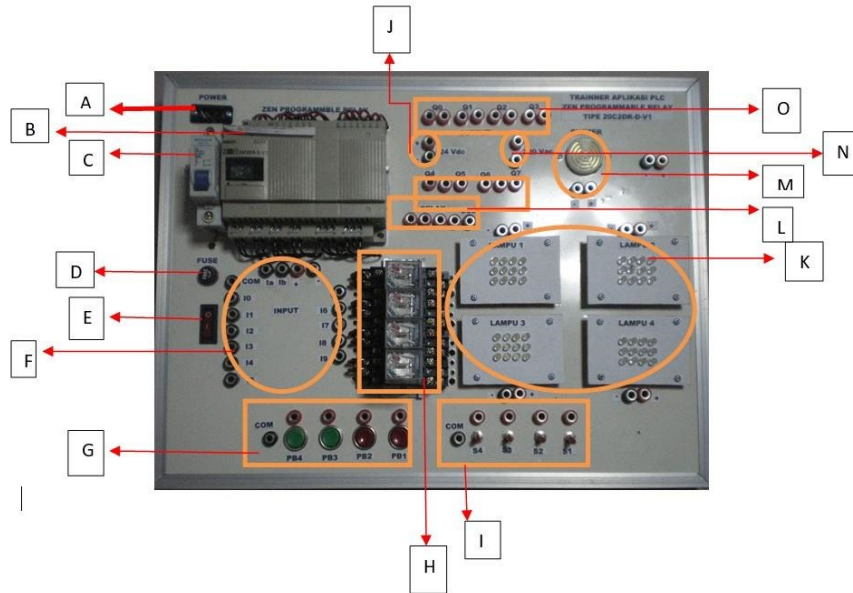
Figure 5. Parts of the ZEN Programmable Relay PLC trainer

Description:
A. Power (catu daya AC) dari PLN 220 V
B. PLC ZEN Programmable relay
C. MCB (mini Circuit Braker)
D. Fuse
E. Saklar power (on-off)
F. Terminal input PLC ZEN Programmable Relay
G. Terminal saklar push botton
H. Relay 24 V dc
I. Terminal saklar toggle

The results of the validation of the ZEN Programmable relay PLC application module and trainer are shown in Table 1. Figure 6 and Figure 7 below.

Table 1. The results of the validation of the ZEN Programmable Relay PLC
Application module by 3 validators.

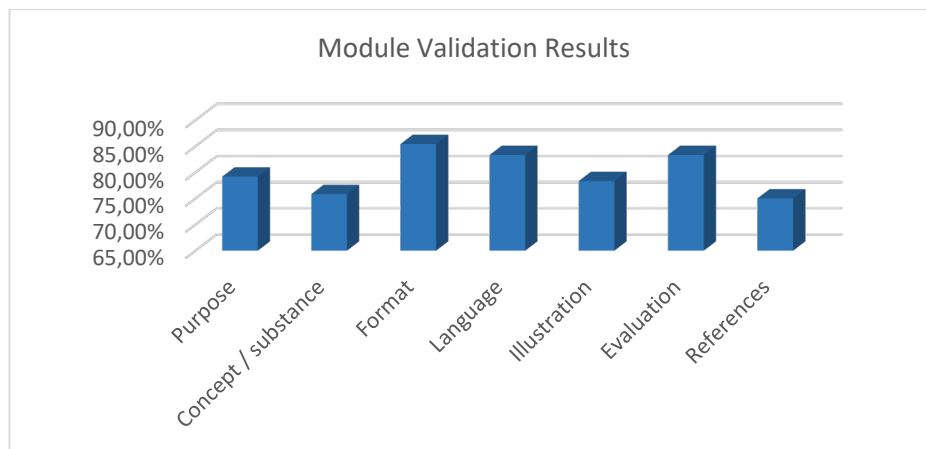| Rated aspect	Average	Categori
Destination	79,17%	Valid
Concept/substance	75,83%	Valid
Format	85,42%	Valid
Language	83,33%	Valid
Illustration	78,33%	Valid
Evaluation	83.33%	Valid
Bibliography	75%	Valid
Rata-rata	80,06%	Valid

Figure 6. Validation diagram of ZEN Programmable Relay PLC Application Module by Validator

Figure 6 shows a diagram of the results of the validation of the practice module by the validator. Based on the results of the module validation calculations, the total average result is 80.06% which is categorized as valid so that it can be used as a PLC learning reference.

Table 2. The results of the validation of the ZEN Programmable Relay PLC application trainer by 3 validators

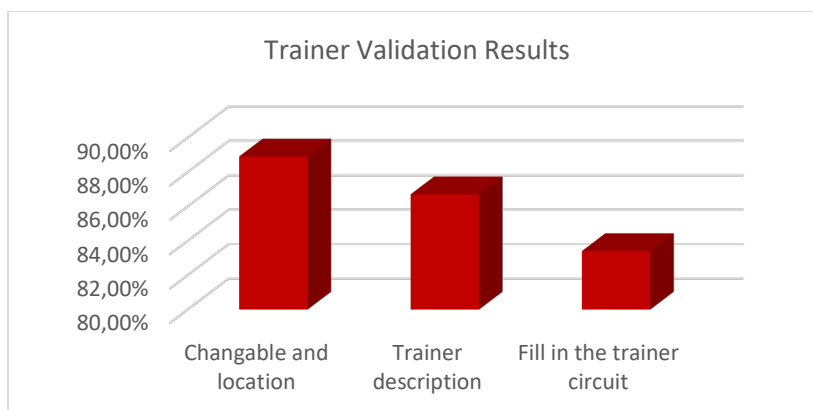| Rated aspect	Rata-rata	Kategori
Appearance and layout	88.9%	Valid
Trainer Description	86,7%	Valid
Fill in the trainer series	83,4%	Valid
Average	86,3%	Valid

Figure 7. Diagram of the validation of the ZEN Programmable Relay PLC Application Trainer by the Validator.

From Table 2, it can be seen that the results of the validation assessment of trainers in the 3 aspects assessed were 88.9% appearance and layout, 86.7% trainer descriptions and 83.4% contents of a series of trainers. With the results of the acquisition of these 3 aspects, it can be seen that the overall average result of the trainer validation assessment is 86.3%. In accordance with the Likert scale criteria, the Zen Programmable Relay PLC application Trainer is suitable for use as a PLC learning reference.

The results of the student response questionnaire regarding the module, got a score of 78.83%, the trainer got a score of 78.33%. So it can be concluded that the developed module and training kit can be used as a reference for PLC learning.

3.1 Performance Test Results

Calculation of the level of student learning completeness from each treatment in Learning Activities (KB) 2, KB 3, KB 4 and KB 5 contained in the module obtained an average value from the results of the details of student performance assignments starting from the preparation stage, program creation stage, the finishing stage of the program, where each stage has several indicators that have an assessment weight according to the level of difficulty, then the weight is scored in total. As shown in Table 4, the following is a performance test assessment instrument for KB 5.

Table 3. Performance Test Instruments for Learning Activities 5 Zen Programmable Relay PLC Application Modules

Job Performance Details	Student		Weight	Score
	Yes	No		
1. Preparation for the practicum				
a) Open the ZEN Support Software program using one of the methods described.			10	
b) Open the ZEN Support Software worksheet by selecting New.			10	
2. Making the Program				
a) Make NO input instructions in the form of I1 - I2, and T0			10	
b) Make output instructions in the form of SET M0 and RESET M0m and [Q0, T0.			10	
c) Making horizontal connecting lines.			10	
d) Make a vertical connecting line			5	
e) Simulate ladder programs			5	
3. Practicum Implementation				
a) Prepare a tool that is PLC ZEN Programmable Relay trainer			10	
b) Arranging a series of flip-flop lamp applications			10	
c) Transfer the ladder program to the ZEN Programmable Relay PLC			10	
d) Run the KBM 5 application with the trainer.			10	
Total score			100	

The results of the performance test for each Learning Activity (KB) get an average total score of 95 for KB 2, 85 for KB 3, for KB 4 and KB 5 the average is 90.

4 Conclusions

This research produces learning tools for students of Electrical Engineering Education Unesa in the form of modules and training kits for the Zen Programmable Relay PLC Application. While the instruments used are module validation sheets, trainers, student responses and performance tests. The sample of students is students who have programmed PLC. They were given a response instrument and conducted a performance test trial in turn. The results obtained are the validator's assessment of the module with an average value of 80.06% and an assessment of the training kit of 86.33%. The results of the student response questionnaire to the module were 78.83% and the response to the training kit was 78.33%. The results of the performance test for each KB get a total score of 95 for KB 2, 85 for KB 3, for KB 4 and KB 5 it is 90. Based on these results, it can be concluded that the ZEN Programmable Relay PLC Application Module and Training kit is categorized as valid and can be used as one of the following: one PLC course reference [11].

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