Evaluation of Programmable Logic Controller Training Implementation Using Kirkpatrick (4 Levels)

Nurulita Imansari [1], Umi Kholifah [1], Akbar Mukti Sasono [1]

[1] *Universitas PGRI Madiun, Madiun, Indonesia*

Abstract – **This study aims to evaluate the implementation of the Programmable Logic Controller (PLC) training conducted by HMPS Comet. Evaluation is carried out using the Kirkpatrick method which consists of 4 levels, namely: level 1 reaction, level 2 learning, level 3 behavior, and level 4 results. Levels 1 and 2 are carried out when the activity takes place, level 3 is carried out after the implementation of the training, namely during class learning activities, and level 4 is carried out about the value of learning outcomes. The instrument used to evaluate levels 1-3 is a questionnaire with a scale of 1-5, while the instrument for evaluating at level 4 uses a test, namely the posttest. The results obtained from the evaluation that has been carried out at level 1, level and level 3 show good results. The results at level 4 indicate that students participating in the training have improved their learning outcomes.**

Keywords – **evaluation, 4 levels, Kirkpatrick, training, PLC.**

1. Introduction

In this era of digitalization, students are required not only to have academic quality but also need to have an expertise or skill that is mastered [1].

This is certainly very relevant to the demands of the world of work today.Students of the Electrical Engineering Education study program as prospective vocational teachers in Indonesia, and of course, they have to have additional skills to be able to answer the needs of the world of work.

This is in line with research conducted by Ismail [2] which states that a vocational teacher has to have social, knowledge, and pedagogical competence. Following current needs, it is ensured that the skills, knowledge, and attitudes of TVET teachers have to be in harmony with changes in technology, the needs of the world of work, as well as advances in equipment and machinery. Based on this, skill is very important because it is very necessary and will be the spearhead in competition in the global world of work. The way to improve and process skills requires a training or course that can develop the expertise they have [3].

Training is a program that provides insight and knowledge for anyone who needs skills and insight to complement and increase their skill level [4]. In addition, training can be interpreted as a short-term educational process using systematic and organized procedures so that participants can learn working technical knowledge and expertise for a particular purpose. Training is a process in which people learn to acquire certain skills/abilities to help achieve organizational goals, and training is a short-term educational process using systematic procedures to improve employee behavior in one direction to increase the achievement of organizational goals [5].

One of the relevant and important training activities to be carried out is PLC Training. PLC is one of the mandatory skills that have to be possessed by Electrical Engineering Education students. PLC is currently often used in the field of industrial automation, especially in the monitoring and control of the machine. PLC has inputs and outputs that can be connected to sensors, relays, contactors, and others [6].

But professionally defined, according to NEMA (National Electrical Manufacturers Association USA), the definition of PLC is a digital electronic device that uses programmable memory to store instructions and to carry out special functions such as logic, sequence, timing, calculation, and arithmetic operations to control machines and processes. In an automation system, the PLC is the heart of the control system [7].

Given the importance of PLC in current technological developments, PLC training has to be carried out to equip students with these skills. HMPS Comet as a student organization has carried out PLC training. To measure the level of success of the program that has been implemented, it is necessary to do an evaluation. According to [8] evaluation is defined as a systematic process with the goals to be achieved, evaluation always includes the value of the decision implied in the goal, in other words, the end of an evaluation is a decision about the existence of an activity or program. In line with this opinion, Lutfiah [9] states that evaluation is also a process of describing, collecting, and presenting information and data from the programs being implemented. Such information and data are useful in determining direction and establishing decision alternatives. The intended decision is to determine whether the program is following the stated program objectives. One evaluation model that is suitable for evaluating a training activity is the Kirkpatrick evaluation model.

The evaluation model developed by Kirkpatrick is known as the Kirkpatrick Four Levels Evaluation Model. This evaluation is carried out on the effectiveness of the training program (training). Kirkpatrick's evaluation model includes four levels of evaluation, namely: level 1 reaction, level 2 learning, level 3 behavior, and level 4 result [10].

2. Method

This study uses the Kirkpatrick evaluation model which consists of four evaluation levels, namely: level 1 reaction, level 2 learning, level 3 behavior, and level 4 result [11], [12]. The research subjects in this study were students of the electrical engineering education study program who attended PLC training consisting of 32 students. The instruments used in the research were questionnaires and tests. The questionnaire was used at levels 1 to 3. The questionnaire used a Likert scale of 1-5 which consisted of 5 answer choices, namely very not good, not good, good enough, good, and very good. Level 1-2 evaluation is carried out during PLC training, level 3 evaluation is carried out when students attend lectures, and level 4 evaluation is carried out at the end of lecture activities, namely during the semester final exams.

The analysis used to analyze level 1-3 evaluation data uses the following categories [13]. This category can be seen in the Table 1 below:

Table 1. Validation Category

Coefficient	Category
$1 \leq Va < 2$	Very Not good
$2 \leq Va < 3$	Not good
$3 \leq Va < 4$	Good enough
$4 \leq Va < 5$	Good
$Va = 5$	Very good

Note: Va is the value for determining the level of validity.

At level 4, two tests were carried out, namely the pretest and posttest; this was intended to see an increase in scores before and after participating in training activities. To analyze this increase is done by using the N-Gain analysis.

Analysis of improving learning outcomes using N-Gain which can show differences in student learning result before and after being given PLC training. The normalized score gain indicates the level of effectiveness of the PLC training rather than the score or posttest gain. N-Gain formulated [14]:

$$N - Gain = \frac{T_{Post} - T_{Pre}}{T_{maks} - T_{Pre}}$$

Information: :
N-Gain = Gain index
Tpost = Score after treatment
Tpre = Obtained score before treatment

With the scoring criteria can be seen in Table 2 below.

Table 2. N-Gains . scoring criteria

No	N-Gain category gain	Information
1	0.70 > N-Gain	tall
2	0.30 N-Gains 0.70	currently
3	N-Gains < 0.30	Low

3. Result and Discussion

Based on the results of the analysis, the average value is obtained as shown in Table 3 and Figure 1 below:

Table 3. Average evaluation results at each level

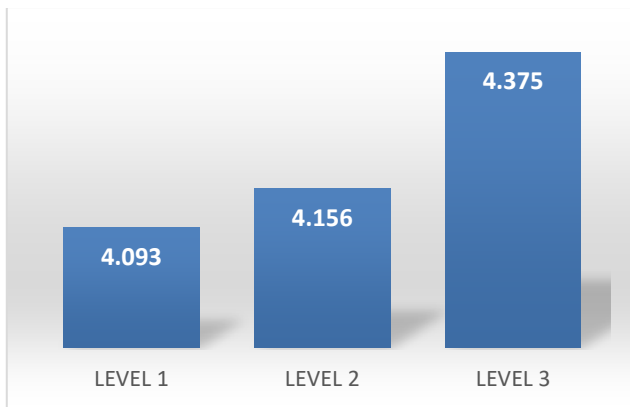| Levels	Score	Interpretation
Level 1	4,093	Good
Level 2	4.156	Good
Level 3	4,375	Good

Figure 1. Average evaluation results at each level

• Level 1 – Reactions

Evaluation level 1 is the first step taken to analyze the reactions of content creator participants to measure participant satisfaction. The reaction stage is essentially an evaluation of the satisfaction felt by the trainees with all the activities they take part in [9]. Level 1 evaluation activities are a crucial component in an education and training activity because people will learn better when they react positively to the learning environment. Explained in more detail which states that at level 1 this is an evaluation of participants' reactions to the implementation of the training [15]. Participants provide an assessment of the quality of the training. This measurement/assessment is directed at seeing the level of participant satisfaction (customer satisfaction) with training, namely how participants assess whether a training program is of good quality and meets the satisfaction of these participants. A training program is considered effective if participants find the training program fun and satisfying for them, and in the end, they feel interested and motivated to learn. The success of organizing training activities is strongly influenced by the interest, attention, and motivation of the trainees in participating in the course of the activity; and people will learn better when they give a positive reaction to the learning environment [16]. Level 1 evaluation is very important because if the trainees feel dissatisfied, they will make very little effort to learn and apply the material obtained when the training will be applied to their field of work.

The average evaluation value at level 1 was 4,093 and entered the good category. This can be interpreted that the training participants have satisfaction with the implementation of the training. In addition, the training participants also felt interested in participating in the training, and the training participants were also motivated to take part in a series of training activities.

• Level 2 – Learning

Level 2 evaluation emphasizes the instructional achievements obtained by participants after participating in training activities. In organizing training, there are generally three aspects that are taught, namely knowledge, attitudes, and skills [5]. The existence of student evaluations can provide opportunities for students to express what they feel, for example in learning the educator gives material or explains the material too quickly so that students do not understand and are confused. Educators have to be communicative so that they can find out what are the obstacles to students not being able to or not understanding the material. It is a way for students and teachers to share and ask questions and answers with each student.

Students participating in the training are considered successful in participating in this PLC training activity if there is a change in knowledge, skills, and attitudes towards the expected direction following the instructions and objectives of the training. The training objectives measured include theoretical insights, practices related to skills, and changes in attitudes, especially work attitudes. Based on the evaluation results obtained an average value of 4,156 and entered the good category.

• Level 3 – Behavior

Level 3 evaluation of training results is an evaluation to see if there is a change in behavior after a person has received training [17]. Behavior in students can be seen from the responses or actions in learning, namely by looking at the results of the assignments that have been given and the evaluation of the material that has been carried out. From there it can be seen how to complete assignments and students' understanding of the extent to which students can explore these skills. With the evaluation of the behavior of students, educators can understand all situations, conditions and assess the attitudes of students. This behavior change is assessed when students have finished training at HMPS Comet and return to lectures. The behavior that is evaluated in this case is the behavior of students while taking the Industrial Automation course. During the practicum, students are assessed on the use of tools, problem-solving abilities, and implementation of training materials in practicum activities. The existence of responses to students can be seen from the results of educators designing effective and conducive learning. If the participants have active behavior, it can improve the quality of students' trust and the quality of learning designed by educators.

In educators seen from how to convey learning material whether it is effective for students and the methods used in learning are in accordance with students. Students can be seen from several aspects, namely from the way of learning and being active at each meeting. Based on the evaluation results, the average value for level 3 evaluation was 4,375 and was in a good category.

• Level 4 – Results

Based on the results of the analysis, the N-Gain values were obtained from the pretest and posttest as shown in Figure 2.
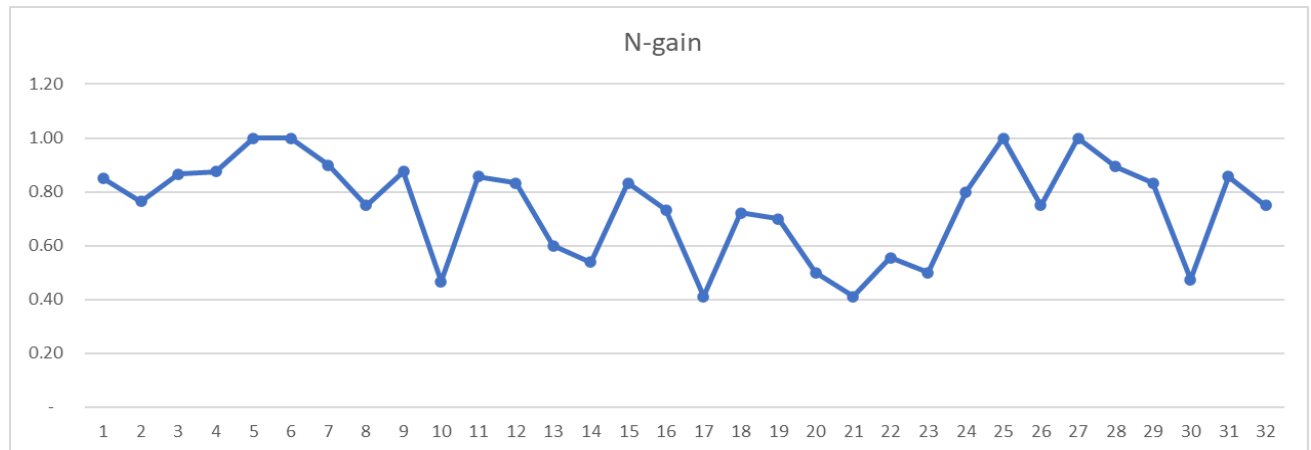

Figure 2. N-gain Graph

Evaluation at level 4 focuses on achieving the final results that occur, namely the impact of the PLC training attended by students on their learning outcomes. Students after participating in delivery course program activities can improve the quality of students. Courses given by students can increase delivery skills and increase students' insights in broadening knowledge. This evaluation is obtained from the results of the pretest and posttest, where what is measured is the increase. Based on the data above, the average N-gain value is 0.75 and is in the high category. The high increase can be explained as follows: 1) training activities are considered more interesting thereby increasing student motivation to learn, this can be seen from the high score at level 1; 2) the training model implemented also carries the concept of student-centered learning, this will certainly increase students' learning motivation to learn and this will certainly have an impact on their learning outcomes.

Based on the evaluation results, it can be recommended that the PLC training held by HMPS Comet is good. The importance of the evaluation process that can be carried out from several parties involved, namely from institutions, educators, and from students. Evaluation is carried out to minimize an error and see the shortcomings of a program. In this evaluation each party plays an important role in evaluating activities and programs. Linkages between one another can produce an impact in a program. This evaluation can improve or evaluate programs that aim to see the success of the program.

4. Conclusion

Based on Kirkpatrick's four evaluation levels it can be concluded that at level 1 the evaluation results obtained show that students were satisfied and interested in this PLC training activity, at level 2 the results were obtained show there was an increase in insight, skills and changes in student attitudes, at level 3 the result was a change in students' behavior , especially work attitude behavior after students take part in PLC training. Finally, at level 4 the evaluation results show that there is an increase in students' abilities from previously attending training and after participating in training, in which the results of the increase are in the high category. This shows that the PLC training carried out has been able to increase students' insights, skills and work attitudes. This increase is later expected to be a capital for students when they enter the world of work.

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