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Learning Media Simulators Lighting System with Proteus Software in Vocational Schools

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ABSTRAK

Simulator merupakan media yang diperlukan oleh siswa agar dapat belajar dengan aman, efisien, dan efektif. Simulator dapat digunakan sebagai alternatif media pra praktik yang dapat mendukung kelancaran proses belajar siswa untuk menghindari kejadian trial and error, oleh karena itu dalam penelitian ini bertujuan untuk mengembangkan dan menguji kelayuakan simulator sistem penerangan pada mata pelajaran kelistrikan otomotif. Penelitian ini merupakan penelitian Research and Development (R&D) borg and gall, langkah langkah penelitian pengembangan ini tediri dari 10 langkah yaitu (1) Mengidentifikasi potensi masalah, (2) Mengumpulkan informasi, (3) Desain, (4) Validasi desain, (5) Perbaikan desain, (6) Uji coba produk, (7) Revisi produk, (8) Ujicoba pemakaian, (9) Revisi produk final, dan (10) Produksi masal. Metode pengumpulan data melibatkan dua orang ahli materi dan satu orang ahli media. Uji coba pemakaian produk dilakukan pada siswa kelas otomotif SMK. Teknik pengumpulan data pada penelitian ini menggunakan kuisioner dengan analisis data yang digunakan adalah deskriptif kuantitatif. Hasil dari penelitian yaitu simulator sistem penerangan yang telah dikembangkan sangat layak digunakan dalam pembelajaran, sehingga dapat digunakan untuk mempermudah siswa dalam proses pembelajaran sistem penerangan. Siswa dapat menggunakan simulator untuk belajar mandiri maupun berkelompok.

ABSTRACT

Simulators are a medium that students need to be able to learn safely, efficiently, and effectively. Simulators can be used as an alternative pre-practice media that can support the smooth learning process of students to avoid trial and error incidents. Therefore, this research aims to develop and test the feasibility of a lighting system simulator for automotive electrical subjects. This research is a Research and Development (R&D) study of Borg and Gall, the steps of this development research consist of 10 steps, namely (1) Identifying potential problems, (2) Gathering information, (3) Design, (4) Design validation, (5) Design improvement, (6) Product trial, (7) Product revision, (8) Usage trial, (9) Final product revision, and (10) Mass production. The data collection method involved two material experts and one media expert. The product usage trial was conducted on students in the automotive class at Vocational High School. The data collection technique in this study used a questionnaire, and the data analysis used was descriptive quantitative. The research results are that the lighting system simulator that has been developed is very suitable for use in learning, so it can be used to make it easier for students in the lighting system learning process. Students can use the simulator for independent or group learning.

1. INTRODUCTION

Education is a conscious and planned effort to realize the learning process and learning process so that students actively develop their potential to choose the spiritual power of diversity, self-control, personality, intelligence, and noble character, as well as the skills needed for themselves, society, nation, and state (Maknun et al., 2019; Rözer & Van De Werfhorst, 2020). At this time, the times are developing so that man continues to enrich his capacity with some knowledge, which can be obtained through formal education, although perhaps with the addition of knowledge obtained from non-formal education. To develop this function, the government organizes a national education system (Afandi et al., 2019; Prasetya, 2021). However, based on the World Population Review Report by Country 2022, Indonesian education is ranked 73rd poorest country in the world in 2022 based on the value of gross national income and the average Intelligence Quotient level of Indonesians is 78.49% and is ranked 130th out of 199 countries in the world and last out of 10 ASEAN countries (’Iffah et al., 2023; Rachmiatie et al., 2023). The world of education in Indonesia is divided into four levels: elementary schools, junior high schools, vocational high schools, and universities. Vocational High School is a final-level high school equivalent to Senior High School. The thing that distinguishes me is that Vocational High School is a formal educational institution that provides vocational education. The purpose of Vocational High School is to increase students' intelligence, knowledge, personality, noble character, and skills to live independently and attend further education through their vocational programs (Eiríksdóttir & Rosvall, 2019; Estriyanto et al., 2017). However, in reality, the open

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unemployment rate for vocational high school graduates still shows the highest rate compared to other levels of education (Febriyana et al., 2023; Soelistiyono & Feijuan, 2021).

Vocational high school has a variety of vocational fields, one of which is automotive engineering, which is a skill competency that is prepared to work in the automotive industry. Especially at Vocational High School Negeri 1 Seyegan, according to observations during the Introduction to the School Environment and observing educators there in the subject of electrical maintenance of light vehicles, the learning of lighting system practices that take place has not produced good grades, and there are still many students who do not understand the material. With the trainer learning media, there are still many students who feel confused when doing practice, making learning less effective and efficient. In addition, there are still many trials and errors when practicing, resulting in the learning media being damaged quickly (Buditjahjanto, 2022; Kjeldsen, 2019). This greatly affects the learning process of students, so pre-practice learning media is needed, which is expected to make practical learning of lighting systems run effectively and efficiently.

Ideally, in practical learning, pre-practical media is needed in the form of a simulator in order to avoid damage to the real media so as to avoid material losses. However, no pre-practical media has been found in automotive electrical practicum, so students often do trial and error. The effective and efficient use of pre-practice media is indispensable in practice (Botturi, 2019; Islakhah et al., 2023). Simulation applications as pre-practice learning media can provide precise output results, can better understand the material provided, and minimize the occurrence of errors or errors when practicing with real tools (Abdelmoneim et al., 2022; Kashikar et al., 2019). The selection of media depends on the problems that occur during learning, and the teacher can choose one of these media or combine several media into one interesting combination. Based on the problems mentioned, simulators can be used as an alternative to pre-practice media that can support the smooth learning process of students in the classroom and outside the classroom. Learning using simulators allows students to absorb the material better, become active, and understand the material while learning. Learning outcomes using simulators show an increase in student learning outcomes and have reached the Minimum Completion Criteria.

Digital simulator learning media in the form of applications can be used to learn anytime and anywhere. Changes in the atmosphere in the process of teaching and learning activities, such as adding simulators in interesting media and leading to basic competencies and computers, can be used as an alternative to making students more motivated to concentrate on learning (Aristawati & Budiyanto, 2017; Susilowati & Hartoyo, 2023). One of the uses as a learning medium is the development of computer-based learning media simulator models. The simulator model is a model of conveying information or messages in the form of a concept presented on a computer screen with text, images, or graphics (Bruck et al., 2021; Liu et al., 2021). Many simulator application models can be used as learning media, one of which is proteus software. Proteus software is one of the electronic software used to design and simulate electronic circuits, so the software has been chosen as a learning medium that is suitable for use in supporting practical learning of lighting systems (Attachie et al., 2021; Tukan & Julian, 2017). Using the proteus application makes digital system learning activities easier to understand. Based on the description above, this research will focus on the procedure used to develop a lighting system practice simulator with Proteus software at Vocational High School Negeri 1 Seyegan and how the feasibility level of a lighting system practice simulator with Proteus Software. This research is urgently carried out in order to overcome the problem of automotive electrical practicum at Vocational High School Negeri 1 Seyegan, namely that there is still a lot of trial and error occurring, resulting in the learning media being quickly damaged. The update of this research is to develop a simulator using Proteus software for the field of automotive science, where Proteus is mostly used to develop simulators in the field of electrical or electronics science (Lin & Zhang, 2020; Maknun et al., 2019). Simulator learning media is an educational and training learning aid as an alternative solution for students to understand teaching materials and increase competence. The simulator itself is a tool that approaches the original replica of equipment, systems, phenomena, or processes, which are generally equipped with a mathematical model or algorithm (Akinwole et al., 2021; Gustavsson, 2021). According to other sources, the simulator is a medium where players can learn to take action and learn the effects of their actions through a feedback mechanism created in the simulator (Aristawati & Budiyanto, 2017). A simulator is a tool or means of learning that is close to the original replica of equipment, systems, phenomena, or processes to simulate or learn to take action and study the effects of a piece of equipment. Simulator media is an alternative solution for students to understand teaching materials and increase competence.

Proteus is one of the software for drawing schematics, designing PCBs, and simulation (Budi et al., 2021; Syahminan, 2020). Proteus 8 professional software can be used to describe/design digital circuit schematics and can assemble digital circuits, both analog and digital. A large number of libraries from Proteus Eight Professional makes this software said to be complete simulation software, namely from passive components, analog, transistors, SCR, FET, button/button types, switch/relay types, digital ICs, amplifier ICs, programmable ICs (microcontrollers) and memory ICs. Besides being supported by complete components, it is also supported by complete measuring instruments such as Voltmeters, Ampermeters, Oscilloscopes, Signal Analyzers, and Frequency generators (Bestley Joe et al., 2020; Waluyo et al., 2021). The use of Proteus software as a learning

medium to simulate lighting systems is a new innovation in vocational education environments. Proteus is usually used in electronic circuit simulations by professionals, but its application in the context of education for vocational high school students is a new step that has not been widely explored in previous literature. Therefore this study aims to aims to develop and test the feasibility of a lighting system simulator for automotive electrical subjects.

2. METHOD

This research is a Research and Development (R&D) study of Borg and Gall, the steps of this development research consist of 10 steps, namely (1) Identifying potential problems, (2) Gathering information, (3) Design, (4) Design validation, (5) Design improvement, (6) Product trial, (7) Product revision, (8) Usage trial, (9) Final product revision, and (10) Mass production (Borg & Gall, 1983). The data collection method involved two material experts and one media expert. The product usage trial was conducted on the Automotive Engineering students of Vocational High School Negeri 1 Seyegan. The data collection technique in this study used a questionnaire, and the data analysis used was descriptive quantitative. Questionnaires containing media feasibility assessments were given to material experts, media experts, and students as users. The small group trial consisted of 11 students, and the large group trial consisted of 23 students. Research instrument grid is show in Table 1.

Table 1. Research Instrument Grid

Data source	Aspect	Indicator	Question Item Number
Materials Expert	Learning design	Conformity to competency standards, basic competencies, and learning objectives	1,2,3
		Specific learning materials	4,5
		Illustrations that support learning material	6
		Practice questions that support learning	7
	Material aspects	Does not depend on teaching materials/other media	8,9,10
		Adapts science and technology and is flexible/flexible to use	11,12
	Utilization	Useful in helping learning	13,14,15
Media Expert	Media quality	Simulator quality displayed	1,2,3
		Ease of use	4,5
		Text clarity/readability	6,7,8,9
		Image clarity	10
	Word Usage	Quality of word use	11,12
	Media layouts	Simulator presentation quality	13,14,15
		Layout	16,17,18,19,20
Group Trials	Material	Material suitability	1,2
		Does not depend on teaching materials/other media	3,4,5,
	Learning design	Ease of operation	6,7
		Ease of selecting materials	8
	Appearance	Clarity and attractiveness of display	9,10,11,12,13,14,15,16
	Utilization	Useful for learning	17,18,19,20

The data collection process uses a research instrument consisting of an observation bucket and a questionnaire. Observations are made by observing student grades and learning conditions so that the results of observations can be used as a reference in making learning media. The questionnaire sheet is used to measure the feasibility of the learning media made. The analysis data obtained from the experts' validation results can be used as a reference for product revision. Quantitative data is obtained by converting qualitative data into qualitative using a Likert scale with a scale of 4 (Strongly Agree), 3 (Agree), 2 (Less Agree), and 1 (Disagree). After obtaining the feasibility percentage, the product feasibility criteria can be determined by referring to Table 2. The product is said to be feasible to use if the feasibility value meets the score category above 50%.

Table 2. Percentage Scale and Categories

Feasibility Percentage (%)	Category
0% - 25.0%	Very Unfeasible
25.1% - 50.0%	Not Feasible
50.1% - 75.0%	Feasible
75.1 % - 100.0%	Very Feasible

3. RESULT AND DISCUSSION

Result

Problems occur in learning the practice of lighting systems that have not produced good grades, and many students still do not understand the material. With trainer learning media, many students still feel confused when practicing, making learning less effective and efficient. In addition, there are still many trials and errors when practicing, so the learning media is quickly damaged. This greatly affects the student learning process, so a pre-practice learning media is needed, which is expected to make learning the practice of lighting systems run effectively and efficiently. After determining the problem, the next stage is data collection. At this stage of data collection, further observations will be made by interviewing the teacher of the light vehicle electrical maintenance subject and the value of students' learning outcomes as a basis for research. In conducting these interviews, several problems were found, including learning that the practice of lighting systems that take place has not produced good grades and that there are still many students who do not understand the material. With trainer learning media, there are still many students who feel confused when doing practice. It makes learning less effective and efficient, and a lot of trial and error occurs when doing practice, so the learning media is quickly damaged. From some of the above problems, it can be concluded that pre-practice learning media in the form of a lighting system simulator is needed to encourage students to learn independently and reduce the risk of damaged learning media due to trial and error by students.

Product design is created as a basic concept for product creation in the form of a practical simulator that will be developed. The basic concept implements the existing trainer practice media at Vocational High School Negeri 1 Seyegan. Display design is a graphic design of the developed simulator. In this study, the display design was carried out using Corel Draw 2020 as a graphic processor, and the design is show in Figure 1.

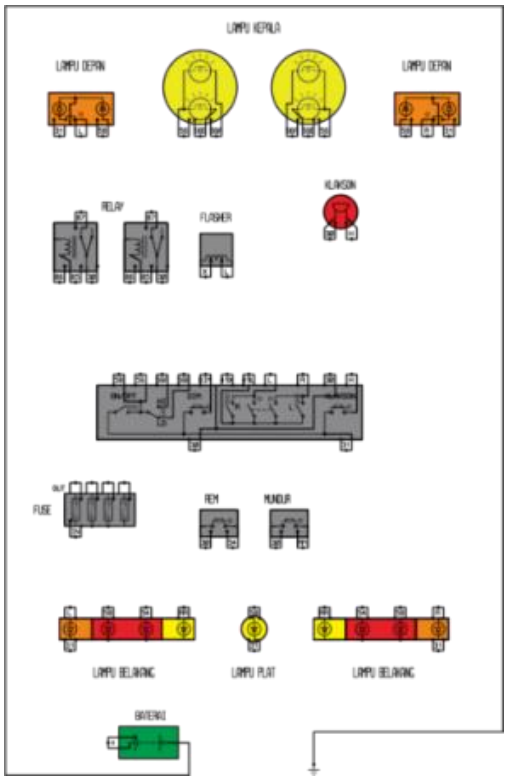


Figure 1. Initial Design

After being arranged in such a way that the product of the development of a lighting system simulator in the subject of electrical maintenance of light vehicles is finally completed, some of the product displays are show in Figure 2.

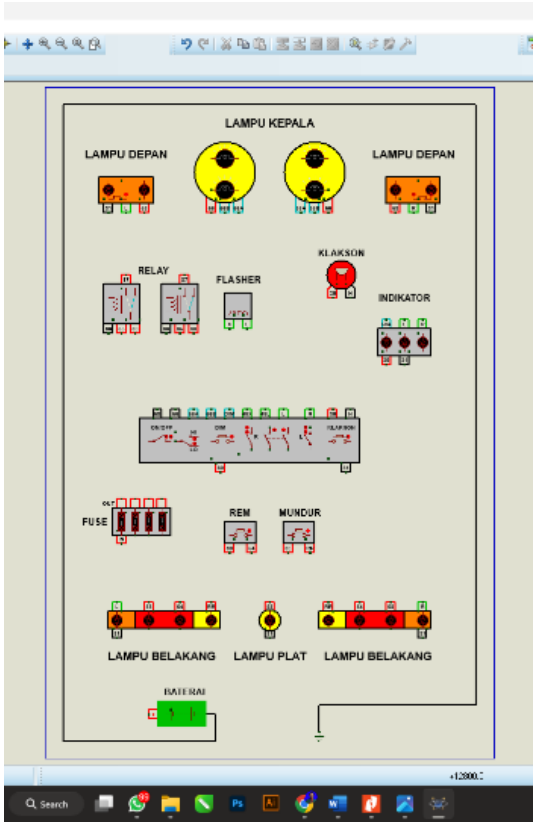


Figure 2. Simulator Results

The material validation stage aims to determine the feasibility of the lighting system simulator in terms of the material that has been developed. Three aspects are validated, namely, aspects of learning design, material, and utilization. The validation stage process is carried out using a duct, and a four-Likert scale questionnaire was given to the material expert to be analyzed and then filled in the questionnaire. In this study, there were two material experts. The results of the material expert validation of simulator development research can be seen in Figure 3. The material feasibility score, if averaged, will get a score of 85.71%. From this score, it can be concluded that the material from the lighting system simulator is in the "Very Feasible" category. The media validation stage aims to determine the feasibility of the lighting system simulator in terms of the media that has been developed. Three aspects are validated, namely, aspects of media quality, word usage, and media layout. The validation stage process is carried out using simulator products, and a four-Likert scale questionnaire is given to media experts to be analyzed and then filled in the questionnaire. In this study, one media expert was present. The results of media expert validation of simulator development research can be seen in Figure 3. The material feasibility score, if averaged, will get a score of 93.93%. From this score, it can be concluded that the media from the lighting system simulator is in the "Very Feasible" category.

Product trials were carried out after the product was revised and declared valid/appropriate by material experts and media experts, and then a small-scale product trial was carried out at Vocational High School Negeri 1 Seyegan. In this trial, the researcher installs the product on a computer in the lab to be tried by students so that students have experience related to the use of simulator products. After that, students fill out a feasibility questionnaire related to the simulator product. The results of the product trial of the lighting system simulator can be seen in Figure 3. The material feasibility score, if averaged, will get a score of 74.13%. From this score, it can be concluded that the lighting system simulator is in the "Feasible " category.

This usage trial still uses the same concept as the previous product trial. The difference in this usage trial is the number of respondents, which is more than in the product trial. The results of the trial use of the lighting system simulator can be seen in Figure 3. The material feasibility score, if averaged, will get a score of 84.04%. From this score, it can be concluded that the lighting system simulator is in the "Very Feasible" category.

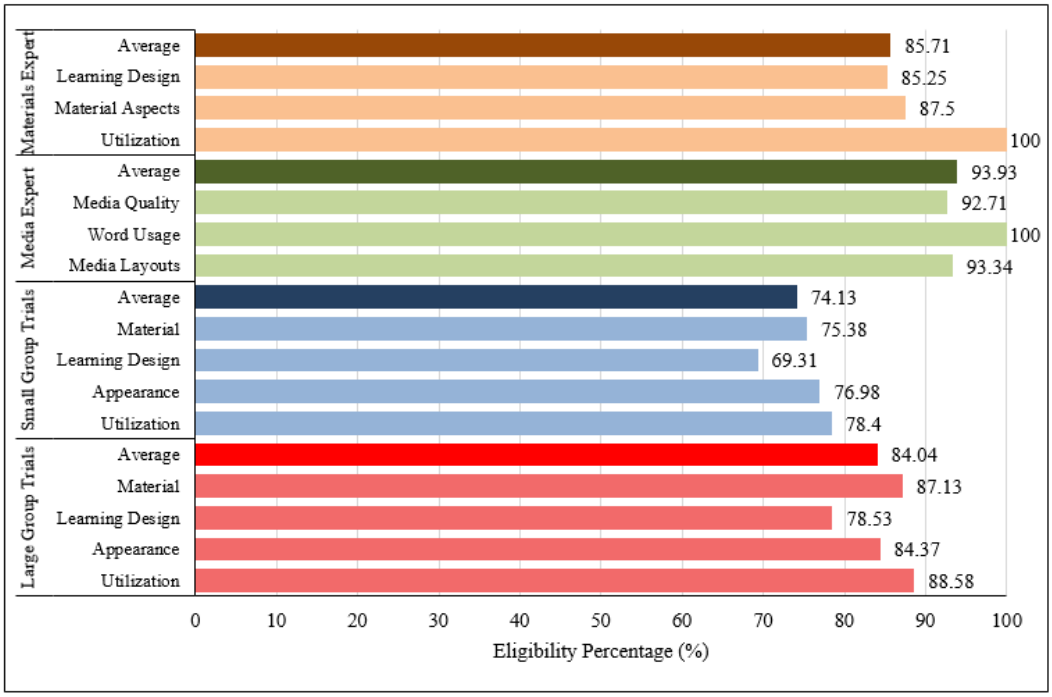
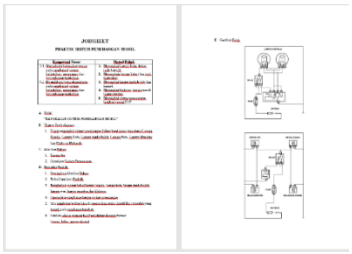
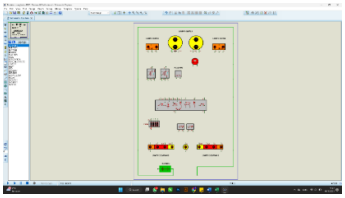
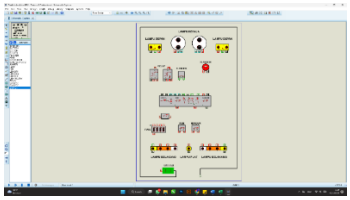
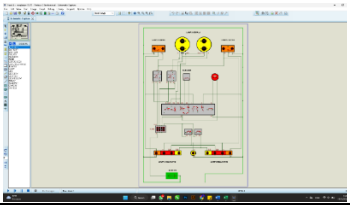
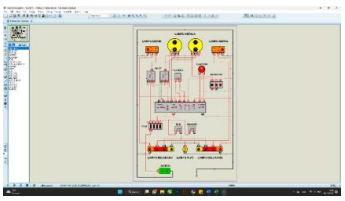


Figure 3. Feasibility Test Results

After the usage trial is carried out, the next step is the revision of the final stage of the lighting system simulator. The reference in the revision of the lighting system simulator is a note of advice given by material experts and media experts to be refined. In product validation, there are several revision notes by experts so that refinements must be made to the products developed. The revision is expected to overcome the weaknesses of the lighting system simulator product. Some criticisms and suggestions from experts to improve the lighting system simulator product are show in Table 3.

Table 3. Product Revision

Input from	Advice	Product Development	
		Before Revision	After Revision
Material	Added job sheets that explained the working system of parts of the lighting system and added basic competencies and learning objectives to the job sheet.	Not Available	
Material	The ignition components were added, and the lamp was painted to match the original color.		
Media Expert	Added current flow to each component and added an indicator light component.		

The final product resulting from this development research is a lighting system simulator with a proteus project file. This media was developed using the proteus application, saved, and converted into a shortcut. This media has a file size of 96 KB and can be run on a computer with a minimum of Windows 7.

Discussion

This lighting system simulator can be used anywhere as long as there is a computer or laptop to support the media. The lighting system simulator works the same way as the trainer at Vocational High School Negeri 1 Seyegan. With trainer media, students can see and observe lecture material in the form of objects that were not explained before (Bruck et al., 2021; Handoyono, 2019). Learning media at this time is not only in printed form but also in visual form. Currently, both visual and printed learning media can be accessed online, making it easier for students to find learning resources (Arifianto & Izzudin, 2021; Muhammad, 2020). The simulator was developed to overcome some of the problems that exist in the learning process of lighting system practice in light vehicle electrical maintenance subjects. Some of the problems overcome are the number of students who feel confused when doing practice, which makes learning less effective and efficient, and a lot of trial and error occurs when doing practice, so the learning media is quickly damaged. According to the research results, learning using the Proteus simulator received a positive response because the activity of simulating electrical circuits using Proteus was a complement to practical activities in the hope of developing basic skills and increasing knowledge of electrical circuits (Mutlu, 2020; Oyebola & Eze Blessing, 2018). The simulator developed using Proteus software is very helpful in the learning process. This is in accordance with the research results, namely that simulation using Proteus has a significant contribution to improving student performance in learning because complex learning involving electrical systems must use simulation software so that students become more enthusiastic, have many choices in experimenting, and are able to foster creativity (Al-Rahmi et al., 2019; Budi et al., 2021).

Simulation applications such as pre-practice learning media can provide precise output results, can better understand the material provided, and minimize the occurrence of errors or errors when practicing with real tools (Lin & Zhang, 2020; Sugi & Ambo, 2018; Wang et al., 2023). Learning outcomes using simulators show an increase in student learning outcomes and have reached the Minimum Completion Criteria (Puradimaja et al., 2018). In addition, by using the proteus application, digital system learning activities are easier to understand (Apaydin & Fusun Oyman Serteller, 2020; Syahminan, 2020). The development of simulator learning media using Proteus Software has the potential to improve the quality of lighting system learning in vocational schools. With software-based simulations, students can better understand the basic principles of lighting systems interactively and visually. This can help overcome the limitations of traditional learning media which are often less able to present real-world contexts. With the use of Proteus Software, vocational students can be more skilled in designing and analyzing lighting system circuits digitally. This is in accordance with the needs of the industry which increasingly demands technology-based technical skills, so that students are better prepared to face challenges in the world of work. The success of using Proteus-based simulation media is highly dependent on the skills and readiness of teachers in utilizing this software. Without adequate training, teachers may have difficulty integrating this media into the learning process. Although this simulation media provides good visualization, digital simulations still have limitations in replicating the physical and practical experience gained through real laboratories. Some concepts may be difficult to fully understand only through simulations.

4. CONCLUSION

The lighting system simulator product, as a learning media in light vehicle electrical maintenance subjects, was developed based on the Borg and Gall R&D development model, which has ten stages. The product resulting from the development research is a lighting system simulator in the light vehicle electrical maintenance subject at Vocational High School. The simulator contains near and far city lights, fog lights, turn and hazard lights, horns, brake lights, and reverse lights. All of this material is packaged in a Proteus-based lighting system simulator with a size of 96 KB. The lighting system simulator product gets the results of the feasibility of the material expert with a final score of 85.71% out of 100%, so the simulator is in the " Very Feasible " category. At the same time, the results of the feasibility study by media experts on the lighting system simulator got a final score of 93.93% out of 100%, so the simulator is in the " Very Feasible " category. In the product trial of class XI, automotive light vehicle engineering students received a score of 74.13% out of 100%, so it was in the " Feasible " category. At the last stage in the usage trial, it got a score of 84.04% out of 100%, so it was in the " Very Feasible " category.

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