Effectiveness of web-based interactive learning model
Programmable Logic Control (PLC)

Syahrul
Universitas Negeri Makasar

Abstract. This study aims to determine the impact of the implementation of interactive learning media Programmable Logic Control (PLC) on the process and student learning outcomes, in the Department of Electrical Engineering Education FT UNM. The subjects of this study were students of Programmable Logic Control (PLC) students and lecturers. The data were collected using test, observation and questionnaire techniques. Data analysis was done by qualitative descriptive technique. The results showed as follows. (1) Interactive learning media of web-based PLC courses qualify for effectiveness. This is seen from several aspects, namely the implementation of all student activities and lecturer activities, as well as positive responses of students exceed the minimum, motivation and student achievement in the PLC classified as high. (2) Interactive learning media of web-based PLC courses meet the requirements of practicality, where based on observations during learning activities are very dynamic learning activities, the interaction between lecturers and students and among students running very active. Therefore, this learning media can be used as one of the teaching media in the Department of Electrical Engineering Education FT UNM.

Keywords: web-based interactive learning, Programmable Logic Control (PLC)

1. Introduction
The development of educational media was initially only regarded as a teaching aid tool. The tools used visual aids, such as images, object models and others that can provide concrete experience, motivation to learn and enhance absorption and learning retention of students. However, because it is too focused on visual aids sometimes people become less concerned with aspects of design, development of learning, production and evaluation [1]. Programmable Logic Control (PLC), is a tool that is widely used in industry. The theory related to this tool is packaged into a curriculum in the Department of Electrical Engineering, which is packed in one course. The function of this tool is as a means of controlling driving machines. As a control device, it certainly has a systematic work process. The work process consists of input, process, and output[2]. Every work process has interactions between the components within the machine [3]. The interaction relationship of this tool can be designed to become an interactive learning. Many learning multimedia have been produced by implementing ICT-based teaching materials [4]. In general, the benefits that can be obtained from multimedia learning are more interesting and effective in learning processes, reduced teaching time and improved quality of student in learning. Teaching and learning processes can also be done anytime and anywhere, and at the same time student learning attitudes can be improved. The benefits above will be obtained by considering advantages of a multimedia learning, namely: (1) enlarging objects that are very small and invisible to the eye such as
bacteria, germs, electrons and the like, (2) minimizing very large objects that are not possible to keep in the school such as elephants, houses, and mountains, (3) presents objects or events that are complicated, complex and take place quickly or slowly, such as the human body system, the operation of a machine, the circulation of the planet Mars, and the development of flowers, (4) presenting objects or distant events, such as the moon, stars, and snow, (5) presenting dangerous objects and events such as volcanic eruptions, tigers, and poisons, (6) increasing the attractiveness and work of students [5].

According to Lestari drill and practice models (practice and exercise) are exercises that are used to hone skills or strengthen mastery of concepts[6]. On the other hand, the computer prepares a series of questions or similar ones found in a book or worksheet. Thus, innovation in learning activities of Programmable Logic Control (PLC) material is needed. Besides that, it can also minimize paper in practical activities. As students are required to practice a lot with practice, it can help students in improving their understanding of the material packaged in an interactive learning media, in this case the PLC course.

From limited observation, the results showed that practicum equipment supporting PLC courses at the laboratory of the Department of Electrical Engineering Education, Faculty of Engineering, Makassar State University, is still limited. With the limited equipment, it is necessary to represent equipment in the teaching and learning process in the classroom, as well as practicum in the laboratory. The control equipment that is widely used today is PLC. This is one of the reasons for the need for PLC learning innovation.

2. Method

This type of research is descriptive qualitative research. This research is conducted by implementing an interactive learning media applied to the Programmable Logic Control (PLC) course in the Electrical Engineering Department of UniversitasNegeri Makassar.

The research data collection techniques used in this study are as follows:

- observation, intended to make observations of learning activities.
- questionnaire, used to obtain data about the response of students and lecturers to the application of Web-based PLC interactive learning models.
- the test, is intended to measure the level of student mastery of the material learned in learning.
- documentation, to obtain all relevant data available at the Department of Electrical Engineering Education at UNM FT.

The data analysis technique in this study is Qualitative Descriptive by explaining the implementation of web-based interactive PLC models. The analysis is done by presenting the results of data collection by providing narratives to the research data, both collected through interviews, observations, and questionnaires.

3. Results

3.1. Description of simulation media with the web

The results of observations in the field show that the availability of practicum equipment in the laboratory of the Department of Electrical Engineering Education at the Faculty of Engineering, especially PLC equipment is still limited compared to the number of students who will take the PLC practicum. Based on the factual data, it is necessary to develop a WEB-based interactive learning media for PLC courses. Interactive learning media is built to represent the physical form and workings process of each component contained in the PLC. In addition to describe the physical form and function of each component in the PLC, it is also illustrated the physical shape and workings of the load which is controlled by the PLC.

PLC learning is made into a simulation using the Macromedia Flash 8. Web application is built as a facility so that the media can be accessed via the internet. Simulations that have been made can be updated on the web. A total of four simulations were built, namely simulating running a motor with the DOL system, simulating running the motor sequentially, simulating running the motor alternately,
and simulations running the motor sequentially automatically. The web is built consisting of five menus namely the introduction menu, PLC introduction menu, PLC component menu, logic instruction menu, and simulation menu. To facilitate the use of the web, a guidebook was created to explain the workings of the web that had been built.

3.2. PLC simulation

PLC simulations that have been made by using Macromedia Flash 8 applications will illustrate how PLC works. To connect between PLC and power circuit, a contactor coil symbol is created just below the PLC output terminal. A symbol is created to represent the contactor coil in a power circuit. Each equipment requires a flow of electric current both PLC and equipment in the power circuit i.e 3 phase induction motor. Electric current functions to support the performance of each equipment. The line is made to represent the conductor of the current to show the flow of current to each equipment.

![Figure 1. Images of omronCPM1A type, power circuits, and supplier flow lines](image)

In this circuit, a simulation of the process of the current trip is described. Starting from the 380 V AC current supply process followed by supplying current from MCB / NFB. To run a 3 phase induction motor can be carried out by pressing the start button. To stop motor operation can be done by pressing the stop button. Similarly, stopping power supply on the power display is done by pressing the MCB / NFB button, and disconnecting all current flow in the circuit by pressing the 380 V AC button.

![Figure 2. Supply current to PLC and power circuit](image)

3.3. Display simulation media with the web

The whole web presentation is divided into five main menus, namely home, introduction of PLCs, PLC trainers, logic instructions, and simulations. On the home menu, visitors are greeted by an animated welcome greeting and introduction to the full image. The introduction menu of the PLC presents the Learning Implementation Plan (RPP) followed by the detail explanation of PLC, representation of the advantages and advantages of using PLC. There are eight parts in the PLC trainer menu, three sub-sections in the work instructions section, and one evaluation sub-section. Eight parts on the menu are the trainer, CPU Components PLC CPM1 10/20 CDR, PLC status indicators, input indicators, input specifications, output specifications, installation of peripheral equipment, examples of cabling, and work instructions. Three sub-sections in the work instructions section are ladder diagram, input / output cabling, and PLC installation. The menu of logic instructions presents two topics,
namely discussion of logic AND instructions and logic OR instructions. In the presentation of logical AND instructions, it is complemented by an explanation of how to write the mnemonic code in order to complete the instructions presented earlier. The logical OR instruction presents the same explanation. There are four types of simulations in the simulation menu section. They include simulation of running a 3 phase induction motor with a DOL system, a 3 phase motor in sequence, a sequential motor alternately, and a 3 phase motor with star and delta circuits. Each menu ends with an evaluation to measure student competency after learning in each part of the discussion.

3.4. Effectiveness Analysis of Interactive Learning Media

3.4.1. Description of observations of student activities
The results of observations of student activities were obtained using observation sheets. Observations were made by two observers. Observations were made on 22 students with the consideration that the student represented all students. The procedure for observing students is done during the teaching and learning process taking place by filling out the observation sheet provided. Based on observational data, it shows (1) student activities in paying attention to the explanation of the lecturer getting a value of 2.5 with a percentage of 19.87%, (2) student activity in paying attention to material in the media with a value of 3 or 23.46 percent, (3) student activities in recording with grades 6 or 12.13%, (4) student activities in asking questions with a value of 5 or 9.63%, (5) student activities in operating the media with a value of 11 or 21.19% , (6) student activities outside of learning such as sleepiness, sleep, daydreaming, etc. with a value of 7 or 13.98%. Based on these data it can be concluded that in terms of student activities, the use of interactive media for learning PLC subjects can be categorized as effective. However, several categories of observations need to be used as considerations for revising the media used.

3.4.2. Description of observations of lecturer activities
The results of observations of lecturer activities were obtained using observation sheets. Observations were made by two observers. Observations were made on lecturers while conducting the learning process from opening to closing of the teaching and learning process in the classroom. The procedure for observing lecturers is carried out during the meeting by filling out the observation sheet provided.
Based on observational data shows (1) lecturer activity in delivering a brief description with a value of 3 or 11.66%, (2) lecturer activity conveys relevance with a value of 1.75 or 6.72%, (3) the activity of the lecturer conveys objectives with values 2.5 or 9.53%, (4) lecturer activities explain the material using web-based interactive learning models with a value of 4 or 15.54%, (5) lecturer activities provide examples or exercises by using web-based interactive learning models with a value of 2, 5 or 9.53%, (6) lecturer activity shows simulation with a value of 4 or 15.54%, (7) lecturer activities open discussion through web-based interactive learning models with a value of 2 or 7.51%, (8) activity the lecturer explains the material / gives an example without using the 1.5 or 5.75% web-based interactive learning model, (9) lecturer activity in guiding / directing students with a score of 2.5 or 9.53%, and (10) lecturer activities in feedback with a value of 2 or 7.51%.

3.4.3. Description of student learning achievements in PLC courses

Based on the results of the study, data were obtained about student achievement. It has a range of scores between 70.50 to 94.00. The results of the analysis obtained a mean of 83.03; median of 83.31; Mode of 85.38; and the standard deviation is 5.51. When compared with the minimum competency standard, it turns out that the average observation (83.03) can be categorized as high. The results of the analysis of student achievement in the PLC course can be presented in the table below.

| Statistic         | Results |
|-------------------|---------|
| Mean              | 83.03   |
| Standard Deviation| 5.51    |
| Variance          | 30.41   |
| Maximum           | 94.00   |
| Minimum           | 70.50   |
| Range             | 23.50   |

To find out the trends in the results of student learning achievements, it can be compared with the categories stated earlier, which are based on a range of scores from 0 to 100. For scores ≥ 85, it can be categorized as very high; scores of 70 to 84 are included in the high category; scores of 55 to 69 are in the low category; and a score smaller than 55 contribute as a very low category.

Based on the categories specified above, it can be seen that out of 22 respondents there were 8 people (36.40%) who had very high practice learning achievements, 14 people (63.60%) in the high category, and none of the respondents had learning achievement in the low or very low category. From these data, it can be seen that most students have PLC learning achievements in the high category.

The above facts show that most of students have high academic achievement in PLC courses, in the sense that student learning achievement exceeds the minimum standards of completeness of competencies that must be achieved by students.

Furthermore, the frequency distribution and histogram of student learning achievements can be presented as shown in the following table:

| No. | Interval score | Frequency | Absolute | Relative | Cumulative |
|-----|----------------|-----------|----------|----------|------------|
| 1   | ≥ 85(Very High)| 8         | 36.40    | 36.40    |            |
| 2   | 70 - 84(High)  | 14        | 63.60    | 100.00   |            |
| 3   | 55 - 69(Low)   | 0         | 0        | -        |            |
4. Discussion

In the education process, learning is something that must be taken by someone, which is directed to develop the potential of students to be able to achieve qualifications and master the competencies set. Along with the shifting of the learning paradigm, from teacher-centred to student-centred classroom activities not only has an impact on methods and learning activities, but also on the media and learning outcomes themselves [7]. In this study, efforts have been made to improve the quality of learning processes and outcomes by applying interactive learning media, especially in the PLC subject.

In terms of the quality of learning outcomes, based on this study it was revealed that after the use of this learning media, students showed high learning achievement compared to the previous student's learning achievement who did not use any learning media (interactive media).

In terms of the quality of the learning process, based on this study it was revealed that with the application of interactive media, students showed great motivation to learn and build positive learning attitudes. Students are increasingly active and creative in learning / discussion activities after getting feedback from peers and lecturers. Cooperation between students in groups is increasingly well organized. They can understand their respective tasks without having to be governed, so that in terms of products, the results and quality of completion of tasks are very satisfying. The indicator is that some discussion groups can complete the given task beyond the given target with accurate results.

Based on the observations of researchers during the intervention of interactive learning media in the PLC course, the use of this media provides various benefits. As stated by Liu that the use of interactive media has a very positive influence on the learning process [8]. Increasing student involvement in the learning process can increase the occurrence of social interactions and mutual trust between one student and others, and also interactions between students and lecturers. Students can focus more on the process. In addition, it can also foster a sense of confidence in students because they are given the trust to be involved in the learning / discussion process. Students can realize their strengths and weaknesses as a result of the feedback received. As stated by Leow and Neo that interactive learning media is effective feedback during the learning process [9]. The application of interactive media can also encourage and train students to be honest and fair, because they are required to be honest and objective in conducting learning activities.

Based on the description above, it can be concluded that the use of interactive media in learning, especially in PLC courses, can improve the quality of learning processes and outcomes. The application of this media can also increase student learning motivation during learning. Likewise, that the time spent in learning is quite efficient. Therefore it was concluded that the application of interactive media in learning PLC courses in the Department of Electrical Engineering Education could be categorized as effective.

5. Conclusion

Based on the results of research and development it can be concluded as follows: 1) Interactive learning media web-based PLC courses meet the requirements of effectiveness. This can be seen from several aspects that the implementation of all student activities and lecturer activities, as well as the positive response of students exceeding the minimum. Motivation and student learning achievements are classified as high in the PLC course; 2) Interactive learning media Web-based PLC courses meet practicality requirements, where based on observations during learning the teaching and learning activities are very dynamic. The interaction between lecturers and students and between students goes well. Therefore this learning media can be used as one of the teaching media in the Department of Electrical Engineering Education at UNM FT

6. References

[1] Arkorful V and Abaidoo N 2015 The role of e-learning, advantages and disadvantages of its
adoption in higher education *Int. J. Instr. Technol. Distance Learn.* **12** 29–42

[2] Fathahillah F and Hardianto H 2017 Purwarupa Sistem Kontrol Elevator Berbasis Programable Logic Control *Setrum Sist. Kendali-Tenaga-Elektronika-Telekomunikasi-Komputer* **6** 142–9

[3] Alphonsus E R and Abdullah M O 2016 A review on the applications of programmable logic controllers (PLCs) *Renew. Sustain. Energy Rev.* **60** 1185–205

[4] Beetham H and Sharpe R 2013 *Rethinking pedagogy for a digital age: Designing for 21st century learning* (routledge)

[5] Mantiri F 2014 Multimedia and Technology in Learning. *Univers. J. Educ. Res.* **2** 589–92

[6] Lestari A . 2015 Application of Computer Based Learning Model Tutorial as Medium of Learning *Am. J. Educ. Res.* **3** 702–6

[7] Wright G B 2011 Student-centered learning in higher education. *Int. J. Teach. Learn. High. Educ.* **23** 92–7

[8] Liu Y 2010 Social media tools as a learning resource *J. Educ. Technol. Dev. Exch.* **3** 8

[9] Leow F-T and Neo M 2014 Interactive multimedia learning: Innovating classroom education in a Malaysian university. *Turkish Online J. Educ. Technol.* **13** 99–110