Development of Miniature Secondary Network of Electric Power Distribution System as a Learning Media for Electrical Engineering Students

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Abstract. This study aimed to produced a miniature type of primary network that is valid and practical electric power distribution in the lecture of the Electric Power Distribution System of the Electrical Engineering Education Study Program, Faculty of Engineering, Padang State University. The type of research used is R & D (Research & Development) methods. This research is a product development research that uses Borg and Gall's research procedure. Research Subjects were students of Electrical Engineering Education S1 Study Program who attended lectures on the Electric Power Distribution System. The test results obtained are learning media categorized as valid as a medium after being validated by 3 expert validators, amounting to 91% meaning that the media has fulfilled the validation aspects, namely the content and purpose components, instructional and technical get very valid categories. Practical level of miniature primary network type of electric power distribution obtained after a limited trial of 95%. Thus the designed media can be categorized as valid and practical to use in learning.

1. Introduction
The of globalization era which is characterized by quality competition, demands all parties in various fields and the development sector to constantly improve their competence. Quality of Human Resources (HR) has an important role in meeting the demands of national development in various fields, this is closely related to the progress and prosperity of a nation. To make qualified human resources start from the field of education, especially the results of graduates must be able to compete with other nations. Creating qualified human resources is not easy if it is not balanced with the right education. It is education that can shape character and be able to equip students with the required competencies in accordance with the level of Indonesia's national qualification framework (KKNI).

Learning the electricity distribution system focuses students in understanding the concept and its application. But in the implementation this course is constrained by the absence of practical work. This obstacle was caused by the lack of adequate equipment for the implementation of the practicum, so as to provide understanding and knowledge students so far delivered by the lecture method which was assisted by power point media.

The weakness of the teaching process that has been carried out, students are not able to imagine how the type of network in the electric power distribution system in the field. The material discussed is not understood by students but they try to memorize the theory given. If something abstract memorized and not understood, it makes the value of student’s learning outcomes not in a good category.

The factors that influence learning outcomes are of many types, but can be classified into two categories, namely internal factors and external factors". External factors aside from the learning...
environment, the methods and media used during the learning process also determine the success of the learning participants. The weak ability of students to understand the material that is discussed is inseparable from the methods and media used when learning [1]. The Department of Electrical Engineering FT UNP currently uses simulation learning media and broadcast media. The media used so far when theoretical learning is only limited to power points, the learning method used is only lectures and question and answer. This allows students not to have a long memory of the material being discussed, because the material discussed is not seen in real terms, and the media used is not optimal. If the media used is more developed, the teacher can also create other methods, which are considered to be more effective in achieving the goals of the learning and teaching process.

The 2016/2017 school year in the January-June semester has sought to improve students' knowledge when learning takes place. Direct learning demonstrates the working principle of the electric power distribution system through simulation software. The problem is that the allocation of theoretical lecture time is only 100 minutes a week, while each component that will be explained by the working principle must be made in advance, so that the discussion time for one topic is insufficient, because it takes a long time to create a simulation [2].

One solution proposed to overcome this problem is to design a miniature electric power distribution system. The miniature that is made equipped with an ampere meter, volt meter and power supply measuring device, so that it is more effective in explaining concepts in learning and does not take a long time to prepare it during learning. A miniature is designed for each topic besides focusing on the concept of a network, miniature is also equipped with a measuring tool, so it is possible to see parameters, the media becomes more attractive, and can make students' interest and motivation increase.

The purpose of making this electric power distribution system is to produces a miniature type of primary distribution system network, which is equipped with a measuring instrument to explain the parameters in the electric power distribution system and to know the validity and effectiveness of miniature as a learning medium. Media is a communication channel tool that comes from the plural "medium", literally means "intermediary" that is the intermediary of the message source (a source) with the recipient of the message (a receiver), it was revealed by Heinich [3]. This definition is in line with opinion, namely 'the word media comes from Latin medius which literally means 'middle', 'intermediary', or 'introduction'. If this media carries messages or information that aims to be instructional or contain teaching purposes, then the media is called learning media.

Meanwhile, Gagne and Briggs [4] also provides a definition of media that is learning media includes tools that are physically used to greet the contents of teaching materials. Furthermore, the NEA (National Education Association) [5] defines the media as forms of both printed and audio-visual communication and equipment that can be manipulated, seen, heard and read.

From some of the expert opinions it was specifically concluded that learning media is a tool that can physically convey and distribute information in the form of learning content from intermediaries to recipients of the message also easily responded by the five senses, namely seeing, reading, listening can be discussed and can be manipulated, besides media instructional learning where the information conveyed has learning content. A good learning media must fulfill the characteristics or characteristics of the media itself. Like suggests three characteristics of educational media which are indications of why the media is used and what can be done by the media that teachers may not be able to do. These characteristics are: Fictional Characteristics, Manipulative Characteristics, and Distributive Characteristics. This feature allows an object or event to be transported through space and simultaneously. The event is presented to a large number of students with a relatively similar stimulus experience of the incident.

Reveals "learning is an effort that is done by individuals to obtain a new behavior change as a whole, as a result of the individual's own experience in interaction with the environment [6]". Meanwhile, "the evidence that someone has learned is the occurrence of changes in behavior in the person, who previously did not exist or the behavior is still weak or lacking". Human learning outcomes appear from changes in aspects of knowledge, understanding, habits, skills, appreciation, emotional, social, physical, character and attitude relationships. Based on the opinions of these
experts, it can be concluded that learning is an attempt to lead to better behavior change, so that a thinking process can be generated that can generate new experiences for learning. According to [7] "Learning outcomes are experiences experienced by students in the process of developing their abilities in one activity or continuously in every learning activity". Meanwhile, according to [8] "learning outcomes appear to be changes in behavior of students, which can be observed and measured in the form of changes in attitudes and skills knowledge." These changes can be interpreted as better improvement and development compared to before, for example, from not knowing to knowing, being rude to being polite, and so on. Learning outcomes show the achievement of learning goals. Learning outcomes can be known by evaluating learning. States that "Evaluation is an activity of collecting data to measure the extent to which a goal has been achieved". Evaluation must measure the level of students' skills, the tendency found in current practice is that evaluation of learning outcomes is only done by written tests, emphasizing aspects of knowledge only. Evaluation is an ongoing process of gathering and interpreting information to assess (assess) the decisions made in designing a teaching system. Evaluation is an assessment or assessment of student growth and development that is directed at the goals or values set in the curriculum"[9].

Based on the opinions of experts it can be concluded that learning outcomes is a benchmark used to determine the success of students in mastering a subject matter. To find out whether students have learned can be seen from the learning outcomes obtained after attending the teaching and learning process.

2. Development Method
Network design that will be made in miniature electric distribution systems with network types, shows network parameters when given a load. This miniature is equipped with a measuring instrument that will reflect network parameters, so that the miniature media used in theoretical learning will be more interesting and more efficient in delivering material to students, because each measuring instrument will show parameters that will be proven in theory. With direct demonstrations like this, students are expected to be able to understand and possess the applied knowledge of the material that has been discussed.

![Figure 1. One Type of Distribution Network Ring (loop)](image)

The stage of making this mass product will be carried out if the product that has been tested and declared effective and feasible for mass production. As an example of making a machine that can convert waste into useful material, it will be mass produced if it is based on a feasibility study from both economic, technological and environmental aspects. So to produce a product, entrepreneurs and researchers must work together.

Data analysis technique used is descriptive data analysis techniques. By describing the validity and practicality of learning media. Media Validity Analysis, validity analysis using a Likert scale based on
the validation sheet. Network Media Practicality Analysis, Analysis of Practical Data Finding, and Analysis of Miniature Media Effectiveness of Electric Power Distribution Network in terms of learning outcomes.

This research is a product development research that uses Borg and Gall's research procedure. Research Subjects were students of Electrical Engineering Education S1 Study Program who attended lectures on the Electric Power Distribution System.

2.1 Validation

Validation of a product can be done by presenting some expert experts or experienced experts to assess the newly designed product so that weaknesses and strengths are known as expert judgment, this is stated by [10]. To determine the level of validity, the Cohen’s Kappa coefficient is used. In general, the Cohen’s Kappa coefficient can be used for:

- Measuring the degree of agreement (degree of agreement) of two assessors in classifying objects into groups / groups
- Measuring the agreement of alternative new methods with existing methods

The formula of the Cohen’s Kappa coefficient is

\[ \kappa = \frac{\sum I p_i \pi_{ii} - \sum I p_i \pi_{ii}}{1 - \sum I p_i \pi_{ii}} \]

Estimated using a formula

\[ \frac{\sum I p_i \pi_{ii}}{1 - \sum I p_i \pi_{ii}} \]

The value of the Cohen’s Kappa coefficient can be interpreted [11]

2.2 Practicality

Analysis looking for practical data by:

\[ P = \left( \frac{X}{Y} \right) \times 100\% \] [12]

Description:
- \( P \) = Value of Practicality
- \( X \) = Score obtained
- \( Y \) = Maximum Score

3. Research Result

Development research is carried out with the aim of producing products in the form of valid, practical and effective learning media that can be recognized and accounted for. In its development process, the miniature distribution system has passed several stages of assessment, trial and improvement as an improvement effort. In addition, the media that was developed through the validation stage have become experts in their fields. In line with the opinion of [13] said that "product validation is carried out by presenting some media expert experts and experienced material experts to assess the newly designed media so that weaknesses and strengths are known as expert judgment." provide new innovations in the world of education, especially in the subject of Electric Power Distribution.

As for testing the validity of learning media made based on the results of preliminary studies, the design of the development of industrial electrical installation trainers with training nuances within the industry is validated before being used in learning. Validation is carried out by 3 validators who have competence in the field of learning media and learning materials. The purpose of validation is so that it can be said as a valid and accountable media [14]. Validity testing of the Distribution Network Miniature begins with media observations by the validator, demonstration, then completing the questionnaire by the validator as validation results data. Recapitulation of data from validation results by 3 validators in detail can be seen in table 1 below:
The results of validation by 3 expert validators consisting of Electrical Engineering lecturers were 1 media expert lecturer and 2 material experts at the Electric Power Distribution course. The results stated that the miniature media distribution system is very valid with a percentage value of 91%, meaning that the media has fulfilled the validation aspects, namely the content and purpose components, instructional and technical which get very valid categories. The Role of the Distribution Network Miniature as a medium of learning makes abstract learning more concrete. The application of network media in learning makes students active, more independent, and increases learning motivation.

Validity assessment is not enough to meet the requirements of development research, it is necessary to conduct practicality tests and effectiveness tests to complete it. Practicality refers to the ease of use of developed media. Practicality tests are carried out by distributing practicality questionnaires to respondents. The respondents who measure the practicality of the distribution network miniature media are students who take the Electric Power Distribution course and the lecturers of the subject. The purpose of the practicality test is to find out the respondent's response to the developed media. Terms that must be fulfilled in the practicality test include ease of use, time efficiency, easy to interpret and have equivalence. Practicality tests are carried out by distributing practicality questionnaires.

Respondents were 23 students. The purpose of the practicality test is to find out the response of the media respondents which are being developed. Terms that must be fulfilled in the practicality test include ease of use, time efficiency, easy to interpret and have equivalence. Based on the questionnaire dissemination, it was found that the practicality rate of miniature secondary network type of electricity distribution was 95% after a limited trial. So that means the media is very practical to be used as one of the learning media because it has fulfilled the practicality requirements.

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