JVCE 8 (1) (2023) : -

Journal of Vocational Career Education

https://journal.unnes.ac.id/nju/index.php/jvce

The Effect of Using a PLTS Trainer Kit with IoT Control on the Competence to Build Smart Buildings

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Article Info

Article History :
Received
July 2022
Accepted
October 2022
Published
July 2023

Keywords:
Trainer kit, Internet Of Things (IoT), media Pembelajran, SMK

Abstract

This research aims to develop and analyze the feasibility and effectiveness of an Internet of Things (IoT)-controlled Solar Power Generator (PLTS) trainer kit. The research method employed is a quantitative approach using the Research and Development (RnD) method, following the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). Data collection is conducted through questionnaires and tests. Questionnaires are used to assess the suitability of the media by media experts and subject matter experts, while tests are used to measure student competence improvement before and after the treatment. The research results indicate that the PLTS trainer kit with IoT control has high feasibility, with a score of 87% from media experts and 88% from subject matter experts, categorizing it as highly feasible. The t-test results show a significant increase in student competence, with an average pre-test score of 58.4 and a post-test score of 76.16. Statistical analysis reveals a calculated t-value of -7.79 and a tabulated t-value of 2.00. Therefore, the null hypothesis (H0) is accepted, indicating a significant difference between the pre-test and post-test. As a recommendation, the researchers suggest that schools should provide adequate facilities for practical learning using the trainer kit. Furthermore, future research could focus on the development of IoT trainers, particularly within the SCADA system.

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p-ISSN 2339-0344
e-ISSN 2503-2305

INTRODUCTION

Solar energy itself has a potential of up to 207,898 MW. This value is the highest among other renewable energy potentials. However, in its practical implementation, solar energy has not been widely adopted by the general public, and one of the reasons is the lack of awareness among people about Solar Power Generation (PLTS) technology (Harahap et al., 2021).

Apart from renewable energy, the industrial world has seen rapid advancements in various aspects, including machinery technology, digital technology, human resources, and more. In the past, industrial production processes were predominantly manual, but now everything has been simplified through automated machines. This automation has further evolved into cyber-physical systems, defined as the connection between machines, devices, sensors, and humans within an industry, all integrated into a single platform via the internet, which is also known as the Internet of Things (IoT) (Adam et al., 2022). More specifically, IoT, also referred to as SCADA (Supervisory Control And Data Acquisition), serves as the supervisor, controller, and data acquisition system for connected devices. SCADA is a subset of IoT primarily focused on industrial applications (Yadav & Paul, 2021).

Vocational education in vocational schools (SMK) is oriented towards practical learning. It is said that human senses enable them to remember 20% of what they hear, 50% of what they see, and 80% of what they see, hear, and do simultaneously (Yuliarsih et al., 2022). This aligns with one of the principles of vocational education formulated by Prosser, which states that vocational education is effective when the students' working environment replicates the actual work environment, and tasks are performed using tools, methods, and machines that are also used in the industry (Aqsha et al., 2020).

Technological advancement is also paralleled by the development of instructional media. Traditional teaching methods, where the teacher explains and students simply listen, are no longer considered relevant and effective. Instructional media serves as a tool to facilitate the conveyance of knowledge to students (Celestino Doanwilmon & Aswardi, 2020). In the field of education, instructional media is seen as a supporting factor for successful learning. It is defined as a tool used by educators to deliver learning materials to students (Afrizal & Suprianto, 2018).

Based on the above description, it is necessary to develop instructional media for the basic competence of building lighting control systems (smart buildings) that integrate power installation, lighting installation, and control installation trainers. Therefore, the researcher has undertaken development by integrating PLTS kit and IoT trainers, where PLTS will support the learning of power and lighting installation, and IoT will support control installation learning.

METHOD

In this study, the Research and Development (R&D) method was employed. This method is a research approach aimed at producing a product and testing its effectiveness (Junaidi & Suprianto, 2020). The research was conducted using the Research and Development (R&D) method, with the development model employed being the ADDIE model. The ADDIE development model consists of analysis, design, development, implementation, and evaluation stages (ADDIE) (Lee & Owens, 2004). The procedural steps of its development are as follows:

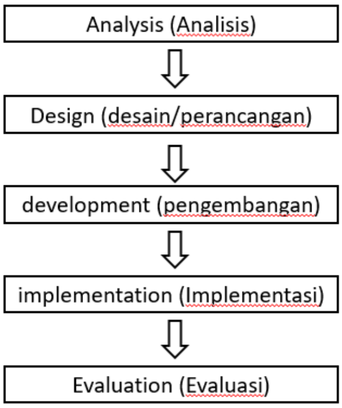


Figure 1. Research flow

RESULT AND DISCUSSION

1. Desain Media Pembelajaran

1) Analysis

The initial stage in the development of instructional media involves researchers conducting an analysis. This analysis is carried out on students majoring in Electrical Power Installation Engineering (TITL) at Nurul Barqi Vocational High School in Semarang. The analysis activity encompasses at least three aspects: curriculum and content analysis, student competence analysis, and instructional media analysis. From the researcher's observations, a problem was identified in the curriculum, specifically in the Basic Competence (KD) related to building lighting control systems (smart building). This requires the teaching staff to instruct students in this competence. However, in practice, students' competence in this area is relatively low, as evidenced by their low scores on daily assessments related to KD.

2) Design

The next step in media development is the design phase. After identifying the problem that a learning media capable of supporting the KD related to building lighting control systems (smart building) is needed, the researcher selected a learning media in the form of a trainer. This choice is based on the trainer's ability to replicate real work objects into a simple device. During this phase, the researcher creates an initial sketch of the trainer's design.

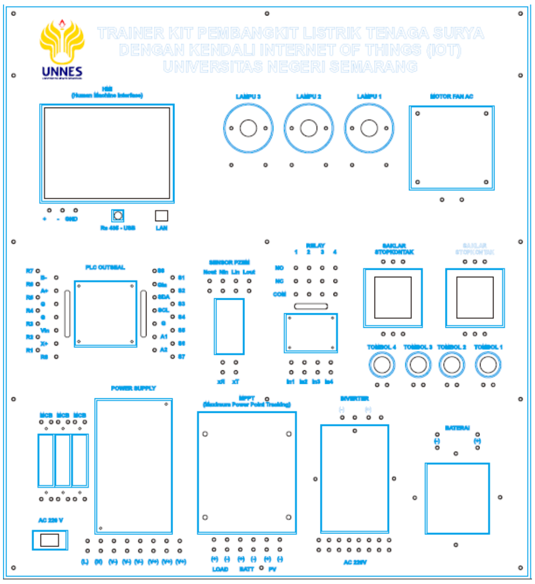
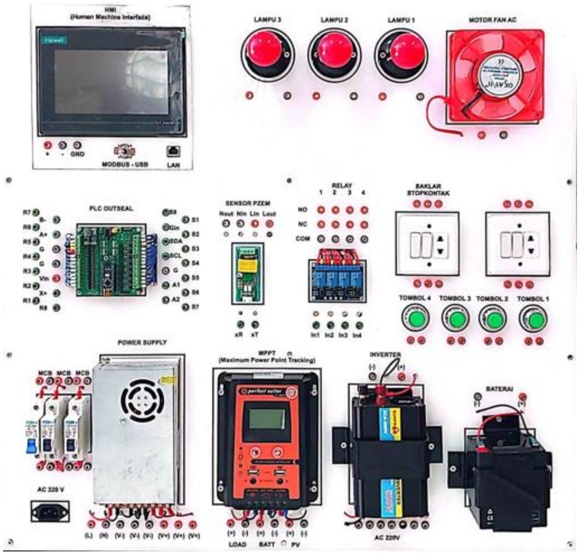


Figure 2. Trainer kit Sketch Design

In the design, the researcher integrated Solar Power Generation (PLTS), PLC Control, HMI Interface, and SCADA/IoT system into a single trainer. The trainer is also equipped with banana plug sockets to facilitate students in assembling components.

3) Development

In this stage, the designed system is implemented into a tangible form. The trainer is in the form of a stand supported by 3cm x 3cm hollow iron. The trainer's base is made of acrylic material shaped using a cutting machine. Additionally, the trainer is equipped with a stand to support the PLTS on the top, which can be detached for outdoor use in building lighting control systems (smart building).



Gambar 3 Trainer kit front view

In the design and development, testing was conducted by media experts and content experts. The media expert evaluation was carried out by Dr. Ir. Ulfah Mediaty Arief, M.T., IPM, who serves as the validator 1 from the Department of Electrical Engineering Education at Semarang State University (UNNES), and Syam Adi A, S.Pd, who is a teacher at the Electrical Power Installation Engineering (TITL) Vocational School Nurul Barqi. Based on the media expert assessment, a percentage of 87% was obtained, categorizing it as highly suitable.

No	**Ahli Media**	**Jumlah Skor**
1.	Dr. Ir. Ulfah Mediaty Arief, M.T., IPM.	92
2.	Syam Adi A, S.Pd	82
Jumlah Skor Total		174
Jumlah Skor Maksimal		200
Presentase %		87%
Kategori		Sangat layak

Table 1. Media feasibility test results

2. Effectiveness of Learning Media

a) Item Validity Test

In this study, the validity test was conducted on the student test instrument. Validity testing in this study was performed on 30 respondents with 40 test items. The researcher set a significance level of 5% or 0.005 for the measurement of r_calculated > r_table. From the validity test results with 30 student respondents and 40 items, a table value of 0.361 was obtained. Thus, from the equation r_calculated > r_table, it was found that 30 items were valid, while 10 items were not valid. From this test, 30 items were selected as research instruments, and 10 items were not used.

b) Reliability Test

In this study, the KR-20 reliability test was used. KR-20 was used because the research instrument consisted of test items, resulting in binary data (correct or incorrect, 1 or 0) (Dewi et al., 2020). In this study, a reliability value of 0.87 was obtained. Based on the criteria for the reliability coefficient, 0.87 < KR-20 < 1.00 indicates very high reliability. Therefore, the instrument in this study is considered highly reliable.

c) Item Difficulty Level Test

This testing is aimed at classifying the difficulty levels of the test items. Out of the 30 valid items analyzed, 3 were categorized as difficult, 21 as medium, and 6 as easy. This classification was based on the difficulty index.

d) Normality Test

The normality test was conducted to determine whether the data followed a normal distribution or not. In this study, the Kolmogorov-Smirnov (K-S) test was used. Based on the K-S test results, values of 0.131 and 0.242 were obtained. Both of these values were > 0.05. Therefore, it can be concluded that the residuals are normally distributed.

e) Homogeneity Test

The homogeneity test was conducted to determine whether the sample data came from the same variance or not. Based on the researcher's calculations, the homogeneity value was 1.38, which is less than 1.86. This suggests that the data is homogeneous.

f) t-Test

The t-test was performed to test the hypotheses related to the influence of each variable. In this study, the average pre-test score was 58.4, and the post-test score was 76.16. The calculated t-value was -7.79, and the t-table value was 2.00. Therefore, it can be concluded that -7.79 < 2.00 < 7.79, indicating that there is an effect of using the trainer on improving students' competency.

g) N-Gain Test

The N-Gain test was conducted to determine the difference between pretest (before treatment) and posttest (after treatment) scores. Based on the test results, the average N-Gain value was 0.89, which falls into the "high" category.

CONCLUSION

The solar power generator trainer kit with Internet of Things (IoT) control has been successfully developed. The trainer is constructed in a stand model and features a panel block made of acrylic to house the components. Based on expert evaluations in the fields of media and subject matter, the trainer kit was categorized as highly suitable, receiving a media expert evaluation score of 87% and a subject matter expert evaluation score of 88%. The evaluation of the solar power generator trainer kit with IoT control yielded an average N-Gain score of 0.89, classifying it as high. Therefore, it can be concluded that this trainer is highly effective in enhancing students' competence in the learning objective of constructing lighting control systems for smart buildings.

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1