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DEVELOPING ANALOG AND DIGITAL ELECTRONIC MEDIA KITS FOR AUTOMOTIVE ENGINEERING EDUCATION STUDENTS

Ibnu Siswanto[1], Agus Puji Prasetyono[1], Sudarwanto[1], Purwanto[1], Atha Fawwaz Rudiyanto[1]

[1]Universitas Negeri Yogyakarta, Yogyakarta, Indonesia.
Email: ibnusiswanto@uny.ac.id

Abstract

Instructional media has an important function for facilitating academia to achieve the learning objectives. Therefore, this study aims to develop an instructional media of the analog and digital electronics for automotive engineering education students. This study used a research and development method which consisting of 4D steps (define, design, development, and dissemination). The instructional media feasibility assessment from the lecturers and students was obtained using a questionaire. The lectures and students, after assessing the media kits, both were suggested that it has a good lay out, appropriate with the learning outcomes, and feasible for benefitting university learners in analog and digital electronics course especially in practice courses. The implementation of this analog and digital electronic media improves the students achievement in the basic analog and digital automotive electronics courses.

Key words: analog and digital electronics, automotive, instructional media, learning objective, practice

INTRODUCTION

The rise of electric vehicles occurs because of a decrease in the amount of fuel oil and the number of pollutions produced from gasoline vehicles (Holland, Mansur, & Yates, 2021; Yu & Lu, 2014). Therefore, the Indonesian government issued Presidential Regulation no. 55 of 2019 concerning the acceleration of the electric vehicle development program for general transportation. The Presidential Decree contains the projection and regulation on research, development, and industrial innovation activities to develop electric vehicles in Indonesia. The regulation also states that electric cars must have a minimum Domestic Content Level (TKDN) of 35% by 2023. This regulation is fostering major changes in automotive industry from gasoline vehicles to electric one.

The issue of global warming and the reduction of fossil fuels has driven the automotive technology shift to electric vehicles to occur more rapidly (Dijk, Orsato, & Kemp, 2013; Tie & Tan, 2013). Subsequently, dramatical changes in automotive technology from gasoline to electric power have far-reaching consequences (Heryanto, Dani, & Dawami, 2020; Sidabutar, 2020). For instance, gasoline-powered vehicles require a fuel system and an internal combustion engine which have a large number of components, while vehicles with electric power require an electric motor whose construction and components are very different but simpler (Becker, Sidhu, & Tenderich, 2009; Pollet, Staffell, Shang, 2012). This progressive shifting also has an impact on the competence of human resources who are involved in the automotive industries.

The knowledge and skills required to develop, maintain, and repair electric cars are different from gasoline-based engine (Becker, Sidhu, & Tenderich, 2009; Kejun, Chenmin, Songli, Pianpian, & Sha, 2021). Therefore, the Department of Automotive Engineering Education, Universitas Negeri Yogyakarta (UNY) needs to provide courses to train its students achieving competencies that are in line with the electric cars' development. The competencies provided to make ready electric vehicle technicians could be range from design to manufacture and maintenance electric vehicles (Grabowski & Sobek, 2019). One of the competencies given to prepare automotive engineering students mastering the competence of electric vehicle is the basics of automotive electricity and the basics of analog and digital systems.

The basics of automotive electricity and digital analog course provides students with knowledge of electronic components, the basic concepts of electrical work, and the basics of control systems. This course consists of theoretical and practical learning activities, each of which consists of two credits. During the practical learning, this course requires media kits that can aids students more easily understand the basic concepts and how the electrical system works in vehicles. However, the existing instructional media of analog and digital courses in automotive engineering education UNY has been damaged due to repeated use. This situation affects the effectiveness of analog and digital course to decrease due to the limited number of the media kits (Kurniawan, Siswanto, Sampurno, & Syafiq, 2020). Therefore, an update for the current instructional media is crucial. In addition, the new

media kits also need to be good designed so that it will appropriate to the learning objectives especially related to student's knowledge and skills on the basics of electric cars.

Instructional media supports educators to convey learning messages to students (Azhar, 2017). Media as a tool used to convey information from the teacher who send the message to the class participants might help the learning process to be more effective (Basori, 2017; Pribadi, 2017). Media in the teaching and learning process could be a graphic, photo, video, engine stand, or electronic devices to help students achieve learning objectives (Arsyad, 2017; Kustandi & Sutjipto, 2011). Media in the learning process might be used for students to work individually or in a group depending on the needs during the learning process (Indriana, 2011).

The use of instructional media can help the teaching and learning process become more effective (Pudjiantoro, 2017; Solikin, Yudianto, & Adiyasa, 2022; Suyitno, Widianto, & binti Masrul, 2018). According to Kustandi and Sutjipto (2011), the benefits of learning media are 1) clarify the messages and information so that it can improve learning processes and results, 2) increase and direct learner's attention so that it can lead to learning motivation, direct interaction between students and their environment and the possibility students to study independently according to their abilities and interests, 3) learning media can overcome the limitations of the space and time, and 4) provide students with similar experiences about events in their environment and allow direct interaction with teachers, the community, and their environment. In addition, it can also standardize the delivery of messages and knowledge, the learning process becomes clearer, more interesting and interactive, and the learning process becomes more flexible (Pribadi, 2017). Practically, the use of media kits in the teaching and learning process is suggested to increase student's motivation and achievement (Lubis & Ikhsan, 2015; Maathoba & Rijanto, 2022; Putra & Maksum, 2020).

There are various media in learning activities based on the needs of the learning process. The selection of media in learning is significanly affected by the material to be taught (Aji & Siswanto, 2021). Several types of instructional media used in learning activities are including graphic media, printed materials, images, projection media, audio, live image/film, television, and multimedia (Indriana, 2011). Hence, educators must purportedly select the most suitable media based on the conditions of students and the material being taught (Abidin, 2017; Atapukang, 2016).

One of the effective media which is easier to use and to develop is training kits and practice modules (Rachmad, Basri, & Andrizal, 2021). Training kits and practice modules are instructional media designed as a whole and specifically to help students master certain skills. This training media can also be used for independent learning so that students do not need to be dependent on their teachers in learning.

Therefore, this study aims to develop a media kit for automotive engineering students to practice on the basics of automotive analog and digital electronics. The media kits are expected to benefit students' knowledge and skills about the basic concepts and practicall use of electrical components that relevant to electric vehicle competence.

METHODS

The method used in this study is a Research and Development method because it is carried out through a series or process for developing or improving products (Sugiyono, 2016). The process of developing the analog and digital electronic media kits uses a 4-D development model (Mulyatiningsih, 2012). The 4-D model is a research model developed by Thiagarajan (1974), it consists of 4 stages including define, design, development, and dissemination. This model was chosen because its procedures are more effective and suitable with need of the media kits development.

This research was conducted in the workshop of the Automotive Engineering Education Department, Faculty of Engineering, Universitas Negeri Yogyakarta. Sources of the data were taken from lecturers, technicians, and students of Automotive Engineering Education Department who teach and have taken practical courses on the basics of analog and digital automotive electronics. The data were collected using a questionnaire to determine the feasibility of the mediat kits. The questionaire cosists of 17 items questions to measure the suitability of the media with learning outcomes, the usability of media to facilitate students in understanding the competencies, lay out, symbol, and texts. After the media kits were concluded feasible based on the experts and users, it further employed for supporting teaching process in the basic of analog and digital electronics in automotive course. One lecturer used the media kits during the class in electronic labs which is followed by a total 32 students.

RESULTS AND DISCUSSION

RESULT

DEFINE

Media for practical learning of the basics of analog and digital automotive electronics is needed because the existing media is already damaged so that it cannot be used anymore. The damage is due to the age factor so that many components are no longer functioning properly. Thus, the researcher initiates the development of the media kits for supporting the teaching and learning activities in automotive engineering education department.

Students majoring in automotive engineering education are mostly graduate from vocational high schools (SMK). They are preferred to do practical learning and tend to have a kinesthetic learning style, a learning style that would be more effective through practical activities. Therefore, to facilitate students in understanding the basics of automotive electronic systems, a practical media kits are strongly needed.

The analog and digital electronics course is a compulsory course with a minimum grade of C and a total 4 credits consisting of 2 theoretical and 2 practical credits. In the Automotive Engineering Education curriculum document, this course leads students to master knowledge, personality, attitudes, and behavior as well as skills in analog and digital electronics in the automotive field. The scope of this course discusses knowledge of analog and digital electronics which includes the basic principles of analog and digital systems, analog and digital measuring devices, transistors, amplifiers, basic logic gates, arithmetic circuits, flip-flop circuits, and sensors (temperature, pressure, light, and rotation).

Based on the initial analysis, assignments, and concepts regarding the needs for the development of instructional media for Analog and Digital Electronics practice, specific objectives are determined first. The purpose of this media kits aims to facilitate students so they can master attitudes, personality, knowledge and skills on analog and digital electronics competencies in the automotive field.

The results and discussion contain information on implementing activities, obstacles faced, impacts, and efforts to sustain activities. The content of the results and discussion can be in the form of a description of the results and findings during the service activities.

DESIGN

The analog and digital electronic media kits were designed based on the analysis which is described in the define steps. Therefore, it should allow students able to identify the components of analog and digital electronics, describe the concept of each component and how it works, and implement these electronic components in the automotive. The media kits are in the form of a panel that displays various analog and digital electronic components. All the components are relevant to systems or parts in the automotive and/or electric vehicles. Hence, this media kits are fully considered to support the students achieving the learning objectives of the basics of analog and digital electronics course in automotive.

Based on the learning objectives of the basics of analog and digital electronics course, there are several electrical and electronic components that must be learned by the students and should be available in the media kits (Table 1).

Table 1. Component

No	Component	Number	Specification
1	Socket DC Toreep	1	
2	Diode	1	1 A
3	Switch Push ON/OFF	5	2x3 Pin
4	Capasitor	1	450 ^{m}f/16 Volt
5	Regulator	1	IC 7805
6	LED	10	3 mm
7	Resistor	10	270 Ω 0.25 W
8	Resistor	5	10 kΩ 0.25 W
9	Socket	10	FCP 1 x 40
10	Socket	10	FCP 2 x 40
11	Cable Jumper M-M	25	
12	DIL Socket	7	IC 14 PIN
13	IC AND	1	
14	IC OR	1	
15	IC NOT	1	
16	IC NAND	1	
17	IC NOR	1	
18	IC EX-OR	1	
19	IC EX-NOR	1	
20	Adaptor	1	12 V 1 A

After defining the number of components need to be displayed in the media kits, another factor which need to be considered in determining the dimensions of the media being developed are its efficiency on storaging and effectiveness during the learning process. Based on these factors, the size of the media kits developed is 220 x 420 mm as shown in (Figure 1)

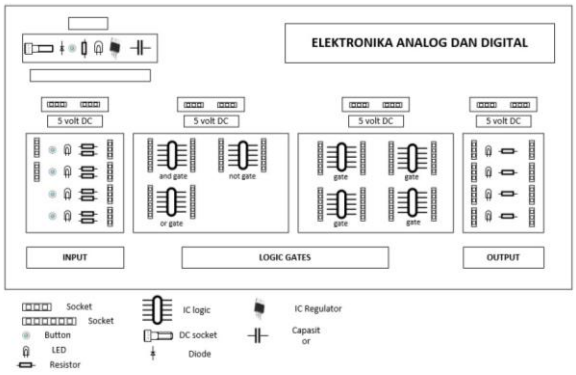

Figure 1. Design of Analog and Digital Electronic Media Kits

DEVELOPMENT

Based on the design of the media kits which has been made, a media kits for analog and digital electronics were developed with the result as shown in (Figure 2).

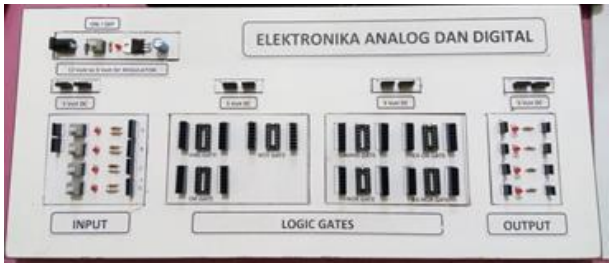

Figure 2. Media kits for Analog and Digital Electronics Course

Furthermore, the instructional media in this study is then subjected for its feasibility by media and material experts. The feasibility assessment carried out includes 1) the suitability of the media with learning outcomes, 2) the feasibility of the media developed to facilitate students achieving the competencies, 3) layout, and 4) quality of symbols or supporting text. The results of the assessment by experts show that the analog and digital electronic media kits get a score of 3.8 (Very Feasible).

After the feasibility assessment by media and material experts, the analog and digital electronic media kits were given to students who have attended the basic of analog and digital electronics in automotive course before. Students were asked to give their opinion on 1) the suitability of the media kits developed with learning outcomes, 2) the appearance of the media, and 3) the benefits of the media. The results of the assessment show that the media kits get a score of 3.8 (very feasible).

The analog and digital electronic media kits have a size of 220 X 420 mm, so it is easy to store in the automotive electrical and electronics lab. The media kits were disseminated by the researchers through a seminar at the Automotive Engineering Education Department. In addition, the media kits that was developed were used for the practical learning process of analog and digital electronics at the Automotive Engineering Education Department. The use of learning media shows that the media developed helps the effectiveness of the practical learning process as indicated by the student learning achievement of 72.54.

DISCUSSION

The media kits developed are in the form of a panel that can be used for student practice in the basic of analog and digital electronics in automotive courses. Therefore, it could be defined an areal objects media based on the division of media types consisting of text, audio, visual, video, real objects, and people (Smaldino, Lowther, & Russell, 2014). The media kits development process consists of defining, designing, developing, and disseminating. This model was first developed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974. The 4-D model was selected because its suitability with learning principles which require an analysis of student conditions, learning objectives, and choosing the right type of media to support the learning process (Smaldino, Lowther, & Russell, 2014).

The data in this study were obtained from material and media experts and students. The results revealed that the media kits are very feasible. This assessment shows that the media is significantly relevant with the predetermined student learning outcomes. This is in line with Sudjana (2013) who stated the accuracy of the material with teaching objectives is very important. It can be further elaborated that the media kits must be based on instructional objectives which contain elements of understanding, application, analysis, and synthesis.

Analog and digital electronics practice media are also considered very feasible in terms of facilitating students understanding the materials. It facilitates students to easily capture the material presented by the lecturer. As for the feasibility of the media, the developed learning media has a very good layout and component quality, so it is very feasible to be used in student learning activities.

Testing of analog and digital electronic media kits were carried out on the basic of analog and digital electronics course. The results show that the 32 students obtained good grades. There were 2 students who got the highest score (90),

while the lowest score (54) was obtained by 1 student. The average of the students' score is 72.54, while the score 74 are mostly achieved by the learners. The development of media kits show that the use of analog and digital electronics practical media has a positive correlation with student's learning outcomes. This is in line with Mulyadi F (2016) which suggested that a good instructional media able to help students's improvement. It happens because this media makes the teaching and learning process better, and it is easier for students to understand the material provided by the lecturer.

Improving the learning process using instructional media is possible due to several factors, including: 1) learning media can explain material that is difficult to understand which is abstract in nature easily because the objects being explained can be seen, heard, and demonstrated directly; 2) by using learning media, the learning process becomes more dynamic; and 3) learning media also complements the shortcomings of traditional learning, namely using the directive method. Furthermore, the beefits of media in a teaching process are 1) clarify the presentation of messages so that they are not too verbalistic; 2) overcome the limitations of space, time and human senses; 3) generate enthusiasm for student learning; 4) allows more direct interaction between students with the environment and reality; 5) enable students to learn on their own according to their abilities and interests; and 6) can provide the same perception for students. (Arsyad, 2014).

However, the role of the lecturer in terms of teaching ability and choosing the right media is no less important in the success of improving the learning process (Emda, 2011). Therefore, the effectiveness of Analog and Digital Electronics practical learning media on learning outcomes is because these media can visualize material that is abstract and difficult to see directly so students can easily understand the material presented.

CONCLUSIONS

The Analog and Digital Electronic media kits have been declared very feasible. This media is significantly relevant to the demands of learning outcomes in analog and digital electronics courses, have a good appearance, and could increase student motivation and enthusiasm for learning. The media is also considered to be able to facilitate students in understanding the competencies learned in the Analog and Digital electronics practice courses.

The results of testing learning media on students obtained good results, with an average value of 72.54. However, due to the limitations of the research, the learning outcomes obtained are still influenced by many other factors such as the ability of lecturers, students' interest and learning motivation, or other factors. Therefore, the media needs to be implemented in the learning process more broadly to determine the impact of its use on student learning outcomes.

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