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Development of Lighting System Simulator Student Worksheet to Improve CPS Skills of Vocational Students

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Abstract: This research aims to develop and test the feasibility of the student worksheet lighting system to improve collaborative problem solving (CPS) skills of vocational students. This research method used research and development with the 4D model consists of stages, namely Define, Design, Develop, and Disseminate. The developmental research was conducted at class XI Vocational High School Muhammadiyah 1 Bambanglipuro, with teachers and students as the research subjects. Techniques in collecting data in this study used interviews, questionnaires, and documentation. This research instrument used consists of interview sheets, validation sheets for material experts and media experts, and student response questionnaires. Data analysis techniques use quantitative descriptive. The results of this research and development obtained student worksheet lighting system products that can improve CPS skills. The final results of the feasibility of the student worksheet information system show the following numbers: 90% by material experts, 83% by media experts so that they are included in the "Very Feasible" category. The results of student responses in trials and usage trials get a figure of 86% in product trials and 87% in usage trials, so it is included in the "Very Feasible" category. Based on these results, the student worksheet lighting system developed can be said to be suitable for use as teaching materials in schools.

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Introduction

Education is the process of instilling knowledge, attitudes and skills of students that enable them to become responsible citizens of society later. The success of education in producing quality students requires an effort. Efforts are made such as, improving the quality of teachers, improving material, improving the quality of learning, stimulating students' interest in learning, and providing motivation (Flórez-Aristizábal et al., 2019; Maknun et al., 2019). The learning process in education requires mutual interaction and communication between educators and students that takes place with educational situations in order to achieve learning goals (Balakrishnan & Gan, 2016).

Indonesian education if seen experiencing ups and downs, where various kinds of educational problems in Indonesia are the biggest challenges in realizing quality education. These problems are divided into two parts, where there are problems in the macro scope and problems in the micro scope (Madhakomala et al., 2022). Education problems in the macro scope, namely a curriculum that is confusing and too complex; uneven education; teacher placement issues; low quality of teachers: expensive education costs. In the micro scope, namely monotonous learning methods; inadequate facilities and infrastructure; and low student achievement.

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Based on World Population Review data in 2021, Indonesia is ranked 54th out of a total of 78 countries in the world education system ranking. The ranking rose one spot from 55th in 2020 (worldtop20.org, 2022). Indonesia is also ranked 4th in Southeast Asia, and also mAccording to the results of a survey on the world's secondary education system in 2018 issued by PISA (Programme for International Student Assesment) In 2019, Indonesia ranked low 74th out of 79 other countries in the survey. Of course it is very unfortunate, with quite a lot of human resources (HR), education should be able to improve the quality of Indonesian human resources but in fact it is not like that.

To address existing educational problems, the President of the Republic issued Presidential Regulation 68/2022 is the government's effort to accelerate and expand the creation of competent and competitive Indonesian human resources to face global challenges (Asril, 2022). Competition in the global era can be done through education (Handoyono, Suparmin, &; Nugroho, 2020). Vocational High School aims at education that requires students to master certain competencies. The purpose of high school is prepared to continue their studies at the college level and vocational schools are better prepared for work but can still continue to the college level (Ariyani et al., 2021; Eiríksdóttir & Rosvall, 2019).

The National Education System stipulates that vocational education is secondary education that prepares students primarily to work in certain fields. With this statement, Vocational High School graduates get demands so that they can compete in the world of work and industry. But in fact, last August 2022, The Central Bureau of Statistics announced the state of employment, stating that Vocational High School graduates dominate the number of unemployed in Indonesia. If you look at Indonesia's open unemployment rate as of August 2022 of 8.42 million people (BPS, 2022). One of the abilities that are needed by SMK students is the ability Collaborative Problem Solving (CPS) skills. CPS skills is one of the most frequently mentioned capabilities in the framework of the 21st century (Graesser et al., 2017, 2018). In addition, the ability of CPS It is also one of the important abilities that are widely used in the workplace, community environment and various other areas of life (A. Graesser, Kuo, &; Liao, 2017). CPS skills is one of the complex abilities of individuals involving cognitive skills and social skills (Harding & Griffin, 2016). In this case, the cognitive skills in question are problem-solving skills, while the social skills in question are collaboration abilities (Nordin & Osman, 2018). One of the advantages CPS skills Able to facilitate individuals to work effectively in a group and apply their problem-solving skills to various situations. Research results have proven that CPS skills are an important component for future research and practice regarding the role of skills in collaborative problem solving (Dowell et al., 2020)

CPS skills are very important for every Vocational High School student, this is based on the ability to solve problems in a structured manner which is an important competency for people in an industry from operators to management level (Sieckmann et al., 2020). Then CPS becomes a very important skill in almost all areas of 21st Century life (Rojas et al., 2021). The application of CPS is able to help students develop their work skills both individually and in teams (Ariyanto et al., 2019). In fact, currently CPS skills in Indonesia is a problem because of the lack of cooperation or collaboration to solve a problem in the world of work and at the education level, not only in Vocational High School. This collaboration problem is also found precisely at Vocational High School Muhammadiyah 1 Bambanglipuro class XI TKRO in learning the lighting system, namely finding obstacles in teaching and learning activities where teachers still use the one-way lecture method, the next is problems in learning media. In learning the lighting system students only memorize material from the

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teacher and follow instructions, sometimes students experience confusion and at the time of practice only do carelessly which can cause damage to the practice media. The teacher also explained that in recent years students' skills in lighting system practice were still lacking, as evidenced by the results of daily test scores of only 13 out of 32 students whose scores were higher than minimum completeness criteria. Therefore, to overcome existing problems, student worksheet is needed which later students before practicing in the original media will use simulators to minimize damage to media or practice tools, this can also increase cooperation.

Based on the above problems according to (Sumarmi et al., 2021) which is one strategy that can be used by teachers to activate the role of students, namely by using student worksheet as teaching material to support student activeness and help reduce student problems in understanding lessons, so it is necessary to have student worksheet that contains tasks that can help students Educate in understanding the material and improving the ability of students to carry out learning activities during learning. The development of student worksheet is expected to improve the ability for student learning activities (Ramadhan et al., 2020). Student worksheet also has at least four functions, including: as teaching materials that can minimize the role of teachers, more activate students, as teaching materials that make it easier for students to understand the material taught, as teaching materials that are concise and rich in tasks for students, facilitate the implementation of teaching to students in learning. Student worksheet here explains about the demands in working on lighting system simulators. Based on the problems that exist in class XI TKRO electrical subjects, especially lighting systems that need improvement to improve CPS skills and it is hoped that later students can collaborate to solve problems and better learning outcomes in learning simulator lighting systems, especially in class XI TKRO Vocational High School Muhammadiyah 1 Bambanglipuro. This research designs student worksheets to improve CPS skills as a research novelty.

Research Method

This research method used research and development with the 4D model (Sivasailam Thiagarajan et al., 1974) defines a 4D model composed of stages Define or defining, design or planning, develop or development and disseminate or dissemination. This research produced teaching materials in the form of student worksheet lighting systems. In the world of education, this development research is indeed present later and is a relatively new type or type of research (Paiva et al., 2020). Development is the process of realizing blue print aka design becomes reality. An important step in the development stage is testing before implementation. Development research is a research method used to produce a particular product and test the effectiveness of that product (Sugiyono, 2015).

Data collection techniques in student worksheet development research use interviews, questionnaires and documentation. Interviews are used as a data collection technique to find students' problems. Questionnaire data collection in this research was to assess the suitability of student worksheets. In this research, documentation techniques are in the form of curriculum documents and learning processes. This documentation serves as reinforcement for research data.

Data analysis techniques use quantitative descriptive. The data obtained from the research subjects were analyzed for scores using percentages with formulas using the following formula (Arikunto, 2021):

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$$P = \frac{the\ total\ number\ of\ respondents'\ answers}{the\ sum\ of\ all\ ideal\ scores}\ X\ 100\%$$

Information:
P : Student Worksheet Eligibility Percentage
100% : Constant
While the eligibility criteria that state that the product developed is suitable for use are presented in the following table.

Table 1. Eligibility percentage scale

Percentage of achievement	Interpretation
76-100%	Very Worth It
56-75%	Proper
40-55%	Enough
0-39%	Not Worth It

Student worksheet lighting system simulator can be said to be valid if the minimum value of expert validation shows the category "Eligible".

Results and Discussion

This study resulted in student worksheet lighting system simulator using Proteus Software. Student worksheet is developed, printed using A4 paper and also electronically based packaged that can be accessed using a smartphone or laptop. Student worksheet is developed using word applications, Fliphtml5, Canva and Proteus Software. Student worksheet lighting system simulator was developed R&D research methods with a 4D model consisting of 4 stages, namely define, design , development and disseminate. The results obtained from the development research that has been carried out show results that are worth using.

Define Stage

The define stage consists of several stages, namely front-end analysis, concept analysis, task analysis, and formulation of learning objectives. At the initial stage, the front-end is to find out the problems that exist in the school environment, especially Automotive Light Vehicles subjects, lighting system materials. Based on the results of observations and interviews by teachers, information was obtained that the learning process still uses the lecture model, therefore the learning process cannot be carried out optimally. Thus the development of teaching materials that are expected to improve problem-solving and collaborative skills between students.

Concept analysis is to identify the main concepts to be taught, feed them in a hierarchical form, and detail the concepts (Vrontis & Christofi, 2021). In this concept analysis, what is carried out is to determine the subject matter of the lighting system by looking at the Competency Standards and Basic Competencies. The task analysis for student worksheet products must be adjusted to existing learning outcomes based on the independent learning curriculum used by teachers for learning activities. The learning material used in this study is a lighting system simulator, especially for the use of simulators in proteus software. The final step is the formulation of learning objectives. At this stage, the preparation of learning objectives is carried out based on the learning outcomes achieved.

Design Stage

At this stage, the initial product design of student worksheet is carried out. This stage has several stages, namely the selection of teaching materials, selection of formats, initial design. In the selection of teaching materials, this is to determine the teaching materials

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developed in accordance with the characteristics of the material and the learning objectives to be achieved. . In this research, the teaching materials to be developed are student worksheet. Student worksheet is created using Microsoft Word, Proteus software, Canva, and Fliphtml5.

At the format selection stage, it is carried out to produce an initial design of student worksheet products by compiling student worksheet manuscripts, choosing layouts, choosing types and font sizes, determining the content components of student worksheet in the form of covers, forewords, descriptions, learning outcomes, learning objectives, student worksheet objectives, discussions, tasks. student worksheet is made as attractive as possible by using images, colors, and illustrations related to the content of the material. The last stage of initial design, this stage produces printed student worksheet. Student worksheet design activities are carried out by describing the function of the tools in the proteus software into illustrative images, material content. After that, the student worksheet is entered into the fliphtml5 application that can be accessed by teachers and students.

Development Stage

At this stage of development, before field trials, products in the form of student worksheet lighting systems need to be validated by experts, namely material experts and media experts. This activity is carried out to assess the initial product, provide suggestions and input for product improvements before field trials. The feasibility results of the student worksheet lighting system are suitable for use if it is in the minimum category of "Eligible". The feasibility results of the student worksheet lighting system can be seen as follows:

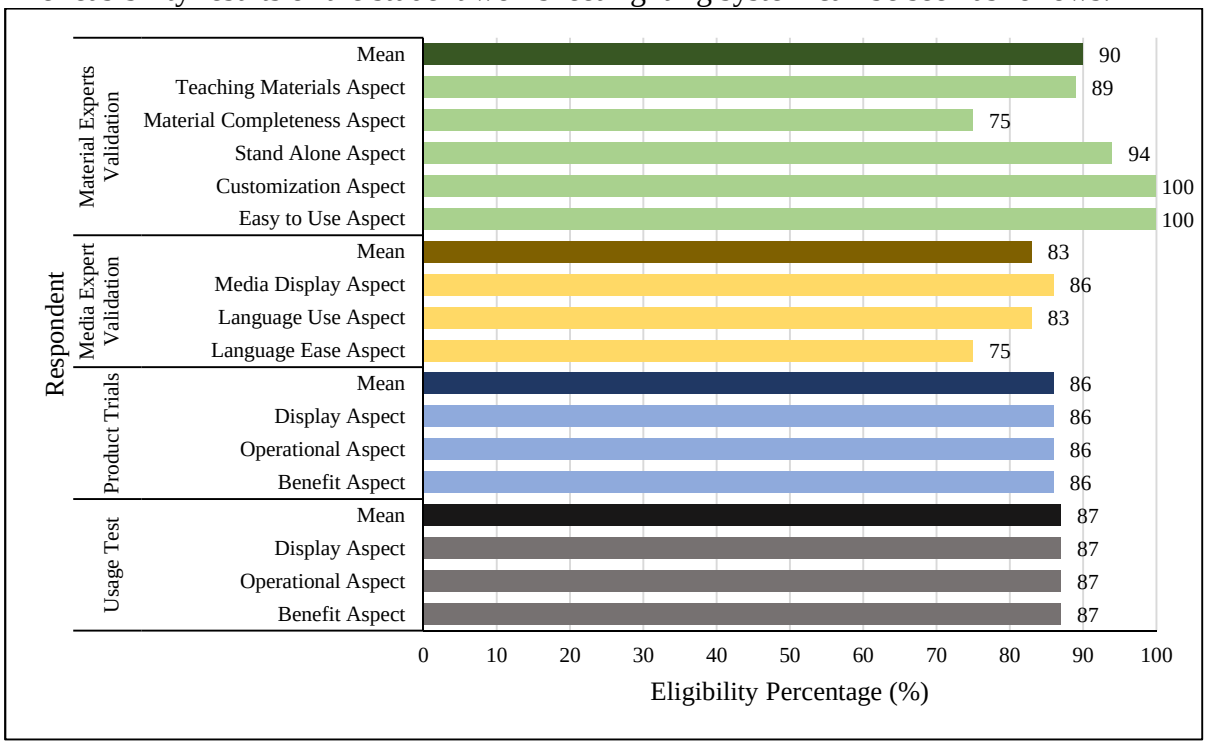

Figure 1. Feasibility Test Results

The results of the feasibility test from material experts, media experts, and usage trials above, the final result of the student worksheet lighting system product feasibility score is to get a value of 90% material experts, 83% media experts, 86% product trials, and 87% usage trials. Of the four results, student worksheet is categorized as "Very Feasible" and has met the valid category that has been determined, namely at least "Eligible", thus the development of student worksheet can proceed to the dissemination stage. Before

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dissemination or dissemination is carried out, for product improvement, product revision improvementsare carried out based on suggestions and input provided by material experts and media experts. The process of revision or improvement of the student worksheet lighting system product is as follows.

Table 2. Product Revision Material Scope

Input	Suggestion	Before	After
Material Expert	Tasks are adjusted to the scope of the material		
Media Expert	EYD-compliant writing		
	Add school logo and UST on the cover		

Here's what student worksheet looks like after making improvements based on suggestions and input from experts:

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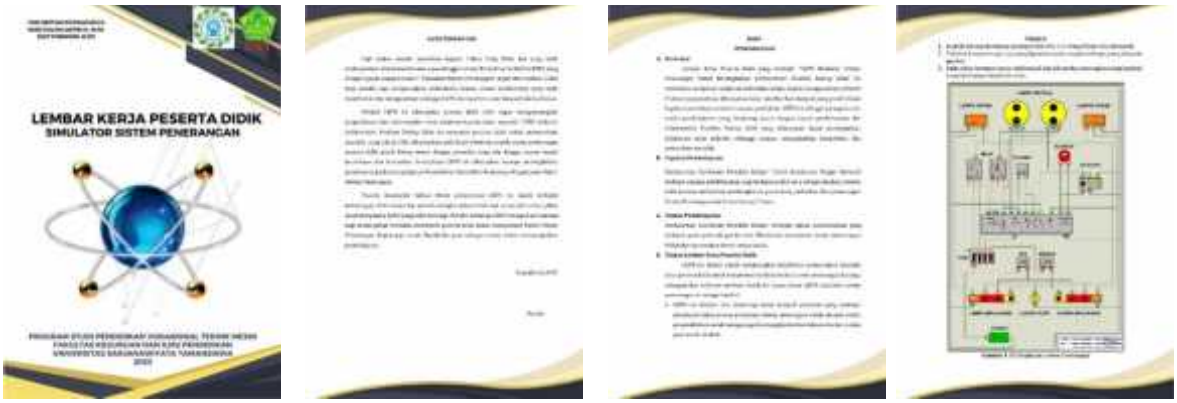

(a) (b) (c) (d)

Figure 2. Display After Repair (a) Cover Page: (b) Preface: (c) Introduction: (d) Tasks

Disseminate Stage

At this stage is dissemination, the dissemination of student workshee is carried out by researchers at this stage with limited use from the author and distributed to Vocational High School Muhammadiyah 1 Bambanglipuro schools and 25 students per class. Researchers spread the final product in the form of student worksheet Lighting System. In addition, other access that can be done online can visit the researcher's account with the website below https://online.fliphtml5.com/gymwc/vtyl/

This student worksheet teaching material is made to overcome several problems during the process of Automotive Light Vehicles learning activities lighting system materials. Some of the problems include learning activities that still use the lecture method, lack of learning media as a guideline and frequent damage stand lighting system because learners only memorize explanations from the teacher. Based on these problems, the learning media created can also be able to help students to achieve learning outcomes, learning objectives and improve CPS skills (N. A. Handoyono et al., 2020). The need for the availability of student worksheet in planning an effective learning process is very important. Student worksheet are sheets containing tasks that must be done by students (Ekantini & Wilujeng, 2018). (Prastowo, 2014) also said that when viewed in terms of the purpose of preparing student worksheet. Student worksheet can be divided into five kinds of forms, namely, student worksheet which helps students find concepts, student worksheet which helps students apply and integrate various concepts that have been found, student worksheet functions as a learning guide, student worksheet which functions as reinforcement, and student worksheet which functions as practicum or experiment instructions. This is based on the above problems according to (Syafina & Suparman, 2019) that is one of the strategies that can be used by teachers to activate the role of students, namely by using student worksheet as teaching material to support student activeness and help reduce student problems in understanding lessons, so it is necessary to have student worksheet that contains tasks that can help students understand the material and improve the ability of students to carry out learning activities during learning.

The student worksheets that have been created are able to help students achieve learning outcomes and improve CPS skills. The need for student worksheets in planning an effective learning process is very important. This student worksheet can be used by teachers as teaching material to support student activity and help reduce students' problems in understanding subjects. The hope of making this student worksheet is that it can increase

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interest, enthusiasm, solving and collaboration between students so that the level of understanding of the lighting system and improve learning is more effective. With this student worksheet, students can solve problems and learn about lighting systems themselves using Proteus software. This is because the worksheet already contains all the material.

Conclusion

The conclusion of this study is as follows: (1) This development research resulted in student worksheet Lighting System to use proteus simulator by going through the stages of 4D model development consisting of define, design, development, and disseminate. The define stage is front-end analysis, concept analysis, task analysis, and formulation of learning objectives. The design stage consists of selecting teaching materials, choosing formats, and initial designs. The development stage consists of material expert validation, media expert validation, product revision, and product testing. The disseminate stage is small-scale dissemination using the website; and (2) Student worksheet lighting system for students in class XI TKRO Vocational High School Muhammadiyah 1 Bambanglipuro which has been developed is suitable for use as teaching material with scores of 90% on material experts, 83% on media experts, so that it meets the eligibility criteria with very feasible theory. The response of students to the student worksheet lighting system for students in class XI TKRO Vocational High School Muhammadiyah 1 Bambanglipuro which has been developed gets a score of 86% in product trials and 87% in usage trials, so that it meets the eligibility criteria with a very feasible category.

Recommendation

Based on the results of the assessment of student worksheets that have been obtained, the researcher suggests that these student worksheets can be used as an alternative student teaching material to support textbooks which are used by students and teachers to increase insight and knowledge. This student worksheet still requires further development to produce better products and be able to provide new innovations in the automotive electrical system learning process. Other researchers who develop student worksheets are advised to develop more complex material to make it perfect

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