Development of an Electrical Engineering Module for the Expertise Program of Industrial Electronics Engineering

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Abstract. This study was designed to: (1) produce a learning module of Electrical Engineering for the tenth-grade students at SMKN 2 Pengasih; (2) examine the feasibility of the developed module. This study was classified as Research and Development. The research design referred to the 4-D model development model with four main stages, namely, (1) Define; (2) Design; (3) Development; (4) Disseminate. It was conducted at SMKN 2 Pengasih Kulonprogo, in the Department of Electrical Engineering. The types of data used were quantitative and qualitative collected with questionnaires. Data analysis techniques were quantitative descriptive. The results of the study revealed that the process of developing the module was based on the stages of define, design, develop and disseminate. The results of the feasibility evaluation by material experts obtained a feasibility level of 91.92% (very feasible). The assessment result of the feasibility level by media experts was 89.15%. While the results of field trials (student respondents) were 78.99% (feasible). Based on the data, the average score was 86.68%. Therefore the developed module was categorized as very feasible to be used as learning materials for students at SMKN 2 Pengasih Kulonprogo.

1. Introduction

The 21st century demands technological developments to be implemented, not only in communication but also in education. There are four levels or stages of education in Indonesia, one of which is secondary education. Secondary education consists of general secondary education and vocational secondary education (Law No. 20 of 2003). Vocational education produces students who are competent in their fields and ready to face the world of work. The competency of students is obtained from the success of the learning process in achieving educational goals. Educational objectives can be achieved with learning components including learning methods, learning media, and so on.

Learning methods are the strategies or techniques of the teacher in delivering materials during the learning process. Learning methods consist of various kinds, including lectures, questions and answers, discussion, demonstration, simulation, and so on. The learning method used by the teacher will affect the students' learning outcomes. The existence of a learning method needs to be supported by tools to deliver materials that are learning media. Learning media are used as tools and activities during the learning process. There are various forms of learning media, ranging from media in the form of audio, images, video, electronics, models, simulators and others. The form of instructional media is adapted to

the learning methods and learning materials thus the contents of the learning process can be conveyed to the students effectively. Therefore, it is very crucial to choose the appropriate learning media used in the class.

Based on observations and interviews conducted in SMK 2 Pengasih, the subject of Electrical Engineering in the tenth grade used the 2013 curriculum. It revealed that the students' learning outcomes are still low in cognitive aspects. This is indicated from the daily test scores obtained in the electrical engineering competencies. There are 34 students out of 64 students who have not yet reached the specified standard score. In learning theory, students only learn when facing to face and still depend on the teacher's explanation in the learning process, lack of a strong knowledge base and understanding of the materials. Learners need teaching materials that can be used to learn independently and contain easy to understand materials, therefore a learning module that contains teaching materials designed based on the syllabus is very necessary to assist the students in independent learning.

Based on the description above it is very important to arrange teaching materials in the form of a learning module to stimulate students to learn actively and independently. This study developed teaching materials in the form of modules for the subject of Electrical Engineering. This module is a teaching material that is arranged systematically and interestingly and also includes materials content, exercises, evaluations, and feedback to achieve certain competencies. The unavailability of electrical engineering modules resulted in students who were not being able to learn effectively and independently and they are very dependent on the teacher in the learning process. Presentation of the learning materials still used traditional learning media. The development of the Electrical Engineering module has not been conducted by the teacher because it still relies on notes and explanations from the teacher during learning. Therefore, the objectives of this study were to produce the module of Electrical Engineering for tenth-grade students of Industrial Electronics Engineering at SMK Negeri 2 Pengasih Kulon Progo and to examine the feasibility level of the developed module.

Nusa Putra (2015) quoted in Maximizing Defense Capability through R&D explained that development is a process that applies knowledge to create new devices. Deni Darmawan (2013) added that development is a process of translating design specifications into physical forms. Development in the sphere of learning includes many technological variations both in theories and practice. Learning media are components of learning resources or physical vehicles that contain learning materials in the environment of students that can stimulate students to learn. In line with Gagne and Briggs, Pujiriyanto (2012: 26) argued that learning media is everything that can distribute messages and information, and contains instructional materials in the learning process to stimulate students to learn. While Wulandari, et al (2015: 375) suggested that the environment can be in the form of models, methods, strategies, media, and / or facilities needed to facilitate the learning process of students. Based on some of the preceding explanation, it can be concluded that learning media mean a form of tools to stimulate the mind, feelings, attention, and interests of students so that a quality learning process occurs and achieve the expected competencies. According to Daryanto (2013), characteristics of writing a good module include: self-contained, stand-alone, adaptive, user-friendly and self-instructional. According to Atwi Suparman (2012), characteristics of good modules include self-instruction, self-explanatory power, self-contained.

2. Discussion

The module development procedure used the Four-D development model from Thiagarajan and Semmel (1974) which consists of four stages, including; define, design, develop, and disseminate as shown in Figure 1.

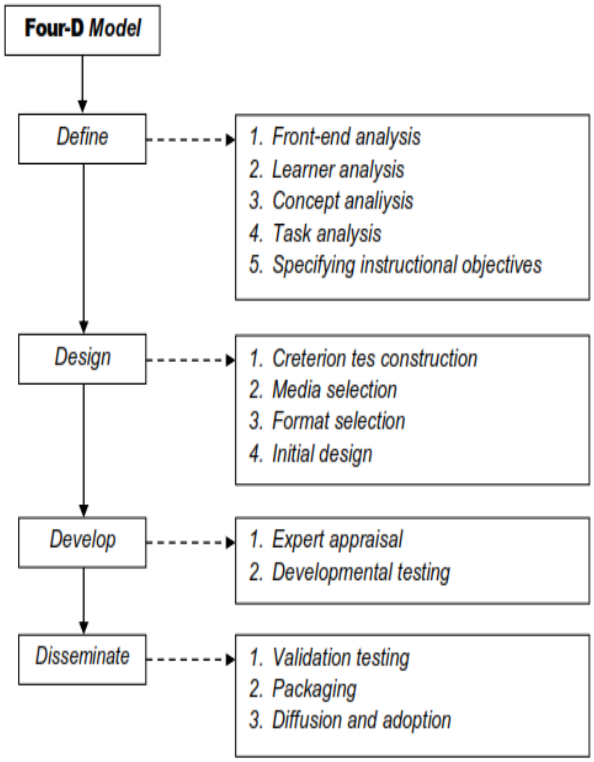

Figure 1. 4D Development Steps

Calculating the average score using the following formula:

$$\overline{X} = \frac{\sum x}{N}$$ – Explanation

X = Average score
∑x = Total score
N = The number of respondents

Data obtained from material experts, media experts, and users are converted to qualitative scores in the form of percentages with the following formula:

$$\text{Feasibility Precentage} = \frac{\text{Number of scores obtained}}{\text{expected number of scores}} \text{ x } 100\%$$

If the feasibility percentages had been obtained then the data were converted to qualitative data using a rating scale in Table 2.

Table 1. Rating Scale

No.	Scale (%)	Category
1	81% ≤ 100%	Very feasible
2	61% ≤ 80%	Feasible
3	41% ≤ 60%	Acceptable

4	21% ≤ 40%	Infeasible
5	0% ≤ 20%	Very Infeasible

The product that will be produced in the development is in the form of modules or printed books presented in Figure 2. The Electrical Engineering learning module is designed based on the required teaching materials of Electrical Engineering for the tenth-grade students in the odd semester. Based on the odd semester learning materials and the results of observations at SMK N 2 Pengasih Kulonprogo, a development plan was created as the basis for the development of the module.

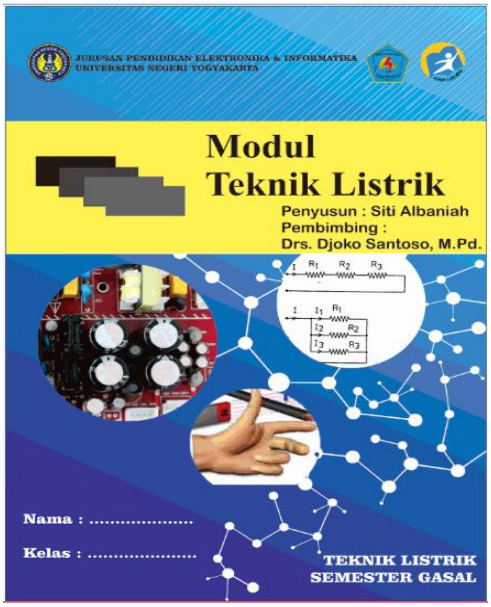

Figure 2. Electrical Engineering Module

The Electrical Engineering module contains six learning materials, according to the Electrical Engineering syllabus. The materials are as follows: (a) Learning I. In this chapter the electrical structure concept is explained. The materials presented in this chapter include atoms and electrons, voltage, electric current, conductors, insulators, semiconductors. (b) Learning II. This chapter explains the concept of the basic unit of electricity. The materials presented in this chapter include international basic unit systems, derivative units, force and mass, energy, electric voltage, and electric current. (c) Learning III. In this chapter, the resistor circuit concept is explained. The material that will be presented in this chapter include resistors**,** ohm's law**,** resistors in series circuits**,** resistors in parallel circuits and resistors in combination circuits**.** (d) Learning IV. This chapter explains the concept of electricity theory. The materials presented in this chapter include Kirchhoff's Laws**,** Thévenin's Theorem**,** Norton's Theorem and Superposition Theorem. (e) Learning V. This chapter explains the concept of capacitor circuits. The materials presented in this chapter include capacitors, various kinds of capacitors, encoding capacitors, series and parallel capacitors and charging capacitors. (f) Learning VI. This chapter explains the laws of magnetism. The materials presented in this chapter include magnetic field**,** magnetic poles**,** magnetic field lines**,** magnetic flux density**,** permeability**,** and magnetic circuits**.**

The percentage of the feasibility of the Electrical Engineering module from three material experts in the aspects of the instruction contained, stand-alone, adaptive, and user-friendly is presented in Figure 3.

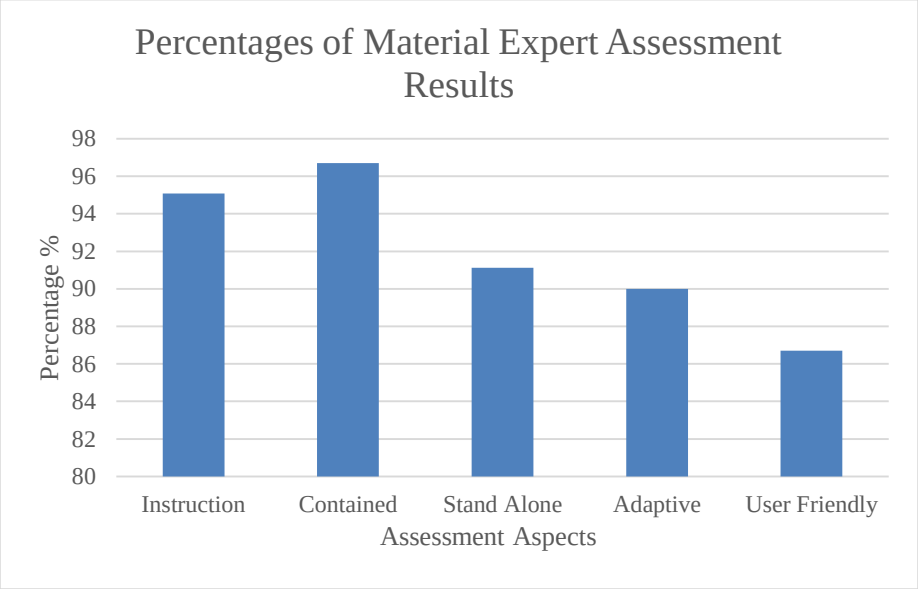

Figure 3. Diagram of Material's Expert Evaluation

Based on Figure 3, the percentage of material expert judgment is 91.13%. From the total score obtained from material experts, the module can be categorized as very feasible to be used as teaching materials in the subject of Electrical Engineering at SMK Negeri 2 Pengasih Kulonprogo.

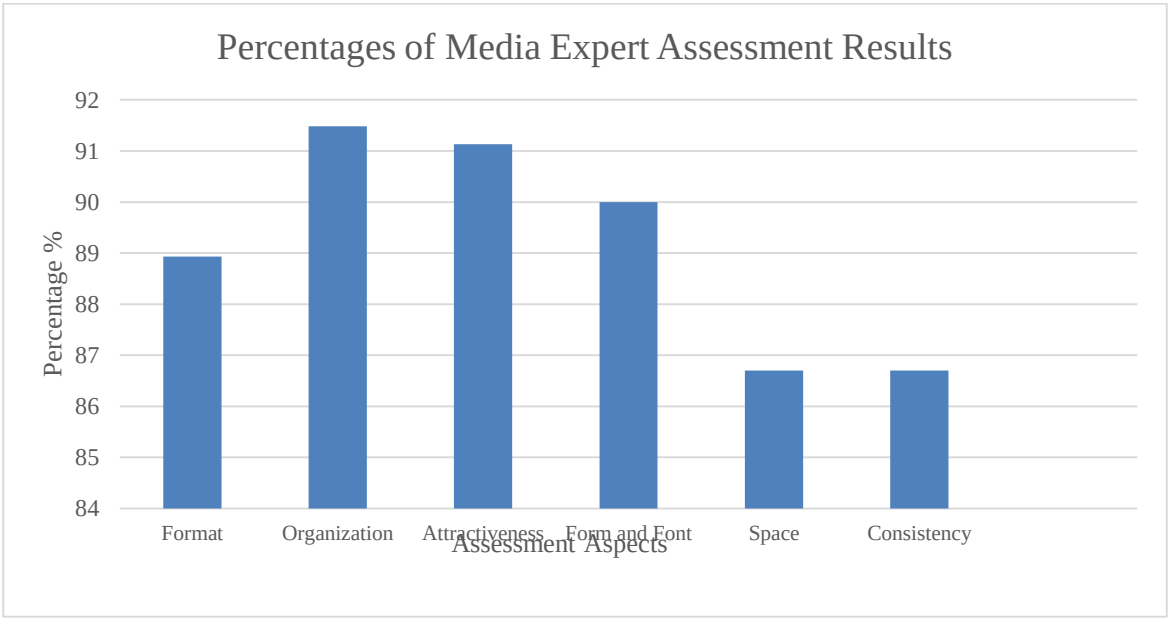

Figure 4. Media Expert Rating Diagram

Based on Figure 4, the percentage obtained by the media experts is 89.15%. From the total score obtained from media experts, the module can be categorized as very feasible to be used as teaching material in the subject of Electrical Engineering at SMK Negeri 2 Pengasih Kulonprogo.

The feasibility test of the learning media was carried out in the tenth-grade classes of Industrial Electronics Engineering at SMK Negeri 2 Pengasih Kulonprogo. The assessment of the module was

reviewed from 3 aspects namely material aspects, media aspects and implementation aspects which are presented in Figure 5.

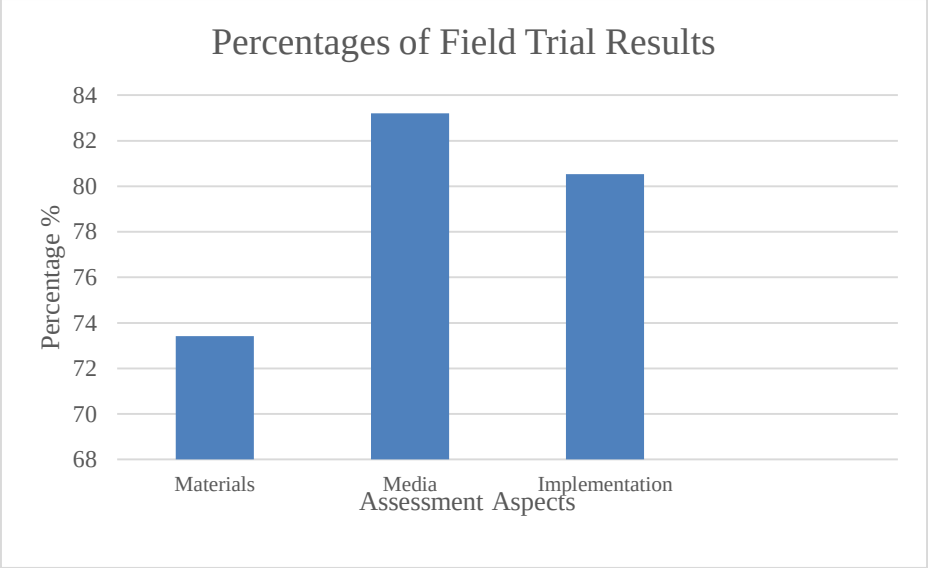

Figure 5. Student Assessment Diagrams

Based on Figure 5, the percentage of the module usage test results obtained an average score of 78.99%. This means that the developed module is suitable for use in the subject of Electrical Engineering in SMK Negeri 2 Pengasih Kulonprogo

3. Conclusions

The development of the Electrical Engineering module for tenth-grade students of Industrial Electronics Engineering was performed through several stages, including determining the material requirements contained in the module, designing the module in the form of an initial draft, and developing the module that has been prepared with the consideration of experts' suggestions. These stages refer to the Four-D development model by Thiagarajan and Semmel namely define, design, develop, and assess. The results of the feasibility level assessment conducted by material experts obtained a feasibility level of 89.15%, categorized as very feasible whereas it was obtained a level of feasibility of 91.92% with a very feasible category by media experts. While the response of students to the module is 78, 99% with a feasible category. The average of each aspect of the instrument obtained the results of 86.68% categorized as very feasible to be used as teaching material for students.

4. References

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