JERE 10 (1) (2021) 8-18

Journal of Educational Research and Evaluation

http://journal.unnes.ac.id/sju/index.php/jere

Development Of LED-Based Props on Planetary Type Starter Motor Maintenance Competency in Vocational Schools

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Article Info

History Articles
Received:
13 January 2021
Accepted:
19 February 2021
Published:
30 April 2021

Keywords:
LED-based props, maintenance competence of the starter motor, learning outcomes

Abstract

This study aims to develop and evaluate the feasibility level of a planetary type starter motor maintenance aids at the Light Vehicle Engineering's expertise program in the Vocational High Schools (VHS). The research was conducted in Semarang Vocational High Schools. The study uses of development models consist of 4 stage (Four D) namely: Define, Design, Develop and Disseminate. This feasibility of props development results tested on media feasibility tests, material feasibility tests, test of improvement of learning outcomes between students whose learning is applied props with students who are not applied props and student responses to developed props. Analysis of media and material feasibility data using descriptive techniques, analysis of improved student learning outcomes using t-test tests that previously conducted normality tests, homogeneity tests. Based on the results of the study, props were declared eligible to be applied in vocational schools with an acquisition of 94.44% for media experts and 96.25% for material experts. Improved student learning outcomes from t-test results. The analysis of students' responses to props obtained by 87.60% was very well categorized.

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p-ISSN 2252-6420
e-ISSN 2503-1732

INTRODUCTION

Education in Vocational High Schools (VHS) is an action that can not be separated from the process of teaching and learning activities. Learning is a process of effort made by a person to change behavior, this process is the result of his experience in interacting with his environment (Slameto, 2010). The purpose of learning is not only to achieve learning success, but also for the process by which students acquire knowledge and develop potential (Dewantara et al., 2019). Learning is an activity designed and implemented systematically with procedures to achieve learning objectives by taking the best approach set by (Sutrisno & Siswanto, 2016). The learning process is said to be successful if the student is able to master the material according to what is expected. From this, we can not be separated from the ability of teachers to choose the right and effective learning media. Teacher's ability to manage learning both in planning, implementing and evaluating the learning process and applying the right learning media effectively affects the student's learning success rate (Hadromi et al., 2021).

According to Arif Rifai & Barnawi in (Edi et al., 2017) vocational high schools have a very important role in improving human resources that have professional skills, abilities, and knowledge. Vocational high school graduates are pursued if they are involved in the work environment will be able to do work according to their competence. Education can meet expectations, meet the needs of the community in realizing community expectations and teachers must have higher expectations for their students. If the learning process is implemented effectively then the quality of education can be achieved which means that learning activities can run smoothly, on target and directed in accordance with learning objectives. (Yuliani & Suragih, 2015) in learning, understanding concepts is a very important thing that students must have. Improving the quality of vocational high school graduates in the learning process can not be separated from the accuracy with using media (A. Rusilowati et al., 2020).

(Farihah & Septiadi, 2019) stated that teachers can carry out meaningful learning, which can make learning more interesting. Learning media should be attract to study the students. Interesting learn media also can stimulated spirit study the students, so that the learning process becomes more maximal and the quality of learning in the classroom can be further improved (Hadromi et al., 2019). (Widodo & Wahyudin, 2018) concluded that learning media is a device used by teachers to send information for students. Learning media must be appropriate, interesting and understandable for students, so that the material delivered by the teacher can be easily understood (Sutaryono et al., 2019). One of the media devices that has been widely used is in the form of learning aids. (Annur et al., 2019) The role of props plays an important role because the props made by the concept can be understood by students. The use of props is one of the alternatives to facilitate teachers and students in achieving learn goals (Indrasari et al., 2021).

The observation of the author when carrying out field experience practice in the Semarang Vocational High Schools for teaching and learning activities applied is still too focused on using media in the form of power points and learning with lectures. In addition, the enthusiasm of learning in students has not been optimal on the competency of starter motor maintenance. This problem is supported by the observation of about 70% of the 35 students who prefer the practice of learning outside the classroom than the practice of learning in the classroom. From the results of this observation, it was concluded that in the process of delivering materials in the classroom is considered less effective without being balanced with the practice of learning outside the classroom for the teaching and learning process in Vocational High Schools.

In addition, there are other problems that arise such as the difficulty of students to know and understanding fully about the starter motor materials, especially the planetary type, so that the ability in students about the starter motor material has not been achieved optimally. (Wahyuni & Rosana, 2019) argues that a lack of understanding of nature, practicality, aesthetics, and work may result from learning. It is in line (Widianto, 2018) that it is still necessary to develop planetary type starter motor props are expected to help teachers and students in the learning process.

The problem formulation in this study is as follows: 1) How to develop props that are feasible for material and feasible in terms of media on the maintenance competence of planetary type starter motors. 2) How the feasibility of student learning outcomes after the development results props are applied. 3) How well students respond to planetary-type starter motor props developed.

The objectives of this study are as follows: 1) to develop and analyze the feasibility of planetary type starter motor props developed, 2) to analyze the improvement of students learning outcomes on the competency of planetary type starter motor maintenance between those applied props and those not applied planetary type starter motor props developed, 3) to find out students responses to planetary type starter motor props developed.

METHODS

This research uses 4-D (Four D) development model consists of 4 stages, namely: Define, Design, Develop and Disseminate or adapted into 4-P models, namely definition, design, development, and dissemination (Wijayanti., T, Sukestiyarno, 2015). The 4-D (Four D) development model referenced in this study is a development model for learning devices developed by (S. Thiagarajan, Dorothly S. Semmel & Melvyn I. Semmel, 1974). This development model was chosen because as a reference and assessed in accordance with the characteristics of the product to be developed, namely LED-based props starter motor planetary type, as well as the 4-D development model is a research and development model that explains the operational steps of development in detail, so that it is more detailed and systematic.

The 4-D (Four D) development model has 4 stages of development, namely:

1. Define, is the initial stage to establish a description of learning that is considered ideal in the 4-D models.
2. Design, is a step that describes the plan or initial design of the product that will be used as learning media development.
3. Development, is one of the stages in developing products that aim to provide validation about the product, whether the product is worth using as a learning medium.
4. Disseminate, is one of the stages in developing products that aim to promote or disseminate products development results in order to be accepted by users, both individuals and groups in a system.

Research Steps

The step in the development of planetary type starter motor props props is shown in figure 1.

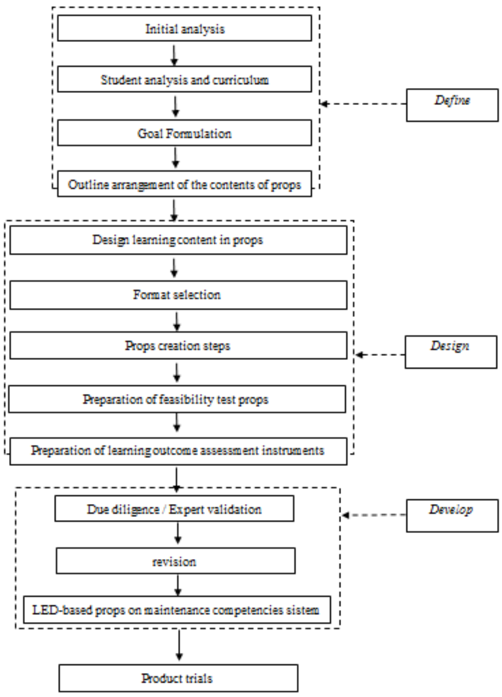

Figure 1. Props Development Steps

Product Feasibility Test

Test performance props

Performance test props aim to know the level of feasibility of props developed when applied in learning. Performance test props are conducted on the competency of starter motor maintenance, especially planetary type aims to know how much learning results students after using the developed props. Performance test props in this study using true experimental design research design with pretest-posttest control group design approach. In this design there were two groups selected randomly after that were given a pretest to find out the initial state of difference between the experimental group and the control group and posttest after being treated (Sugiyono, 2017).

Arikunto in (Samsudduha et al., 2013) test is a tool used to know or measure something in an atmosphere, in a predetermined way and rules. Before the test perpormace props, then researchers make a test problem with stages; test question tested, validity test, and reliability test. The test of the essay was conducted on students XII light automotive technique class Semarang Vocational High Schools who have studied the starter system. Then the questions are analyzed to find out the level of validity and reliable and homogeneity of the data. The valid and reliable questions will be used for pretest and posttest research questions of students of XI light automotive technique class Semarang Vocational High Schools.

Props feasibility test

Prop feasibility test is conducted with difference test of two average student learning outcomes, props feasibility test from material expert, and prop feasibility test from media expert. The Two-Sided Difference Test (Two-side Test) was used to test the differences between two one-side experiments conducted on subjects tested before and after using learning media. The formula for the t-test with the same variant is as follows:

$$t_{count} = \frac{\bar{x}_1 - \bar{x}_2}{S_{gab}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

with

$$s = \sqrt{\frac{(n_1-1)s_1^{\;2} + (n_2-1)s_2^{\;2}}{n_1 + n_2 - 2}}$$

Source: (Sudjana, 2005)

Information :

t_{count} = Statistical value searched

$\bar{x}_1$ = Average test of experimental group

$\bar{x}_2$ = Average test of control group

s_{gab} = Combined standard deviation

s_1 = Standard deviation of test scores of experimental group

s_2 = Standard deviation of control group test values

n_1 = Number of members of the experiment group

n_2 = Number of control group members

Due diligence of media experts and material experts is conducted to determine whether the resulting product can be said to be viable or not (Shofwanthoni et al., 2019; Vembriliya et al., 2019). According to (Fitria, 2013) to measure the level of feasibility assessment of the model is done by testing the results of the assessment that has been given from a team of materials and media experts, then analyzed using the following formula:

$$P_{(k)} = S/N \times 100\%$$

Source: (Fitria, 2013)

Information :

$P_{(k)}$ = Percentage of learning model eligibility

S = Number of assessment aspect scores by experts

N= Maximum number of scoring grades (maximum value of each item x number of question items x number of respondents)

Analysis of student responses

Analysis of students' responses to props aims to know the assessment of students to the product development of props, as for the formula as follows:

$$P = \frac{\Sigma n}{\Sigma N} \times 100\%$$

Source: (Hamdi & Bahruddin, 2014)

Information :

P = Percentage of assessment eligibility

Σn = Total score of aspects of the assessment obtained by students

ΣN = Maximum number of scoring grades (maximum value per item x number of question items x number of respondents)

RESULTS AND DISCUSSION

Development research has produced products in the form of LED-based props on the maintenance competency of planetary type starter motors XI light automotive technique class. The development model in this study is 4-D. 4-D development model conducted through 4 stages, namely: Define, Design, Develop Development and Disseminate. This development model was chosen because as a reference and assessed in accordance with the characteristics of the product to be developed, namely LED-based props of planetary type starter motors, as well as 4-D research and development models in this study explaining the operational steps of development in detail and detail. The stages and results that have been obtained are as follows:

a. Define, is the initial stage to establish a description of learning that is considered ideal by collecting various information related to learning media in the form of LED-based props starter motor planetary type developed and identify problems faced in learning that underlies the importance in developing LED-based props on the competence of starter motor maintenance, especially planetary type.

b. Design, is a step that describes the plan or initial design of LED-based props starter motor, especially the planetary type that will be used as a learning media development. At the design stage there are steps taken as follows: (1) Preparation of the outline of the contents of the props; (2) Design the learning content on props; (3) Format selection; (4) Steps of making props; (5) Preparation of props feasibility test; (6) Preparation of assessment instruments of learning outcomes.

c. Development, conducted an assessment of the validator to validate the instrument of feasibility of expert assessment in terms of materials and media. Validation is done by asking for consideration consisting of 2 material experts and 2 media experts who are in accordance with their fields, namely a teacher of Semarang 1 Vocational High Schools majoring in Light Vehicle Engineering and a lecturer in automotive electrical engineering majoring in Mechanical Engineering Semarang State University to assess the feasibility of the product by filling out the validation sheet that has been prepared. After the planetary type starter props are completed validation so that the criticism and suggestions are obtained then made revisions/ improvements to the props in accordance with the criticism and suggestions given from each validator. After completion of the revision/improvement is then conducted product trials to students to find out how much value obtained when using LED-based props starter motor type planetary developed.

Validation of experts material assessment of LED-based props maintenance motor starter especially planetary type is done by 2 material experts, namely Adhetya Kurniawan, S. Pd., M. Pd., as Lecturer of Semarang State University, faculty of engineering, in Mechanical Engineering and Edi Setyawan, S.Pd., as a teacher of electrical maintenance subjects light vehicles, Semarang 1 Vocational High Schools State. The results of the expert assessment of the material Table 1. next.

Table 1. Material Expert Assessment Results

No.	Material Experts	Score Count
1	Adhetya Kurniawan, S. Pd., M. Pd	33
2	Edi Setyawan, S.Pd	44
	Total Score	77
	Maximum Score Count	80
	Percentage %	96.25
	Category	Very Decent

Based on the results of material expert assessment data in table 1. can be analyzed from the aspect of expert assessment of materials, material experts argue that the products developed already include and can be used as a support in learning. Based on the average percentage of assessments by material experts according to Table 1. and fall into the category of "Very Worthy". Validation of media experts assessment of LED-based props starter motor maintenance especially planetary type is carried out by 2 media experts, namely Febrian Arif Budiman, M. Pd., as Lecturer of Mechanical Engineering Semarang State University, faculty of engineering and Sentot Cahyono, S.Pd., as a teacher of electrical maintenance subjects light vehicles, Semarang Vocational High School. The results of the expert assessment of the material Table 2.

Table 2. Media Expert Assessment Results

No.	Media Experts	Score Count
1	Febrian Arif Budiman, M. Pd	41
2	Sentot Cahyono, S.Pd	44
	Total Score	85
	Maximum Score Count	90
	Percentage %	94.44
	Category	Very Decent

Based on the results of media expert assessment data in table 2. can be analyzed from the aspect of assessment of media experts, media experts argue that the product is included in the development of creative and interesting. Based on the average percentage of assessments by media experts according to table 2. and fall into the category of "Very Worthy".

On the assessment sheet media experts and material experts listed columns of criticism and suggestions. The advice written on the assessment sheet column serves as a guideline for revising products in the form of LED-based starter care props, especially the planetary type developed. As for the advice of material experts in Table 3. and media experts table 4., including:

Table 3. Expert Advice Materials

No.	Criticism and Suggestions	Repair	Information
1	Images of pieces of planetary dental units should be included	Fixed	A cutout image of the planetary dental unit has been added to the props
2	Explanation of the parts of props in the manual book	Fixed	Corrects the description of the props sections in full in the manual book

Based on the results of the analysis from material experts in table 3. need to be made improvements to the wiring image of props. According to experts wiring image material on props need to include images of planetary dental unit pieces so as not to confuse students in learning to use LED-based props starter motor care especially planetary type. Therefore, it is necessary to make improvements to the wiring image of these props. Based on the results of input from material experts in table 3. that given a complete explanation of the parts of props in the manual book so as not to confuse students in learning before using props.

Table 4. Media Expert Advice

No.	Criticism and Suggestions	Repair	Information
1	Media can be used in research	-	-
2	Props are appropriate and usable	-	-

Based on the results of the class of light automotive technique the analysis of media experts in table 4. that the learning media in the form of LED-based props starter motor especially planetary type already includes all assessment items and can be used without revision. Therefore, there is no need to make improvements so that it can be used in the research stage.

d.Disseminate is done in the form of softcopy in the form of video learning starter motor props planetary type uploaded on youtube and files in the form of a manual book containing the identity of props, materials, how to make and how to use props and test questions conducted through micosoftteam belonging to automotive electrical teachers. From this in order to be accessible to students XI 1 light automotive technique class (dick group) and XI 2 light automotive technique class (experimental group) Semarang Vocational High Schools.

The results of the pretest and posttest competency tests between the experiment group of 32 students and the control group of 32 students of Automotive Light Vehicle Engineering Semarang 1 Vocational High Schools. The results of improving the competence of students between control classes do not use with experimental classes that use LED motor starter props, especially planetary types. Figure 2 and Figure 3 show a bar chart of average pretest and posttest scores of students between the experiment group and the control group.

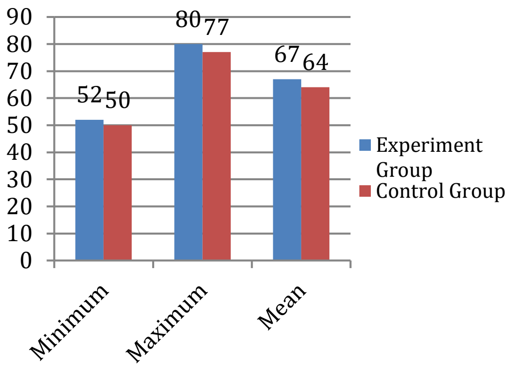

Figure 2. Pretest Value Bar Chart Between Experiment Group and Control Group

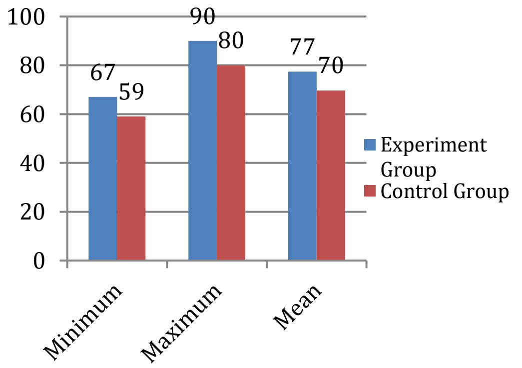

Figure 3. Posttest Value Bar Chart Between Experiment Group and Control Group

The normality test is known to result in pretest normality with the formula Chi-squared $x^2{}_{count}$= 5,43 for the control group, $x^2{}_{count}$= 1,28 for the experimental group at a significance level of 5% and dk= 6-3 = 3 obtained $x^2{}_{table}$= 7,8. While the posttest normality result with Chi-squared formula

$x^2{}_{count}$= 5,02 for the control group, $x^2{}_{count}$= 4,28 for the experimental group at a significance level of 5% and dk= 6-3 = 3 obtained $x^2{}_{table}$= 7,8, can be seen in the following table 5.

Table 5. Pretest and Posttest Normality Test Results Between Control Group and Experiment Group

No	Test	$x^2{}_{count}$	$x^2{}_{table}$	Conclusion
1	Pre test Control Group	5.43		Normally distributed data
2	Pre test Group Experiments	1.28	7.81	Normally distributed data
3	Post test Control Group	5.02		Normally distributed data
4	Post test Group Experiments	4.28		Normally distributed data

Normality test results obtained data that $x^2{}_{count}$ < $x^2{}_{table}$ (5,43 < 7,81), (1,28 < 7,81), (5,02 < 7,81) and (4,28 < 7,81), it can be concluded that the pretest and posttest data between the control group and the experiment group is normally distributed data. Furthermore, the results of the pretest and posttest homogeneity tests between the control group and the experiment group can be seen in table 6. next.

Table 6. Pretest and Posttest Homogeneity Test Results Between Control Group and Experiment Group

Test	F_{count}	F_{table}	Conclusion
Pre test	1.23	1.82	Homogeneous data of the same variant
Post test	1.04		Homogeneous data of the same variant

Based on table 6. the calculation of homogeneity test results obtained F_{count} pretest between the control group and experiments is 1,23 While the posttest F_{count} between the control group and the experiment is 1,04 with the numerator dk 32-1=31 and the denominator dk 32-1=31 at a significance level of 5% obtained F_{table} = 1,82. The results of the calculation show F_{count} < F_{table} it can be concluded that the data is homogeneous.

The average difference test obtained a pretest t_{count} between the control group and the experiment group of 1,59 while the posttest t_{count} between the control group and the 6,00 experiment group with a significance rate of 5% had a dk 32+32-2=62 obtained t_{table} (0.95)(62)= 1,67. The t-test calculation results are described in table 7. next.

Table 7. Results of Average Pretest and Posttest Differences Between Experimental And Control Group

Test	t_{count}	t_{table}	Inferred
Pre test	1.59	1.67	No improvement in learning ouncomes
Post test	6.00		There is an improvement in learning outcomes

Based on table 7 t_{count} pretest is in the Ho reception area (t_{count} > t_{table}) it can be concluded that the experiment group is no better than the control group. While the posttest t_{count} are on the rejection of Ho (t_{hitung} < t_{table}) it can be concluded that the experiment group is better than the control group.

This research has produced a final product with a very decent category based on the assessment by 2 media experts and 2 material experts. LED-based props products starter motor maintenance especially planetary type obtained a feasibility rate from media experts of 94.44% and material experts of 96.25%. Based in terms of assessment in terms of media aspects that are assessed, namely the assessment of appearance, size, use of tools and competencies. In terms of material aspects that are assessed are learning, curriculum, content of materials and media functions. Props meet the category and are said to be worth using in research.

The final product of LED-based props of planetary type starter motor care has been tested to two classes, namely XI 2 light automotive technique class which consists of 32 students as an experimental group and XI 1 light automotive technique class which amounts to 32 students as the control group of Semarang 1 Vocational High Schools. LED-based props products of planetary type starter motor treatments that have been tested for effectiveness and proven effective to improve learning outcomes with the average learning outcomes of the control group increased by 5.69 and the experiment group increased by 10.44. LED-based props products starter motor maintenance planetary type received an excellent response from students with a percentage of 87.60%, so it can be concluded that LED-based props starter motor maintenance planetary type deserves to be used in improving the competence of starter motor maintenance, especially planetary type as well as getting excellent response from students.

(Ani Rusilowati et al., 2020) props have the advantage, which is to help teachers in the learning process when delivering materials to the maximum, thus reducing conventional teaching methods. Props help students, so that students can see for themselves the internal process (An'nur et al., 2020). Props contain wiring images of how planetary type starter motors work using LED lights to make it easier for students to understand them. Learning by using props gives an idea of the understanding of the starter motor, the names of the starter motor components, about how the starter motor works, how the maintenance on the starter motor is especially planetary type. In addition, the advantages of LED-based props starter motor maintenance, especially planetary type is that students become independent in learning because props can be used in the classroom or outside the classroom.

This is in line with existing research from the previous and almost the same, including research from (Widjanarko, 2014) entitled "Application of LED-Based Props to Improve Student Learning Outcomes on Competency Knowledge Examination and Trouble Shooting Motor Starter Type Planetary". Based on the analysis that has been done, the average increase in the study results of the control group was 6.35 and the experimental group by 11.37. Based on this, it can be concluded that there are differences in learning outcomes between the control group and the experimental group in the development of a learning medium, where the results of the experimental group study are more effective compared to the control group.

CONCLUSIONS AND SUGGESTIONS

Conclusion

Product feasibility test results, obtained percentage and final result for media experts by 94.44% and for material experts by 96.25%, so it can be stated that the final product LED-based props starter motor maintenance developed categorized as "feasible" to be applied in class learning.

Improved starter motor maintenance competency is obtained from pretest-posttest scores among students who have not used props with students who use props. The average learning outcome of the experiment group students using planetary starter system props with an initial average of 67.00 increased to 77.44. Meanwhile, the control group that used learning with lectures with an initial average of 64.06 increased to 69.75. In the group of learning experiments using props increased by 10.44 and the learning control group with lectures increased by 5.69. Based on the final calculation of the value $t_{count}=$

6,008 > t_{table}= 1,67 at α=5% with dk=62, t is in ho's rejection area, it can be concluded that the experiment group is better than the control group.

Students response to the final product of starter motor props obtained a final percentage result of 87.60%, so it can be stated that the starter motor props product is categorized as "Excellent".

Suggestion

The advice presented from this study is to get optimal learning suggested before using learning media with planetary type starter motor props are recommended to read the manual book props first.

For students are advised to learn not only using media in the form of planetary type starter motor props but also balanced by using other media such as books, engine book manuals, modules, power points, learning videos.

Planetary type starter motor props are expected to be developed with the addition of audio when the flow of LED light runs so that students can understand the electricity flow and its explanations.

ACKNOWLEDGEMENT

Thank you to Semarang 1 Vocational High School for helping this research so that it can be arranged properly. Adhetya Kurniawan, S. Pd., M. Pd., and Edi Setyawan, S.Pd. as material validators. Febrian Arif Budiman, M. Pd., and Sentot Cahyono, S.Pd. as media validators.

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