Implementation of The Festo PLC Module to Increase Student Learning Outcomes at Mechatronics Courses

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ABSTRACT
Technological developments in various production processes in the industrial world are progressing rapidly, of course this will have consequences, that the workforce operating plants in the industry must meet adequate qualifications so that production runs optimally. This will be a challenge for educational/training agencies or institutions to always develop their learning patterns so that their students can be accepted according to the qualifications of the industrial world. Student learning outcomes are influenced by many factors, one of which is the use of learning media in accordance with the learning objectives to be achieved. The research objective is to apply the Festo PLC module to improve student learning outcomes on the subject of the operation of the Programmable Logic Controller (PLC) Mechatronics Courses at Mechanical Engineering Department, Faculty of Engineering, Universitas Negeri Surabaya. The research method uses classroom action research which is analyzed descriptively quantitatively. Based on the results that have been achieved, the conclusions in this research are (1) student learning outcomes have achieved individual completeness is 95% while classical completeness is 100%; (2) students show a positive response to learning activities by expressing interest, pleasure, and motivation to attend lectures using the Festo PLC module because it is easy to understand.

Keywords: *PLC Festo, Learning Outcomes, Students Response, Mechatronics.*

1. INTRODUCTION

The technological development of various production processes in the industrial world has progressed rapidly, of course, this will have consequences, that the workforce that operates *plants* in industry must meet adequate qualifications so that production runs optimally[1]. This will be a challenge for institutions or educational / training institutions to always develop their learning patterns so that their students can be accepted in accordance with the qualifications of the industrial world. Many advanced companies have implemented automatic control systems to support their production processes. Because this system has many advantages, namely the way it works is simple, easy to operate, easy to maintain, and efficient in

Referring to the development of industrial process technology, the Universitas Negeri Surabaya (UNESA) Mechanical Engineering department, especially in the Mechatronics course, the subject of PLC requires learning facilities and infrastructure in order to meet the demands of the industrial world. The form of efforts that Universitas Negeri Surabaya (UNESA) has implemented is the cooperation with IsDB (Islamic Development Bank) which is a multilateral financial institution established in 1975 by the organization of Islamic conferences. One of the learning support equipment received is in the form of various Programmable Logic Controller (PLC) trainers' products from PT. Festo.

The main problem is that Festo PLC trainers have not been used optimal in supporting learning. This is because there is no learning tool in the form of a module as a guide for lecturers and students in operating the Festo PLC trainer. To answer these problems, in this study will be developed learning tools in the form of Festo PLC modules to support Mechatronics lectures at the Department of Mechanical Engineering FT Unesa. It is expected that the results of this research will be able to bridge the competence of PLC control material owned by students with the demands of the needs of the rapidly growing industrial world, especially from graduates majoring in Mechanical Engineering Universitas Negeri Surabaya (UNESA) who will later work as professionals in industry.

The use of learning tools plays an important role in the process of changing behavior through activities in actual situations. For example, in order for students to

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operate a computer, the teacher must provide a computer; In order for students to be skilled in operating lathes, teachers must provide lathes, and so on [2, 3]. Such hands-on experience is certainly a very rewarding learning process because the possibility of misperception will be avoided. However, in reality not all study materials can be presented directly. For example, to learn how the process of smelting steel in a high kitchen is possible, it is impossible for the teacher to make a tall kitchen in the classroom; To learn how living things live on the seabed, it is impossible for teachers to guide students directly to the bottom of the sea and so on. To provide such a learning experience, teachers need learning tools such as films or photographs and so on [4].

To understand the role of learning tools in the process of obtaining learning experiences for students, Edgar Dale described them in a *cone of* experience that is now widely adopted to determine what devices are appropriate for students to have a learning experience easily [5]. Based on the cone of experience put forward by Edgar Dale, it can be said that knowledge can be obtained through direct experience and indirect experience. The more direct the object studied, the more concrete the knowledge gained; Vice versa, the more indirect the knowledge is obtained, the more abstract the knowledge obtained by the student [6].

Module as a learning tool or means that contains material, methods, limitations, and evaluates that are designed systematically and interestingly to achieve the expected competencies in accordance with their complexity [4]. In addition, the module can be formulated as: a complete unit that stands alone and consists of a series of learning activities that are structured to help students achieve a number of objectives that are specifically formulated and clearly [7].

The use of Modules is beneficial in the following cases: (1) Increase the effectiveness of learning without having to go through face-to-face regularly due to conditions and situations in the surrounding environment; (2) Determine and determine learning time that is more appropriate to learning needs and development; (3) Strictly recognize the achievement of learning competencies gradually through the criteria set out in the module; (4) Knowing the weaknesses or competencies that have not been achieved by learners based on the criteria set out in the module so that tutors can decide and assist learners to improve their learning and remediate [2].

As one of the teaching materials, the module has the following functions: (1) Independent teaching materials, meaning that the module functions to improve the ability of students to learn on their own without depending on the presence of educators; (2) Substitute for the function of educators, meaning modules as teaching materials that are able to explain learning material well and are easily understood by students according to their level of knowledge and age; (3) As an evaluation, it means that with the module students are required to be able to measure and assess their own level of mastery of the material that has been learned [6], [17], [18].

Assessment of the feasibility level of learning modules includes aspects of material, media and assessment of students as users [5,19-21]. The evaluation results of the material expert component get the "very feasible" category with an average score of 3.23 from the maximum score value of 4, then the average total score of the media expert evaluation results is 3.12 from the maximum score value of 4 so that it is included in the "very feasible" category, the total score of the initial field trial results is 3.39 from the maximum score value of 4 so that it is included in the "very feasible" category, Then the total score from the results of operational field trials is 3.29 from a maximum score of 4 so that it is included in the "Very Decent" category.

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Referring to some of the results of the research above, the author will conduct research on the application of the Festo PLC module to improve student learning outcomes in Mechatronics lectures, the subject of PLC in the Department of Mechanical Engineering FT Universitas Negeri Surabaya (UNESA).

2. METHODS

This research is classroom action research (CAR) that aims to improve student learning outcomes through the application of the Festo PLC module. The subjects of this study were students of the S1 Mechanical Engineering Education Study Program 20 20 Surabaya State University who at the time this research was conducted were programming 30 Mechatronics courses. To collect the necessary data in this study using observation techniques, questionnaires and performance tests in the form of job sheets. Research instruments in the form of observation sheets, questionnaire sheets and performance appraisal sheets.

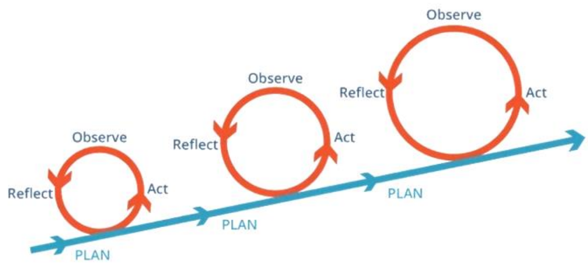

Figure 1. Cycle in Classroom Action Research [7].

The data needed in this study are the results of skill tests which to find out learning outcomes an instrument is needed to assess the results of the skill test. To analyze student learning outcomes in the Mechatronics course, a quantitative descriptive analysis is carried out with indicators of student success said to be complete learning if they get a score of ≥ 75. Classical completeness is said to be achieved if all students in the class complete learning as much as 80%.

3. RESULTS AND DISCUSSIONS

Cycle I

a. Planning

Based on initial observations before starting the study, a problem in Mechatronics learning was obtained, namely low student learning outcomes. One of them is because PLC material is difficult to understand because there is no learning module. At this stage, a first cycle learning plan, teaching modules and formative test sheets have been prepared that will support the implementation of learning using a direct learning model.

b. Action

In accordance with the plan that has been made, learning activities are carried out with a direct learning model using modules. However, before the implementation of learning, a pretest is first given to determine the initial achievement of students. After giving the pretest, the lecturer carries out actions in accordance with the learning plan that has been prepared. During learning activities, observations and mentoring are carried out to students in learning using the module books that have been provided.

The actions carried out at this stage in more detail are: a) The lecturer asks students to sit according to the attendance number. b) The lecturer explains to the students that from that day the implementation of learning will be carried out differently from the usual learning, namely by using module learning and the lecturer distributes module books that will be used in learning. c) Lecturers present and demonstrate the operation of PLC Festo to students. d) After finishing presenting and demonstrating the material for approximately 20 minutes, the lecturer gives time for students to read and study the material in the module book being delivered and do formative test questions that are already available in the module book. e) The lecturer goes around the classroom to observe the students and occasionally asks the students if there are any difficulties in understanding the material contained in the module book. f) After students finish studying the material in the module book, the lecturer asks questions to students about the material they have learned. g) Lecturers provide opportunities for students to discuss and ask questions about the material being studied, if there are students who have difficulty in understanding the material in the module, the teacher provides opportunities for students who understand better to explain.

c. Observation

The results of cycle I observations are recorded in the prepared observation sheet. Observations in cycle I obtained the following results. 1) Student activeness observation sheet. The actions taken at the observation stage are as follows. a) The observer observes the course of learning. In this observation, a previously prepared observation sheet is used. Observation sheets are used to record the behavior patterns of subjects in one cycle. b) The task of the observer is to observe the course of the teaching and learning process as a whole. Observation sheets are used to record the activities of lecturers and students. c) From observations of students, the following findings were obtained: (1) The classroom atmosphere was less controlled at the beginning of learning. (2) There are still many students who chat alone when lecturers give students the opportunity to read and study modules on their own. (3) The courage of students to answer questions and ask questions has not grown, because students still feel afraid of being wrong. Based on observations, an average score of 60% was obtained. If confirmed with the range of activeness score criteria, student activeness can be categorized as low. Thus, it can be said that in the implementation of Cycle I, the majority of students have relatively low activity.

In the first cycle of learning using the module learning model, the average score of students reached 64.5 with a percentage of classical completeness of 40%.

d. Reflection

After observing the learning actions in the classroom, then a reflection was held on all activities that had been carried out in cycle I. In cycle I activities, the following reflection results were obtained. 1) Based on the test result data on the cycle, classical completeness has not been achieved. The completeness of learning obtained in the first cycle was 40% with an average score of 64.5. This is not as expected because the expected results are at least classical completeness expected ≥ 80%, with student scores above KKM, which is 75. 2) During learning, students' ability to learn such as asking, explaining, expressing ideas directly or in writing is still classified as moderate in cycle I.

Based on the data obtained in cycle I which still does not meet the established success indicators, then henceforth it is necessary to give cycle II. Actions that need to be improved by lecturers in cycle II based on the results of observations in cycle I are to motivate students more so that students are more active in the learning process, such as asking or answering questions.

Cycle II

a. Planning

Based on the results of reflection on cycle I, the planning prepared for cycle II is carried out by taking into account the following. 1) Lecturers must always motivate students to be active in group learning. 2) The lecturer also emphasized that students are more courageous to express opinions or ask questions, 3) To increase cooperation between members, at the next meeting students are given problems that allow students to carry out activities such as discussing with friends and asking questions directly to the lecturer. In the planning of the second cycle, formative test sheets, learning evaluation test questions, and observation sheets of lecturer and student activities are also prepared.

b. Action

The implementation of learning in cycle II to correct deficiencies or problems faced in cycle I. In cycle 2 learning activities are still carried out with a module learning model. The steps taken at this meeting are still the same as the steps carried out in Cycle I, only this meeting is carried out with different material. Because the material to be studied is quite a lot, the lecturer reminds students to make the best use of their time.

The lecturer gives time for students to do the questions on formative test sheet 2, then discusses the answers from formative test 2 together with students. Cycle 2 ends and students are again given an evaluation test II to see the student's ability. The lecturer instructs students to divide the class into 2 groups during evaluation test 2, some students do evaluation question 2 while others wait outside until the specified time.

The lecturer distributes questions and answer sheets by calling the students' names one by one. After receiving the question and the width of the answer, the students work on the question calmly. The lecturer surrounds the students who are working on the questions to ensure that the students do not cheat on each other. After the students finish doing the evaluation questions, the lecturer instructs the students to collect answer sheets. The results of this test will then be processed to see the completeness of student learning on the material provided.

c. Observation

At the observation stage, steps were again carried out as the steps that had been carried out in Cycle I. Based on observations in the entire Cycle II, an average score of observation results of 80.5% was obtained. If confirmed with the range of activeness score criteria, student activeness can be categorized as high. Thus, it can be said that in the implementation of Cycle II, the majority of students have high activity [9]. It also shows that the majority of group members have been active in the learning process.

In the second cycle in Mechatronics learning using modules obtained an average student score of 82.5 with a percentage of classical completeness of 83.3%.

d. Reflection

In cycle II activities, the following reflection results were obtained. 1) The completeness of learning obtained in the second cycle was 83.3% with an average score of 82.5. This shows a change for the better and has been as expected because the expected results have reached the expected classical completeness, which is ≥ 80%. 2) During learning, students' abilities in learning such as asking, explaining, expressing ideas have made significant progress. Almost all groups of students are actively involved in the high category in all activities in cycle II. Overall, it can be interpreted that the majority of students already have activeness that is in the high category. 3) Broadly speaking, the implementation of cycle II went well. This can be seen from the end of cycle II which was able to complete the learning achievement of 25 students (83.3%).

Based on the implementation of actions for 2 cycles that have been carried out, data is obtained that student learning outcomes have improved. The improvement of learning outcomes is known by applying the Festo PLC module which can be seen in the following table.

Table 1. Student learning outcomes data.

Description	Value	
	Cycle I	Cycle II
Average rating	64.5	82.5
Students complete	12	25
Unfinished students	18	5
Classical completion	40%	83.3%

Based on research that has been carried out, it is known that student learning outcomes in Mechatronics learning through the application of the Festo PLC module have increased. The average score of students increased from cycle I of 64.5 to 82.5 in cycle II. Based on these data, it is known that students who have passed the MCC (Minimum Completeness Criteria) in the first cycle are 12 students from the entire number of students with a percentage of 40%. In the second cycle there was an increase of 83.3% consisting of 25 students who had passed KKM. The achievement of classical learning outcomes in cycle II has reached success indicators because students experience classical learning completeness ≥ 80%.

In addition to improving learning outcomes, the application of the Festo PLC module received a positive response from students. As many as more than 90% of students are motivated to participate in learning because PLC material becomes easier to understand.

The application of the Festo PLC teaching module in the Mechatronics course makes learning more meaningful, fun, and raises student activity because the modules are arranged using easy-to-understand language equipped with practice questions and applicable job sheets that are easily found in the industrial world and everyday life. This encourages students to play an active role in finding answers to problems through the process of thinking and discussion. The application of modules in learning can overcome the limitations of time, space, and sensory power so that it is possible for students to measure or evaluate their own learning outcomes. In addition, students are more active learning because teachers can act as mentors, not just as teachers.

Module learning is learning that demands the independence of students in learning because with modules students will be able to take the initiative to open and read material in order to have an initial understanding before the lecturer provides learning. With the exercises contained in the module, students will have creativity in solving latikan problems. With the answer key given, students can assess for themselves the results of the exercises that have been done in learning so that students can independently complete the module in a time that suits their mastery abilities.

When students finish doing all activity sheets and worksheets, students are only allowed to take tests if they have really mastered the module material and then give tests when students have finished completing activity sheets and worksheets quantitatively and qualitatively [11]. By the time students have completed the test sheet, students who have reached the teacher's score of 75 immediately assign enrichment tasks or give new modules as a follow-up. For students who have not reached a score of 75, the teacher must identify what the student's mistakes are and then give special guidance to the student [13], [14], [15], [16]. From the description and data mentioned above, it can be said that with the use of learning modules, students are trained to read and understand the material independently and become more active in the learning process. The description above shows that the use of the Festo PLC module in the Mechatronics course can improve student learning outcomes by at least 80% of students obtaining a score of ≥ 75 [22]-[26].

4. CONCLUSION

The implementation of the Festo PLC module in the mechatronics course can increase 30% of the average value of learning outcomes from cycle I (64.5) to cycle II (82.5) and increase 100% classical completeness from cycle I (40%) to cycle II (83.3%). Thus, it can be said that the limit of the minimum completeness criteria has classically been reached so that the implementation of the Festo PLC module is declared capable of improving student learning outcomes in the Mechatronics course. In addition, students show a positive response to learning activities by using modules that are seen in increasing student learning motivation with an activity score from 60% to 80% because it is easy to understand.

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