Training Kit and Module on Plc Programming Competence for Students of Electrical Engineering Education

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INFO ARTIKEL	ABSTRAK
	Abstract: This research aims to determine the validity and practicality of training kit and PLC learning module as an instructional media for PLC course for students of electrical engineering education at Universitas Negeri Surabaya. That was development research using Thiagarajan's 4D models, this study only used the first three stages, not up to the disseminating stage, as the researcher only developed the training kit and module. The design of the training kit and module were developed and validated based on the look of the product, the quality of the media, and the suitability of the media for the curriculum and illustrations. The results of validation and trial process were used to determine the feasibility level of the module that had been developed in terms of validity and practicality. Findings showed that the training kit validation was valid at 85.18%, the module validation was valid at 83.33%. Another finding depicted that students' responses showed that both the training kit and module were practical with percentages of 85% and 82.17% respectively. So that the training kit and PLC module were feasible to be used in PLC learning process by students of Electrical Engineering Education program at Universitas Negeri Surabaya. **Abstrak:** Penelitian ini bertujuan untuk mengetahui validitas dan kepraktisan training kit dan modul pembelajaran PLC sebagai media pembelajaran mata kuliah PLC bagi mahasiswa pendidikan teknik elektro Universitas Negeri Surabaya. Yaitu penelitian pengembangan menggunakan model 4D Thiagarajan, penelitian ini hanya menggunakan tiga tahap pertama, tidak sampai tahap diseminasi, karena peneliti hanya mengembangkan training kit dan modul. Perancangan perangkat pelatihan dan modul dikembangkan dan divalidasi berdasarkan tampilan produk, kualitas media, dan kesesuaian media untuk kurikulum dan ilustrasi. Hasil proses validasi dan uji coba digunakan untuk mengetahui tingkat kelayakan modul yang telah dikembangkan ditinjau dari validitas dan kepraktisan. Hasil penelitian menunjukkan validasi training kit valid sebesar 85,18%, validasi modul valid sebesar 83,33%. Temuan lain menunjukkan bahwa tanggapan siswa menunjukkan bahwa baik perangkat pelatihan maupun modul praktis dengan persentase masing-masing 85% dan 82,17%. Sehingga training kit dan modul PLC layak untuk digunakan dalam proses pembelajaran PLC oleh mahasiswa program studi Pendidikan Teknik Elektro Universitas Negeri Surabaya.
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In this current era, the success of being a teacher is not merely about increasing professionalism (e.g. professional certification and benefits), attendance, and the number of teaching hours. Rather, teachers should be able to reframe the design of comprehensive education and learning process. Nowadays, teacher's professional development program confronts number of challenges. They have to be able to provide learning experience and to combine inquiry teaching, design, and collaboration methods as well as effectively use technology and the 21st century skills assessment (Rosyada, 2017). A successful professional development program that can provide teachers with relevant knowledge, tools, and practices to the 21st century teachers has a number of common characteristics (Trilling & Fadel, 2009). The 21st century challenges young people to become good learners so that they are required to be able to learn from mistakes they have committed. They must be independent not because of the teacher's orders or schoolwork's, but due to the idea of individual willingness to learn. They must be familiar with a flexible learning process, using different learning strategies, and keeping abreast of the rapid changes of the world. If they are able to

achieve changes quickly and independently, then the teacher must be able to compensate for these changes. In short, teachers must be persistent of what responsibilities they have committed (Rosyada, 2017).

Meanwhile, educators who are involved as the members of the National Education Association (NEA) based in the USA see that Critical thinking and problem solving, Communication, Collaboration, and Creativity and innovation are the four most sustainable competencies as the variables demanded by each company and needed by every professional (National Education Association, 2010), of which the Four aspects are called as four Cs. The students must be prepared with the four Cs (National Education Association, 2010). Skills taught in education and training can determine students' prospects for developing their future workplace skills (Mikkonen, Pylväs, Rintala, Nokelainen, & Postareff, 2017). Without ignoring other various competencies, these four competencies should be carried by teachers well in dealing with the 21st century.

The Department of Electrical Engineering Education at Universitas Negeri Surabaya has graduates who are prepared to become vocational high school teachers. Students should accomplish 144 credits minimum in four to five years. The structure of the curriculum consists of the core curriculum intended to develop the main competencies of graduates (about 85% of the total credits must be taken by students) and elective curriculum intended to strengthen key competencies/supporting competencies (around 15% of all credits must be taken by students) (Ibrahim et al, 2014). The development of the curriculum is referred to the National Standards of Higher Education based on competency and KKNI (Indonesian National Qualifications Framework) (Government of the Republic of Indonesia, 2012) and based on the spectrum of Vocational High Schools (Government of the Republic of Indonesia, 2018). The subject of the Programmed Control System becomes one of the subjects of industrial automation technical competencies. One of the material in the Programmed Control System is Programmable Logic Controller (PLC). Considering the importance of PLC material to vocational students, the PLC material is included in the Department of Electrical Engineering Education curriculum at Universitas Negeri Surabaya, which is set in three credits including theory and practice. The limitations of the instructional media for PLC course lead to the needs to improve the PLC programming skills of the students.

In accordance with the demands of the 21st century, the teacher must prepare students to have critical thinking, communication, collaboration, and creativity and innovation competencies. The transfer of knowledge, recognition, and accumulation of learning outcomes requires teachers' involvement in terms of learning outcomes as well as learning and assessment activities. (de Paor, 2018). Therefore, the Electrical Engineering Education study program must equip prospective teachers to compensate for changes that occur quickly and become the front line of the change, Their students must have the knowledge and skills that can lead them to be effective 21st century teachers. One of the knowledge and skills that must be possessed by vocational teacher candidates is PLC programming competence. However, can the learning of the PLC in the Electrical Engineering Education Study Program improve student PLC programming skills? Based on this question, it is necessary to conduct a study to improve students' PLC programming skills. As the initial research, this development study was carried out by making training kits and modules that were feasible as PLC instructional media. The next question is whether the training kit and PLC module are suitable to be used as PLC learning media. Feasibility test was mandatory to be conducted to know the validity and practicality of the training kits and modules. The validity test used validation instruments and the practicality test used questionnaires revealing students' responses to developed PLC training kits and modules.

There are several important principles that appear in most of the accepted main learning theories according to Cartwright (1999). First, active learning remains that students must be actively involved in learning assignments. The second principle is the outcomes of knowledge. When a student answers a question, he must immediately find out whether the answer is correct. Third, excessive learning becomes much important in learning process because it can motivate students to get better learning attainments. The fourth is ordering, that aims to determine learning goals so that the learning process is conducted systematically. The fifth is remote practice, in which many short training modules produce better learning and retention than long modules. The last is learner's characteristics that show the training module should be tailored to the students' interests and abilities. The latest kit generation has been extensively evaluated for teacher professional development and kit curriculum implementation (Lawrenz, Huffman, & Welch, 2001). However, the information about student's learning outcomes remains limited. Gagne & Briggs (1992) state that the learning results refer to the student's ability made through learning process and can be observed through their performance.

PLC Programming Competencies

Spencer (1993) defines competence as the basic characteristics possessed by an individual that are causally related to fulfilling the criteria needed in occupying a position. Competence consists of five types of characteristics namely motives (consistent will as the cause of particular action), innate factors (consistent character and response), self-concept (self-image), knowledge (information in certain fields) and skills (ability to carry out tasks). Confusion often arises because of the use of the term '*competence*' to indicate one's inner capacity and competence as the elements of the role of life or work. The National Council for Vocational Qualifications (NCVQ) refers to the Competency Unit and Competency Element so that it tends to avoid the use of terms created; NCVQ also refers to general and specific competencies. This brings several terminological definitions for future

development (Burke, 2005). In connection with the above definition of competence, PLC programming competence can be defined as student's PLC ability, including knowledge about PLCs and its practices. The competency is encompassed in the Basic Course Outline of PLC course. Learning plan (LP) is the planning stage in the learning process that can continue with the preparation and implementation stages of learning process. Therefore, the LP must reflect the learning process as desired to meet the learning outcomes through a progressive learning cycle, training, and assessment at each stage of learning outcomes. The LP is expected to guide lecturers and students to realize independent learning and student-centered learning (Bilfaqih, Ibrahim, et al, 2014). The goal of PLC learning is that students can create programs with mnemonic codes and ladder diagrams using Programming console and CX Programmer. From the learning outcomes of this lecture, the final abilities, indicators, study materials, approaches/methods/models/learning strategies, learning resources, time and grid scores are then formulated.

PLC Training Kit

PLC is an automatic control system that is widely used in industry so that it requires students to master the competencies. According to Bolton (2006), PLC is a special form of microprocessor-based controller that utilizes memory that can be programmed to store instructions and implement functions such as logic, timing, enumeration, and arithmetic to control machines and processes. Yilmaz's (2011) research showed that the use of PLC internal modules can make the learning process easier. Coskun (2009) concluded that working by using prototypes allows students to acquire practical knowledge and skills in which they can use these skills for maintenance, repair, and control the machines. Likewise, Riera (2009) conveyed that PLC training on physical and virtual targets is a complementary solution to increase both safety and satisfaction. Gavali (2016) has created a Graphical User Interface platform and related technologies to improve learning with a case study of design projects in engineering in the Programmable Logic Controller course. The assessment shows that students have a better response to technology-based practicum activities. Many types of PLCs are used in the world of industrial automation, including Omron, Schneider, Mitsubishi, Festo, and Siemens. A PLC can be programmed with a software. The PLC that will be used for this present study is the CP1E Omron PLC with CX-Programmer, CX-Designer and CX-Simulator software. In this study, a kit was developed to adjust the Basic Course Outline that had been compiled, covering practicum of parking door arrangement, traffic light arrangement, and precised light lamp simulation.

METHOD

This study was development research using 4D model which consisted of four stages namely define, design, development, and disseminate (Thiagarajan, 1974) (see Fig. 1).
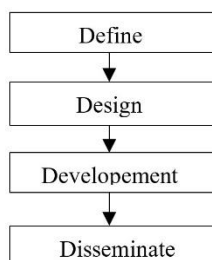

Figure 1. Stages of 4D Model (Thiagarajan et al, 1974)

However, this study only included the first three stages namely define, design, and develop. This was since this present study was only to find out the feasibility of the learning modules developed because the scope was still on a small or limited scale.

Define Stage

At this stage, the activity focused on the analysis of the situation faced by the teacher, the students' characteristics, and the concepts that will be taught. At this stage, this study specified the requirements for making module materials by analyzing the objectives and limitations of the learning materials. This stage consisted of five steps which ended with setting learning objectives, see Fig. 2.
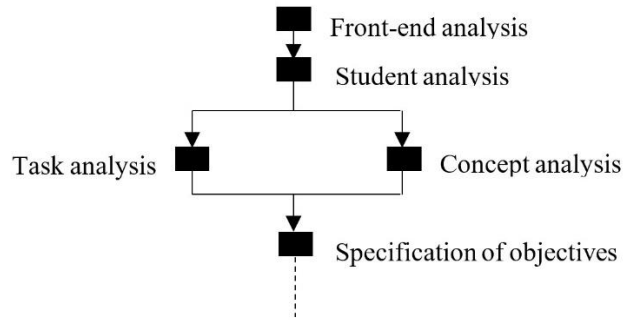
Figure 2. Define stages (Thiagarajan et al, 1974)

Front End Analysis

Front end analysis referred to learning about the teacher's main teaching problems to improve the quality of teacher performance in special learning. The initial analysis aimed to find out what was needed in preparing learning materials. The first step in the final analysis was to identify the underlying problems faced as the background of the study. Therefore, the researcher conducted this study to overcome the existing problems by developing training kit and module that fit the student needs. Based on the identification, further learning tool was developed according to the current RPS.

Student Analysis

Student analysis aimed to determine the initial behavior and students' characteristics. The results of the student analysis could be used as an illustration to prepare the learning module. At this stage, the researcher used the results of ability tests and observations to analyze students. Based on the results of the test, it was known that the most student did not understand PLC programming techniques properly. To overcome this problem, there was a need for training kit and learning module that were in accordance with the students' reasoning level so that they easily received learning material.

Task Analysis

Task analysis aimed to identify basic abilities to be mastered by students and analyze sufficient abilities and the sub-abilities. Task analysis also was to find out the general learning objectives outline of the knowledge and students' skills that would be learned.

Concept Analysis

Concept analysis aimed to identify the main concepts that would be taught and systematically arranged them in the order in which the concepts were presented to give details of relevant concepts. In this study, the material / concepts in the training kit and learning module used referred to the RPS of PLC Bachelor of Electrical Engineering Education study program at Universitas Negeri Surabaya.

Design Stage

The purpose of this stage was to design a training kit and learning module for PLC courses. Activities at this stage included four stages, which were drawn in Figure 3.
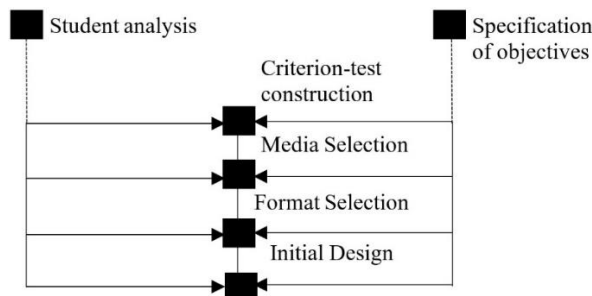

Figure 3. Design Stage (Thiagarajan et al, 1974)

Compilation of Benchmark Reference Assessment

Compilation of benchmark reference assessments referred to the indicators of learning attainment that had been described in the define stage. In this study, a form of competency test was prepared. Competency testing was stated in the module and carried out at the end of each discussion in learning activities as the application of concepts. The making of this competency test referred to the indicators of learning outcomes that had been formulated previously and adapted to the ongoing learning material.

Media Selection

In this study, the selection of media and learning resources is based on the final analysis, student analysis, and task analysis. Based on the problems faced by students, a training kit and learning module needed to be developed in PLC course. In this study, the media or tools used in teaching and learning activities encompassed laptops, LCDs, PLC training kits, and learning modules.

Selection of Learning Device Formats

Learning devices in this study covered RPS, Module, and PLC training kit. The RPS format referred to the Unesa Academic Script (Ibrahim et al, 2014), and Bilfaqih's review (Bilfaqih, n.d.). Moreover, the module format referred to the Unesa Academic Text (Ibrahim et al, 2014) and Nurseto's research (Tejo, 2011). Enke stated that increasing work-related competencies was important for the competitiveness of companies (Enke, Kraft, & Metternich, 2015). To build this competency, independent and controlled learning was undertaken. The core element of learning was a learning module with a different focus. To develop the competencies needed, the design of the right learning module was very important. The design of the training kit adjusted the RPS, which was for PLC programming practice to regulate traffic lights, to adjust the parking door bars, and to adjust the lights.

Initial Design of Learning Tools

The initial design was the design of learning modules created to involve the activities of students and teachers and adjust the allocation of time with the material. At this stage, the researcher composed a learning module in accordance with the planned format.

Development Stage

The development stage aimed to produce a revised learning module based on inputs from lecturers/experts which then validated the module so that it was suitable to be used for limited trials, see Figure 4.
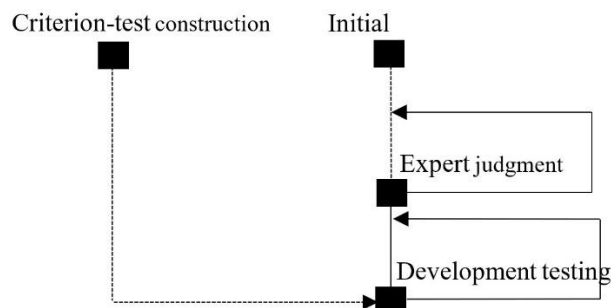

Figure 4. Development Stage (Thiagarajan et al, 1974)

Expert Judgment

Expert judgment was a technique in getting advice / input to revise learning devices. This advice could be obtained from competent experts so that the training kit and module were produced appropriately and effectively. The training kit and module were validated by three validators as material, design, and learning experts respectively. In addition to providing suggestions, experts assessed the learning tool according to the existing indicators. The validation results were then analyzed and revised according to the validator's suggestions.

Trials

Trials were conducted to obtain responses, reactions, and comments of the learning tools developed. In this stage, the results of observations were obtained from ten electrical engineering education students who were enrolled in the PLC course

Developed Product Specifications

The training kit was designed in a square shaped box measuring 55 cm x 55 cm x 10 cm and the components were neatly placed inside (see Fig. 5).
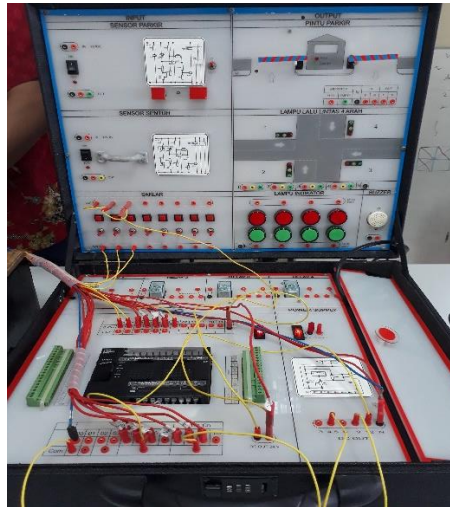

Figure 5. Design of PLC Training Kit Display

The whole design of the PLC training kit added a plate formed in such a way as to be the leg of the training kit so that it could stand upright, and the angle of view could also be adjusted according to the comfort to make students easier to do the practicum. This design referring to Kiangala (2019), Yilmaz & Katrancioglu (2011) dan Coskun & Işik (2009). Fig. 6 shows the results of the PLC training kit design for the fast bell application while Figure 7 shows a trial training kit for managing traffic lights.
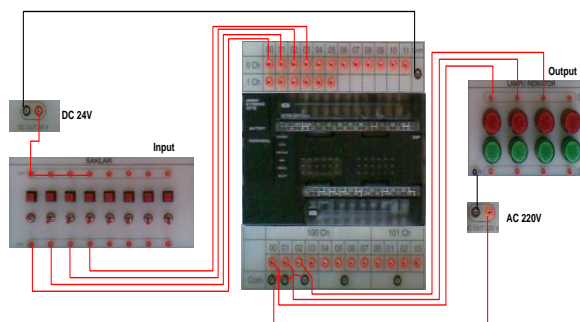

Figure 6. The results of the PLC training kit design for the fast bell application
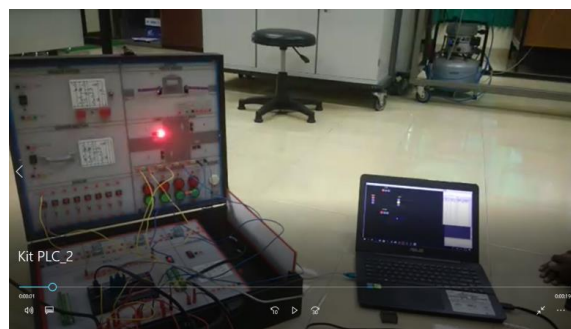

Figure 7. Testing of training kit of traffic control

RESULTS
Validity

Validation results were obtained through validation assessment by three validators from material, media, and language experts. From the results of the evaluation of the three validators, the rating results of each indicator/aspect that had been assessed and analyzed using a Likert scale (Schulze, Zoll, Schulze, & Zoll, 2015) were calculated (Acharya, 2010). The following is the description of the data presentation results from the validation of the training kit and PLC module.

Results of Validity Test of Training Kit Media

Indicators or aspects assessed by the validator on PLC training kit media included media suitability with the RPS, display and media quality, and media suitability with the module. To obtain a valid assessment on each indicator or aspect assessed, there were several items of assessment for each indicator. Table 1 depicts the following are the results of the evaluation of the validator training kit.

Table 1. Validation Results of training kit assessment

No.	Assessment Aspects	Rate					∑ Validator's Answers	Rating Results %
		1	2	3	4	5		
	Media Display and Quality							
1.	Suitability between the training kit box and the circuit				1	2	14	93.33
2.	Accuracy between the component placements with the material order				2	1	13	86.67
3	Training kit has an interesting design				2	1	13	86.67
	Total of Rating Results							**266.67**
	% Average = Total of Rating Results / Total Items							**88.89**
	Suitability between media and curriculum							
4.	Training kit can enhance the learning attainments.			1	1	1	12	80
5.	The development of training kit fulfills the required learning indicators.			1	2		11	73.33
6.	Suitability between *training kit* and the *module*				2	1	13	86.67
7.	Easy operation of the training kit				1	2	14	93.33
	Total of Rating Results							**333.33**
	% Average = Total of Rating Results / Total Item							**83.33**
	Suitability between media and module							
8.	Suitability between trainer and the job sheet materials			1	2		11	73.33
9.	Suitability between the practicum-with-trainer and the job sheet materials				1	2	14	93.33
	Total of Rating Results							**166.67**
	% Average = Total of Rating Results / Total Item							**83.33**

In accordance with Table 1, the validation results of the training kit in three aspects assessed namely the media display and quality show 88.9%, the suitability of the media with the curriculum of 83.33%, and the suitability of the media with the module by 83.33%. With the results of the acquisition of these three aspects, it could be seen that the overall results of the validation assessment of the training kit were:

$$\frac{\sum Rating\ Results}{Total\ Item} = \frac{(88.9\% + 83.33\% + 83.33\%)}{3} = 85.19\%$$

The results of the overall validation assessment of the training kit were 85.19%. In accordance with the assessment criteria using a Likert scale, the PLC training kit application at traffic lights, parking door bars, and light simulations showed very feasible and could be used as a learning medium in PLC course. Figure 8 shows the rating chart of the results of the validation of the training kit.
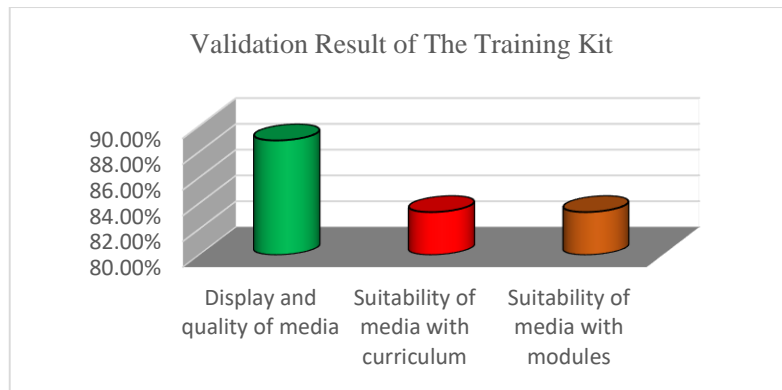
Figure 8. Graph of evaluation results of the training kit validation

Results of module validation

Indicators or aspects that were assessed by the module expert included the suitability of the module with the curriculum, display of module, and ease of understanding. To obtain a valid assessment on each indicator or aspect assessed, there were several items of assessment for each indicator. Table 2 conveys the results of the module validator assessment.

Table 2. Results of module validation

No.	Assessment Aspect	1	2	3	4	5	∑ Validator's Answer	Rating Results %
	Module display							
1.	*Cover module* has an interesting design			3			12	80
2.	Clear cover design reflects the contents of the module.		1	2			11	73.33
	Total of Rating Results							**153.33**
	% Average = Total of Rating Results / Total Item							**76.67**
	Illustration							
3.	The information is clearly read and understandable.		1	1	1		12	80.00
4.	The drawn object is proportional and clear.				1	2	14	93.33
	Total of Rating Results							**173.33**
	% Average = Total of Rating Results / Total Item							**86.67**
	Suitability between module and the media							
5.	The writing and language are easy to understand.		1	1	1		12	80.00
6.	The sketch of the circuit and the ladder are clear.				2	1	13	86.67
	Total of Rating Results							**166.67**
	% Average = Total of Rating Results / Total Item							**83.33**
	Suitability between module and the curriculum							
7.	Indicators of PLC course can be fulfilled through assignments stated in the module.				2	1	13	86.67
8.	The module contains appropriate materials to the learning objectives.				2	1	13	86.67
	Total of Rating results							**173.33**
	% Average = Total of Rating Results / Total Item							**86.67**

In connection with Table 2, the results of the validation of the modules in four aspects showed that module display got 76.67%, illustration of 86.67%, suitability of modules with media of 83.33%, and suitability of modules with curriculum of 86.67%. Figure 9 depicts that the graph of the evaluation of module validation results.
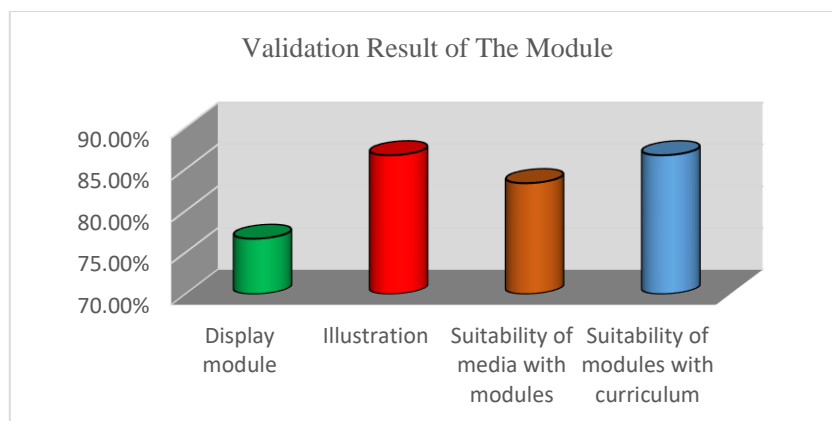
Figure 9. Graph evaluation of module validation results

With the results of obtaining these four aspects, it could be seen that the overall result of the module validation assessment was:

$$\frac{\sum Total\ of\ rating\ results}{Total\ Item} = \frac{(76.67\%+86.67\%+83.33\%+86.67\%)}{4} = 83.33\%$$

The overall result of the module validation assessment was 83.33%. In accordance with the assessment criteria using a Likert scale, the PLC module applications on traffic lights, parking door bar, and lamp simulation was categorized as very feasible and could be used as the learning media in PLC course.

Limited Trial

Limited trials were conducted on ten students of Unesa's electrical engineering education study program with different levels of academic ability. This trial was carried out outside the lesson hours which took place in the Unesa Electrical Engineering control system laboratory conducted in three stages. The first stage worked on traffic lights and the second stage worked on the parking door practicum. The last stage worked on the lamp practicum for the fast bell right. The following was the result of student's responses in using the training kit and PLC module application at the traffic light, parking door bar, and light for the fast bell right. Table 3 and Figure 10 show the results of student responses to the training kit.

Table 3. Results of student's responses on the developed training kit

No.	Aspects	Rating					∑ Students' Answers	Rating Results %
		1	2	3	4	5		
	The interest of the media design							
1.	The design of PLC *training kit* is good.			3	2	5	42	84
2.	The PLC t*raining kit* is interesting when being used in practicum.			1	5	4	43	86
	Total of Rating Results							170
	% Average = Total of Rating Results / Total Item							85
	The ease of understanding the media							
3.	The training kit is neat and understandable.			1	5	4	43	86
	Total of Rating Results							86
	% Average = Total of Rating Results / Total Item							86
	The ease of media operation							
4.	PLC *Training kit* is easy to use.			1	4	5	44	88
5.	The placement of *test point* is affordable.			3	4	3	40	80
	Total of Rating Results							168
	% Average = Total of Rating Results / Total Item							84

In regard to table 3, the result of student's responses on the training kit showed that the aspect of media attractiveness in terms of design got 85%, facilitation aspects in media understanding of 86%, and the ease of media operation of 84%.
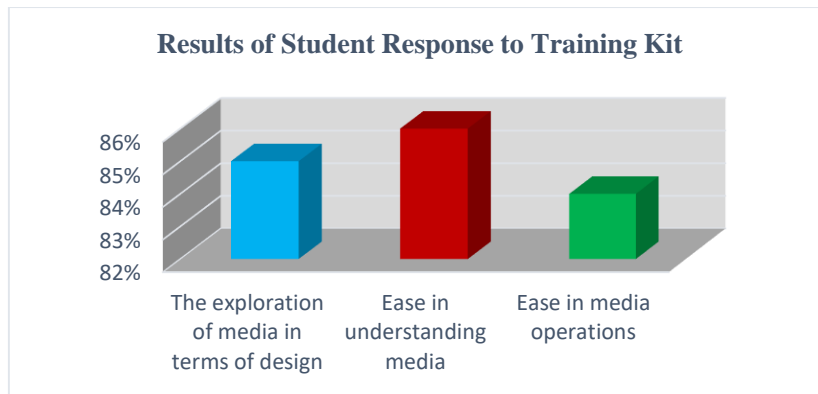
Figure 10. Graph of student's responses on the training kit

With the results of the acquisition of these three aspects, it could be seen the overall average result from the results of student responses to the training kit was:

$$\frac{\sum Total\ of\ rating\ results}{Total\ Item} = \frac{(85\%+86\%+84\%)}{3} = 85\%$$

The results of the overall student's responses on the training kit were 85%. In accordance with the assessment criteria using a Likert scale, the PLC training kit application at traffic lights, parking door bar, and lamp simulation was categorized as very practical and could be used as a learning media in PLC course. Table 4 and Figure 11 show the results of student's responses on the developed module.

Table 4. Results of student's responses on the developed module

No	Aspects	Rating					∑ Students' Answers	Rating Results %
		1	2	3	4	5		
	Appearance and placement							
1.	The cover design of the module is interesting.			2	5	3	41	82
2.	The cover picture and the title of the module reflect the contents of the module.			2	3	5	43	86
3.	The media display can help students enhance their knowledge.			2	3	5	43	86
4.	The neat of the writing used in the module			2	4	4	42	84
	Total of Rating Results							338
	% Average = Total of Rating results / Total Item							84.5
	Language							
5.	The language is easy to understand.			2	4	4	42	84
6.	The language level is suitable for the students.			4	3	3	39	78
7.	The language is in accordance with PUEBI.			3	3	4	41	82
	Total of Rating Results							244
	% Average = Total of Rating Results / Total Item							81.33
	Illustration							
8.	The information is readable.			3	4	3	40	80
9.	The drawn objects are proportional and effective.			2	5	3	41	82
10.	The pictures are clear.			3	4	3	40	80
	Total of Rating Results							**242**
	% Average = Total of Rating Results / Total Item							**80.67**

In connection with Table 4, the acquisition of student's responses on the module shows that the aspects of display and layout got 84.5%, language aspects of 81.33% and illustration aspects of 80.67%.
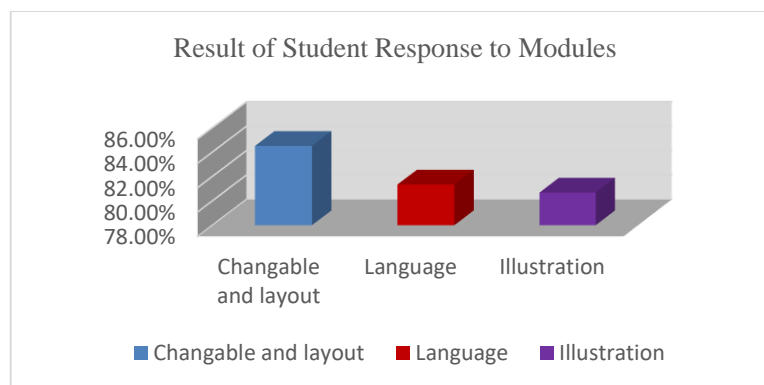
Result of Student Response to Modules

Figure 11. Graph of student's responses on the developed module

With the results of the acquisition of these three aspects, it could be seen the overall average result from the students' responses to the training kit was:

$$\frac{\sum Total\ of\ Rating\ Results}{Total\ Item} = \frac{(84.5\% + 81.33\% + 80.67\%)}{3} = 82.17\%$$

The results of the overall students' responses on the module were 82.17%. In accordance with the assessment criteria using a Likert scale, the PLC module applications at traffic lights, parking door bar, and lamp simulation was categorized as very practical and could be used as the learning media in PLC course.

DISCUSSION

This study only made training kit and module for PLC learning media for electrical engineering education students. From the results of the study, it was found that the training kit and PLC module were feasible to be used as learning media for PLC course at Universitas Negeri Surabaya. This study used four D models (Thiagarajan, 1974), but only up to the third D. An effective tess (Plomp, 1994) could be carried out, which had been reviewed from the learning outcomes test. Learning outcomes test was used to measure PLC programming skills through learning using media training kits and modules from the results of this study. The results of the study (Sahasrabudhe & Kanungo, 2014) showed that the relationship between media choice in e-learning programs and the effectiveness of the program was moderated by the domain of learning programs and learning styles of students, or by developing a computer-based assessment of the specific domain of problem-solving competencies. In modeling problem solving competencies, four components of competency are distinguished namely application of knowledge, metacognition, self-concept, and interest and thirteen aspects of competences, each assigned to one of four components (Rausch, Seifried, Wuttke, Kögler, & Brandt, 2016). Realistic problems with a focus on professional activities such as programming (constructive problem solving) and troubleshooting programmable logic controllers (analytical problem solving) were used to measure the specific domain of problem-solving competencies (Walker, Link, & Nickolaus, 2016).

CONCLUSION

This study concludes that (1) the result of the training kit validation is 85.18%, (2) the result of module validation is 83.33%, (3) the result of student's responses on the training kit was 85%, and (4) the result of student responses to the module amounted of 82.17%. So that, it can be determined that the training kit and PLC module are feasible to be used in PLC learning for students of Electrical Engineering Education, Universitas Negeri Surabaya.

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