Design and Fabrication of Smart Relay Trainer Kit for Electric Motor Control Learning

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Abstract. A small number of PLC trainers for electric motors are used by the Department of Electrical Engineering at the Universitas Negeri Medan. A smart relay, a device resembling a PLC, must be added. This study prioritizes trainers as a learning medium and attempts to construct a smart relay-based electric motor operation trainer. Research and development is the research methodology used. Based on this methodology, a smart relay trainer is planned and constructed, after which it is handed to students for use as a learning kit. Through the distribution of questionnaires to students, this study put the smart relay trainer to the test. The results of the content expert validation test and media experts percentages were received 80% and 98%, respectively, with very good qualifications. According to the research, the Smart Relay-Based Trainer kit learning materials are appropriate for use in the electric motor learning process.

Keywords: Trainer Module, Electric Motor, Smart Relay

1 Introduction

The Electrical Engineering Department requires its students to be proficient in a variety of technological advancements. Use and Control of Electric Motors is a course that requires students to understand technical advancements. The automatic operation of electric motors will be covered in this course. Trainers are used as a practical learning tool in this course. Tools called teaching aids or trainers are used to support lecturers' explanations while talking about particular learning resources. Learning media, on the other hand, can be seen as a vehicle that is packed with information that will be presented by lecturers and analyzed by students [1].

Media are frequently described in the context of education as graphic, photographic, or electronic instruments that are used to record, process, and reorganize spoken or visual information. All types of media are instruments for disseminating or delivering information. Basically, learning is an endeavor to instruct learners (children and students). Everything that

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can add knowledge and information to the continuing conversations between teachers and students is learning. Here, the learning medium contributes to the dissemination of educational messages. Learning media can be defined as "everything that can convey or distribute messages from a source in a planned manner, so that there is a conducive learning environment where the recipient can carry out the learning process efficiently and effectively" after understanding the meanings of the words "media" and "learning" separately [2].

Because smart relays have capabilities that can replace the use of conventional controls, the industrial world has switched from utilizing conventional controls to controlling with smart relays. Learning programming using smart relays is required to broaden students' knowledge of devices other than programmable logic controllers (PLC) that can be used to control the functioning of electric motors. Learning tools that can help students comprehend smart relay programming, such as a smart relay trainer for electric motor operation, must be used to complement the programming lessons. Because PLC is studied after students have learned smart relays in the most recent curriculum, smart relay trainers are required as a support for practical learning. If this smart relay trainer is not created, it will impede students' learning of PLC and result in subpar test results.

2 Literature Review

2.1 Learning Media

Learning media in general is a tool for teaching and learning. Everything can be utilized to facilitate learning by stimulating the learner's ideas, feelings, attention, and abilities or skills. This restriction is fairly thorough and covers a wide range of topics, including the understanding of resources, environment, people, and training methods. Learning media includes things like books, movies, videos, and more that are used to physically transmit educational content. The National Education Association then said that learning media included hardware technology as well as print and audio/visual media for communication [3].

The usage of teaching materials is still restricted to the knowledge provided by the teacher and a small amount from books in the traditional teaching and learning process. Even though learning resources are freely accessible everywhere, both inside and outside of schools, other tools that can encourage students' enthusiasm for learning have received less attention. In order to achieve the best learning outcomes, it is important to focus on the content of the lessons being taught as well as the learning materials and instructional media that will be used. Anything with a message or an educational goal is considered instructional media. The instructional message can be conveyed to students through images, movies, posters, audio recordings, and other media.

Lecturers can employ a variety of learning tools to get their point through to students. Regarding the mode of learning, different learning media include audio, visual, and audio-visual content. Media that uses sound for delivery is referred to as "audio media". In this situation, sound can take the shape of a recording, radio, or another medium. Media that uses eye-observable pictures for its delivery is referred to as visual media. Moving and stationary visual and audio media can be combined to create audio-visual media.

2.1 Smart Relay

Since the functions present in smart relays are not less sophisticated than those found in PLCs, or even simpler, smart relays are frequently referred to as little PLCs. There are two ways to program smart relays: either directly using the buttons on the smart relay, which are facilitated by the presence of an LCD screen, or by using a computer that has a program for smart relays installed. The trainer is a group of tools in the lab that are used for practice. It is designed to help students learn to apply the knowledge and concepts they have learned to actual items since they may be used to train for work.

Trainers can assist students with practical tasks, as well as improve their thinking abilities, motivation, and attention. They can also make it simpler for teachers to list the components that need to be transmitted in learning. With their eyes, students can quickly perceive, comprehend, and apply a subject. As with smart relay trainers in electrical engineering expertise programs, media trainers can be used in a variety of professional domains. A smart relay trainer is an excellent tool for studying electrical installation circuits, including lighting and power installation circuits. It is simpler for children to learn when multiple elements are included in a single unit. Students who can visualize things can also immediately observe and evaluate the circuits and parts on the media trainer. Smart relay trainer media can be used to facilitate learning in an efficient and effective way. Figure 1 shows the Schneider smart relay.

Fig. 1. An electric smart relay

The scan procedure, which involves 3 phases, is how smart relays work. Reading the input data connected to the smart relay input is the first phase, which is referred to as reading. Exercising a program that is already stored in memory is the second stage, which is referred to as the execute program phase. Writing the program to the smart relay and updating it in accordance with the desired output circumstances is the final stage, which is referred to as write. Ladder diagrams (LD) and function block diagrams (FDB) are two types of the programming language used in smart relays. Symbols are used to convey the logical commands in ladder diagrams. Every ladder has one or more rungs, and each rung is made up of contacts and coils. Each rung on the ladder diagram is arranged vertically so that it resembles a ladder.

3 Methods

Research and development (R&D) is a research technique used to create specific items and evaluate their efficacy. Research that is utilized for needs analysis is used to be able to make some products, and research is required to test the efficacy of some products so that they can function in the larger community. Therefore, research and development are longitudinal (gradually can be multi-years). The objective of this project is to design and construct a learning media product. A Smart Relay-based Learning Media for Motor Control Trainers was created in this study and is located in the Department of Electrical Engineering at UNIMED. Research and evolution were used to create this study on the development of learning media. There are 10 steps in using the Research and Development (R&D) research model, namely: (1) Research and information collecting, (2) Planning, (3) developing preliminary form of product, (4) Preliminary field testing, (5) Operational field testing, (6) Operational product revision, (7) Main field testing, (8) Main product revision, (9) Final product revision, and (10) Dissemination and implementation.

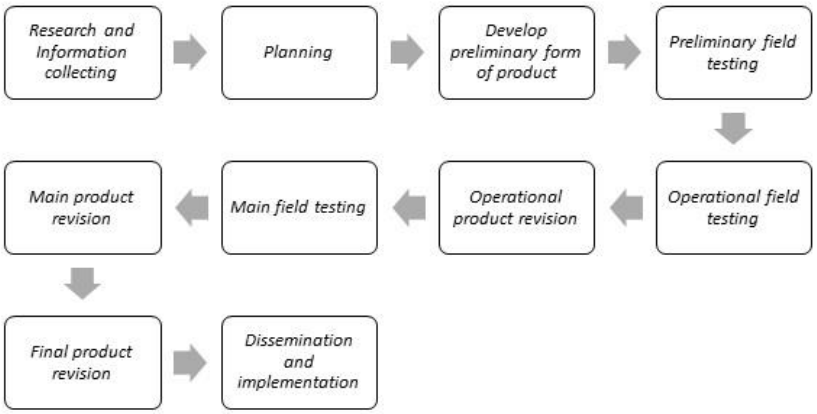

Fig. 2. The procedure step in R&D research model

Product trials are conducted to learn more and gather data that will be utilized to assess a product's degree of efficacy, efficiency, or feasibility, as well as whether the final product is truly of high quality. In this study, quantitative data was employed as the type of data and descriptive statistics of percentages as the data analysis method. Without trying to draw generalizations or conclusions that apply to the wider population, descriptive statistics are statistics that are used to evaluate data by describing or characterizing the obtained data as they are. A design experiment must be carried out to assess the caliber of the feasibility and the resulting learning resources. As a result, tests on the intended product must be carried out. The learning media for electromagnetic controllers based on smart relays on electric motor installations was examined by media and subject matter experts before being tested on 32 students in class A, fifth semester.

4 Result and Discussion

The creation of learning materials for motor-based trainers based on smart relays is done in two steps, the first of which is to validate the materials by having them put to the test by media and subject matter experts. Electrical professors with expertise in the field of education test learning media professionals. An electrical lecturer with extensive knowledge of electric motors evaluated the content test. The second step entails testing media items on UNIMED's Electrical Engineering Department students. The research being done is research and development of Smart Relay-Based Electric Motor Control Trainer Learning Media in the Subjects of Using and Controlling Electric Motors in the Department of Electrical Engineering, to create the goal of creating learning media for trainers to control motors based on smart relays, understanding the media, and student responses to learning media. motor controller trainer using smart relays.

Fig. 3. Motor Control Trainer Kit

This research was conducted to see whether the Smart Relay-Based Motor Control Trainer Media is extremely suited to be utilized as an auxiliary media in the learning process in the electrical engineering department's electric motor installation courses, as well as to determine how students react. The end product from this limited research is not intended for large manufacturing because it simply examines feasibility and responsiveness. Each component terminal on the smart relay trainer is connected to a banana plug or connector, which allows components to be connected following the circuit work drawing on the job sheet. The electrical installation components are designed for the device. A job sheet for operating electric motors is available to the trainer. Figure 3 shows the product of a trainer.

The results showed that the smart relay-based motor controller learning medium was suitable for use as a teaching tool for students studying the use and control of electric motors in the electrical engineering department. Using a Likert scale on an instrument during design validation will yield a more accurate result on the respondent's opinion or attitude. The material for controlling electric motors was put through a media feasibility test in terms of its substance or content, design, usability, language, and operation. The results of the media and material feasibility tests receive percentages of 98% each from media specialists, while the feasibility of the content test receives a percentage of 80%.

Consequently, the validation findings from the smart relay-based motor control trainer learning materials on the topic of the usage and control of electric motors are described in a very practical way and can be applied to the learning process. When conducting small group testing for a product employing six student respondents, the results received the lowest score of 37 from respondents in the very high category. When conducting big group trials, the results received the lowest score of 33 from respondents in the very high category. such that instructional media might be utilized in the teaching and learning processes. Table 1 shows the points of criteria.

Table 1. Point of Criteria.

Test	Total Points	Percentage	Qualification
Content Test	35	80 %	Very Good
Media Test	86	98 %	Very Good
Small Group Test	220	-	Very High
Big Group Test	750	-	Very High

The learning media created by the researcher are claimed to be extremely feasible for material or content specialists, media professionals, and for very high student response rates since the research the researcher conducted supports the researcher's premise. In order to make it possible for the electrical engineering department of the UNIMED engineering faculty to build learning materials for trainers based on smart relays that cover the operation and control of electric motors.

5 Conclusion

Based on the study's results and discussions, it can be said that the smart relay-based motor controller trainer may be used as a learning aid and is well received by students in the UNIMED

electrical engineering department's course on using and controlling electric motors. The validation test results by media experts had a 98% pass rate with very decent qualifications. The validation test results by content experts had an 80% pass rate with very decent qualifications. The validation test results by small groups had 6 respondents who all scored very highly, and the validation test by large groups had 20 respondents who all scored very highly.

Based on the research, the following recommendations for learning materials for smart relay-based motor controllers can be made: It is expected that lecturers will be able to use the learning resources for smart relay-based motor control trainers on electric motor installations as a tool or trainer to aid in the learning process for learning how to use and regulate electric motors. For students, it is expected that the existence of a smart relay-based motor control trainer on the use and regulation of electric motors will boost their sincerity and purpose to learn so that the knowledge they acquire from lectures can be used to compete in the workplace. In the eyes of other researchers, the creation of smart relay-based motor control trainer learning materials is still not perfect, particularly in the electrical engineering department. These materials' drawbacks include the color of the symbol for each component being less thick and the lack of perpendicularity of the tool. for further researchers that want to carry out this study in an effort to fix the flaws in the learning medium so that it can be flawless.

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