Electropneumatic Training to Improve the Professional Competence of Muhammadiyah Vocational Teachers: Industrial Revolution 4.0 Implementation

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Abstract. Vocational High Schools (SMK) are required to have competencies and be able to meet the growing industrial needs. Competent vocational teachers play an important role in producing skilled human resources (students). To achieve these competencies, it is necessary to improve the quality of learning media. Therefore, the use of learning media, especially in the field of electropneumatic, is crucial. This training aimed to provide knowledge and skills for operating electropneumatic systems on industrial equipment. The method used in this research was a combination of the theory presented classically and practice using an electropneumatic trainer module designed and built by the team. A pre-test and a post-test were conducted to evaluate the results of the training. The training was held for one day with a total of 15 participants from SMK Muhammadiyah 3 Klaten Utara. The evaluation results showed that the teachers’ (15 people) understanding of electropneumatic material increased by 56% from the pre-test with an average score of 40 to the post-test with an average score of 62. It is hoped that this training can help teachers at SMK Muhammadiyah 3 Klaten Utara to improve their competence in teaching and provide significant benefits for students facing challenges in the field of industrial automation, especially electropneumatic.

Keywords: competencies; electropneumatic; skill

1 Introduction

The world of education is currently facing significant changes due to the Industrial Revolution 4.0. Technological advances in this era have changed the industrial landscape, influenced production methods, and demanded new skills [1, 2]. Vocational high schools (SMK), as educational institutions that focus on vocational and skills education, must anticipate this change by updating the curriculum and increasing the professional competence of teachers. For vocational teachers, increasing professional competence is urgent to be able to provide relevant education following the demands of the times [3, 4].

One of the most important aspects of Industrial Revolution 4.0 is the application of electropneumatic technology in various industries [5, 6]. Electropneumatic combines electronic and pneumatic technologies to control systems and drives in industrial processes [7]. Therefore, electropneumatic training is very relevant to improving the professional competence of vocational teachers in dealing with ever-evolving industrial changes.

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Vocational School Teachers who have a deep understanding of electropneumatic will be able to teach students about the basic concepts, working principles, and practical applications of this technology in the industry.

The implementation of Industrial Revolution 4.0 in the world of education requires collaboration between educational institutions and the industrial world [8-10]. Electropneumatic training is an important bridge between vocational teachers and industrial needs. Mastering electropneumatic is a critical step to ensure that vocational students acquire skills relevant to the world of work, which is increasingly connected to technology. By integrating electropneumatic training into the curriculum and teaching practice, vocational teachers can prepare their students well for the challenges and opportunities offered by the Industrial Revolution 4.0 era.

SMK Muhammadiyah 3 Klaten Utara is one of the service partners of the Mechanical Engineering Study Program, Faculty of Engineering, Universitas Muhammadiyah Yogyakarta (UMY). The topic of this service is electropneumatic training to improve the professional competence of vocational teachers to face the Industrial Revolution 4.0. One of the areas of expertise of SMK Muhammadiyah 3 Klaten Utara is electronics engineering and motorcycle engineering, and one of the topics included in the teaching curriculum is industrial automation. This electropneumatic training aims to improve the quality of teaching and produce SMK graduates who are ready to face challenges and make a real contribution in the 4.0 Industrial Revolution era.

2 Methodology

2.1 Stages of Training Implementation

This electropneumatic training method was divided into two learning activities, namely theoretical learning and practical learning. The training materials involved the use of electropneumatic technology, which combines electromechanical and pneumatic systems, to operate devices and systems efficiently. Detailed learning activities are described as follows:

2.1.1 Theory Learning

Theory learning is a learning activity that is carried out at the beginning of training and focuses on understanding the concepts, principles, and theories behind a subject or skill [11]. Theoretical learning methods include lectures, reading reference materials, listening to lectures, participating in discussions, and researching relevant literature [12, 13]. Theoretical learning was carried out to provide training participants with a strong basic knowledge of training topics before entering practical aspects. The theory learning methods applied to this training were the lecture and question-and-answer methods. The presenter explained the topic of the training in front of the class using presentation media. The lecture activity took place in two directions, with a question-and-answer session between the training participants and the presenter.

2.1.2 Practical Learning

Practical learning is carried out after the participants got and understood theoretical learning and then applied it to practical learning. Practical learning methods using simulations and practice are effective approaches to learning practical skills [14, 15]. The simulation practice in this training used interactive and realistic electropneumatic simulation software to help teachers understand and visualize important concepts. The simulation
software used was FluidSIM 4.2. The applied practice was a learning method with real objects in which participants practiced directly using electropneumatic equipment in a series of practical exercises using an electropneumatic trainer designed to strengthen their understanding of the use and operation of electropneumatic systems.

2.2 Stages of Training Evaluation

The evaluation stage of electropneumatic training for vocational teachers was carried out in three stages, namely as follows:

2.2.1 Initial Stage

The training participants were given a pre-test to measure the basic knowledge of Vocational School Teachers as trainees in electropneumatic knowledge before participating in the training [16, 17]. The pre-test results were then analyzed using descriptive analysis. This pre-test was carried out in addition to knowing the participants' initial abilities and being used as a source of data analysis for evaluation in improving the participants' abilities. This increase was analyzed by comparing test scores before and after joining the training program.

2.2.2 Core Stage

Training participants took part in two learning activities, namely theoretical learning, and practical learning. During the theoretical lesson, the participants were guided by a speaker from UMY who explained the training material in the field of electronics. Practical learning was accompanied by one instructor and two technicians to assist participants during learning with simulations using FluidSIM 4.2 software and practice using electropneumatic trainers. At this core stage, participants were expected to play an active role so that they can provide the understanding and practical skills to trainees in control systems that use electropneumatic components.

2.2.3 Final Stage

The final stage of the training is to evaluate the participants' abilities [18, 19]. After completing the training, the participants were given a post-test. The results of this post-test score data served as the basis for an analysis using descriptive analysis. Indications of increasing the ability to participate as Vocational School Teachers after participating in the training program can be seen by comparing the results of the pre-test scores and post-test scores.

3 Results and Discussion

The results of this training were obtained after the implementation and evaluation of training activities. The results and discussion of the training are explained in more detail as follows:

3.1 Initial Stage

The initial activity of the training, namely the pre-test stage, aimed to determine the initial abilities of the participants, consisting of 15 teachers at SMK Muhammadiyah 3 Klaten Utara
before they participated in the training by giving 20 objective questions in the electropneumatic field within 15 minutes. The results of the distribution of the pre-test scores of the training participants from Table 1 show a maximum pre-test score of 63, a minimum of 12, an average of 40, and a standard deviation of 15.1. The standard deviation value was quite high compared to the pre-test score, indicating that the trainees had a wide range of understanding abilities in the field of electropneumatic. The pre-test results for all training participants are presented in the graph in Figure 1, showing that there were still many trainees who score below 55. The results for obtaining scores below 55 were 11 out of 15 trainees.

Table 1. Distribution of Pre-test Scores

<table>
<thead>
<tr>
<th>n</th>
<th>Descriptive Analysis</th>
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<tbody>
<tr>
<td>15</td>
<td>Max</td>
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<tr>
<td>63</td>
<td>12</td>
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</table>

Figure 1. Graph of Pre-Test Results for Electropneumatic Training Participants.

3.2 Core Stage

First, in the form of lectures using presentation media, presenters presented theoretical materials on basic concepts, components, working principles, and practical applications of electropneumatic technology in the industry. A question-and-answer activity for the training participants was held at the end of the lecture. The implementation of the lecture for the training participants is shown in Figure 2. Learning theory in electropneumatic training is important to provide a solid understanding of the working principles of the electropneumatic system. With good theoretical knowledge, trainees are expected to be able to identify and solve problems in electropneumatic systems, improve operational efficiency, and optimize overall system performance [20].
Figure 2. Theoretic Learning Activities regarding The Field of Electropneumatic.

Second, in the implementation of training with practical learning through direct practice the training, the participants carried out hands-on practice guided by an instructor and assisted by two technicians from UMY. The practical learning process began with practice using the FluidSim 4.2 simulation software installed on the participant's computer. The trainees carried out a simulation to ensure the circuit is correct by executing the simulation software. The display of the electropneumatic simulation circuit in the simulation software that was executed is shown in Figure 3. Furthermore, the participants carried out hands-on practical learning by installing electropneumatic component circuits using learning media in the form of an electropneumatic trainer module designed and made by the UMY Mechanical Engineering service team, as shown in Figure 4. At the core stage, activities were carried out with a duration of 1 x 8 hours of face-to-face meetings.

Figure 3. Display Electropneumatic Circuit Simulation using FluidSim Simulation Software.
3.3 Final Stage

The post-test was held at the final stage of the training activities by providing objective questions with electropneumatic material to all trainees. The post-test activity aimed to measure the participants' final abilities after participating in a series of training activities. The post-test results showed that almost all participants scored above 55, and only three participants scored below 55. These results indicated that there was a significant increase in the participants' abilities after participating in theoretical and practical learning training activities. The distribution of post-test scores obtained a maximum score of 80, a minimum of 38, and an average of 62 (Table 2), and a graph of the results of the post-test scores for all training participants is shown in Figure 5.

Table 2. Distribution of Post-test Scores

<table>
<thead>
<tr>
<th>n</th>
<th>Max</th>
<th>Min</th>
<th>Mean</th>
<th>Standard Deviation</th>
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<tr>
<td>15</td>
<td>88</td>
<td>38</td>
<td>62</td>
<td>14.3</td>
</tr>
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</table>

Figure 5. Participants Conducted Hands-On Practice Using the Electropneumatic Trainer Module.
The distribution of post-test scores in Table 2 can be explained by the fact that there was an increase in the average score of electropneumatic trainees after participating in training activities, from the previous score of 40 to 62. The graph showing the increase in the ability of electropneumatic training participants through a comparison of pre-test and post-test results is shown in Figure 6.

![Graph of Comparison of Pre-test and Post-test Scores of Electropneumatic Training Participants](image)

Figure. 6. Graph of Comparison of Pre-test and Post-test Scores of Electropneumatic Training Participants.

Based on the results of the evaluation of training activities by comparing the pre-test and post-test scores, it can be concluded that the electropneumatic training activities that have been implemented could increase the professional competence of teachers of SMK Muhammadiyah 3 Klaten Utara as training participants. The professional competence in question was the theoretical and practical abilities of teachers in the field of Electropneumatic, which was one of the areas of science that needed to be constantly updated by SMK teachers in the fields of electronics engineering and motorcycle engineering in the face of the industrial revolution 4.0.

4 Conclusions

Based on the findings and results of the data analysis, it can be concluded that the professional competence of teachers could be improved through the implementation of structured, systematic, and focused training programs in certain disciplines. The electropneumatic training held at SMK Muhammadiyah 3 Klaten Utara was able to improve the professional competence of teachers in the field of industrial automation, especially in the field of electropneumatic, as one of the efforts to face the industrial revolution 4.0. This increase in teacher competence was expected to have significant benefits for improving the quality of education, industry relevance, and student competitiveness. With skilled and updated teachers, students could be more prepared to face the demands of the ever-evolving world of work.

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References


