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Development of Catalytic Converter Learning Media to Improve Knowledge of Automotive Vocational School Students

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ABSTRACT

Improving the quality of vocational high school graduates (SMK) is relevant to the needs of the world of work and industry. All teachers need support in preparing learning media that are by the competencies needed by the world of work and industry. This study aims to develop a catalytic converter exhaust emission system so that it can be used optimally to increase students' knowledge. The design study which is used in this research is a Four-D device development model which includes 4 stages of development, namely: the Define Stage, the Design Stage, the Development Stage, and the Disseminate Stage. The research subjects were students of class VII TKR in SMK Muhammadiyah 1 Salam, totalling 30 students. The stages of development are carried out properly to produce learning media an attractive and representative catalytic converter exhaust emission system so that it can significantly increase students' knowledge. There was an increase in students' knowledge using the learning media of the catalytic converter exhaust gas emission system as evidenced by the average pre-test score of 57.50% and the post-test result of 88.28% or an increase of 30.78%.

Keywords: Catalytic Converter, Learning Media, Knowledge

INTRODUCTION

The Development of science and technology on improving the quality of human resources affects the readiness and competitiveness of a country that is facing the demands of the global era [1][2][3]. Science and technology as well as the quality of human resources (HR) are key factors in determining the success and progress of a nation [4]. A nation that has the advantage of quality and quality education and human resources will be able to compete in global competition [5][6]. To achieve the national education goals above, improvements in the quality and quality of education are needed. Improvement of the quality and quality of education, not only includes educational activities between educators and students, but contains the interaction process of educational components, such as learning tools or media, and learning environment [7][8].

Component interaction-component Education can be carried out at levels of education that have been provided by the government. Educational levels do not only aim to provide a place in every stage of preparing for the future of citizens. But more importantly, the level of education becomes a facilitator in solving problems and investing in a nation [9][10]. One level of education that is prepared as an educational investment that is good enough to prepare skilled workers in facing the future is the vocational education level (SMK) [11][12].

Education Vocational High School (SMK) is a skill-based education [13][14]. Vocational education aims to produce graduates who can easily enter the job market and are capable of entrepreneurship. Vocational education serves to prepare the needs of the workforce needed in economic development and can produce educated and skilled workers by the needs of employers.

Achieving quality vocational education requires effort in solving the problems that occur. The problems of vocational education that are currently occurring and will soon be resolved include: (a) The relationship between industry and trade, government and education and training providers is not well developed [15][16][17]; (b) Vocational teachers still lack experience in the world of work [16][18][19], and (c) Media and practical learning facilities in vocational schools are not by technological developments in the industry [20][21][22][23]. The problem of vocational education will be resolved if related parties such as teachers, industry, and students synergistically understand that vocational education will achieve its goals if science is synergized with the needs of the world of work [13][24].

The automotive world is experiencing rapid development that affects the demands of human needs. Indonesia is one of the largest automotive countries in ASEAN after Thailand. Indonesia will become the largest automotive market in ASEAN in 2021 with a total of 2.3 million vehicles [25][26]. This

development was triggered by Indonesia's stable economic growth, an increasing middle class, and increased investment in the automotive sector as well as the enactment of automotive regulations that support market growth. The most visible developments in the exhaust gas control sector have an impact on the demands for qualifications of workers and prospective workers to master the competence of the exhaust emission system [27][28].

The rapid development of the automotive world needs to be supported by balanced human resources (HR) and knowledge facilities to be able to anticipate the demands of the development of the world of work[29]. Vocational High Schools that function to create skilled workers must try to answer these challenges. Rapid technological developments in the exhaust emission sector require the preparation of the ability of teachers and learning media to facilitate students in gaining competence on exhaust emission systems [30][31]. The lack of number and suitability of learning media is still a problem for teachers in teaching exhaust emission systems [32][33].

Learning media related to exhaust gas emission systems are not widely owned by SMKs with Light Vehicle Engineering Competence (TKR). TKR Vocational High School, which has mostly conventional exhaust emission systems, not catalytic converters [34][35]. Several research results state that currently the industry expects automotive SMK operators to emphasize several renewable competencies such as the competence of the exhaust gas catalytic converter system [36][37]. *Catalytic converter* or also called a catalyst is a component that is included in the exhaust gas treatment which has a function to clean engine emissions from nitrogen oxide/NOx gas [37].

The existence of a catalytic converter is very important because it greatly affects the success of a vehicle passing the emission test. In some countries that have special regulations on emissions, a car owner can be fined because his car is not environmentally friendly. The importance of overcoming the demands of these competencies, catalytic converter learning media needs to be planned, created, and developed so that it can increase the knowledge of TKR Vocational High School students [37][38].

RESEARCH METHOD

The design study which is used in this research is a *Four-D* device development model which includes 4 stages of development, namely: the Define Stage (The planning stage aims to design learning tools), the Design Stage (make design drawings and initial products (prototypes) or product designs), the Development Stage (tool development with expert input), and the Disseminate Stage (socialization of research results). The stages of the research can be seen in Figure 1.

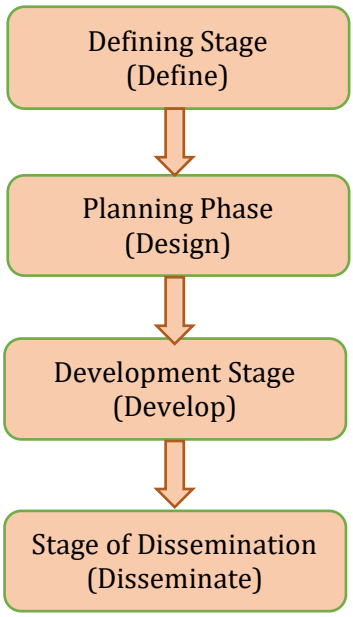

Figure 1. Stages four-D device development model [40]

The object of the research was carried out at SMK Muhammadiyah 1 Salam. Due to the pandemic period, the research subjects taken were 5 students for the small group (trial 1) and 15 students of class VII for the large group (trial 2). The data collection instrument consisted of a questionnaire and a knowledge test sheet (test). The questionnaire serves to measure the responses of media experts and material experts. While the test serves to measure the results of knowledge after the application of learning media for the catalytic converter exhaust gas emission system in the Basic Automotive Engineering subject of combustion system competence.

The media expert instrument consists of aspects related to learning media. The grid for instructional media expert instruments can be seen in Table 1.

Table 1. Media expert grid

Indicator	Item
Ease of operating props	1.2
Suitability of sketches with props	3.4
The practicality of teaching aids in learning	5.6
Effectiveness of props	7.8
The final quality of props	9.10

(Source: [41])

The material expert instrument contains points about aspects related to learning media materials including aspects of learning, material, and content truth. The grid for learning material expert instruments can be seen in Table 2.

Table 2. Grid for material experts

Indicator	**Item**
Giving examples in presenting the material	1.2
Conformity of the material with competency standards	3.4
The suitability of the material with the media presented	5.6
Ease of material for students to understand	7.8
Clarity of sound reading material	9.10

(Source: [41])

The knowledge test instrument uses the taxonomy method with question clarification divided into six parts, namely Knowledge, Understanding, Application, Analysis, Synthesis, and Assessment or more popularly called the C1-C6 method through a series of statistical tests such as validity tests,

reliability tests, difficulty level tests. The grid for the knowledge test instrument can be seen in Table 3.

Table 3. Knowledge test grid

Indicator	Item
Exhaust basic function	1.2
Introduction and understanding of catalytic converter	3,4,5
Application of catalytic converters on motorcycles	5.6
Gas catalytic converter analysis	7
Synthesis of components and functions of the catalytic converter	8
Evaluation of catalytic converter materials on motorcycles	9.10

(Source: [42])

This type of research data is using qualitative and quantitative data, then the data were analysed descriptively. Qualitative data is used to analyse non-test data which can be obtained through comments and suggestions for product improvement from material experts and media experts. Quantitative data is obtained from numerical scores and then entered in a statistical table from the results of the assessment of material experts, media experts, and knowledge tests. The analysis used is:

To find the mean or average value by using the formula:

$$X = \frac{\sum X}{N}$$

X = Average value

ΣX = Sum of all values

N = Number of students

To calculate the value of media experts, material experts, media assessment sheets, and learning outcomes, the following formula is used:

$$\text{Score} = \frac{\text{Value Gain}}{\text{Maximum Score}} \text{ X } 100$$

To be able to give meaning based on the results of media and material experts, use the conversion level of achievement in Table 4.

Table 4. Conversion of Expert Assessment Achievement Rate

Value Range	Category
87 – 100	Very good
73 – 86	Well
59 – 72	Enough
45 – 58	Not enough

(Source: [43])

The prerequisite tests for the analysis carried out were the normality test, homogeneity test, and t-test. A normality test is used to determine the distribution or distribution of research data. A homogeneity test is used to determine the similarity of the variance of two data. The t-test was used to compare the average knowledge test results of the control and experimental groups.

RESULTS AND DISCUSSIONS

Researchers developed learning media based on the Four-D device development model.

Defining Stage (Define)

The activity of the definition stage is often called a needs analysis. This stage

consists of five main analysis steps, namely: First, front-end analysis by analysing the syllabus of the combustion system and formulating problems related to the exhaust gas emission system learning media.

Table 5. Competency achievement indicators

Basic Competencies	Basic Material
Understanding, Identifying, and developing concepts	Motor vehicle emission control technology

Second, student analysis (learner analysis). At this stage, the researcher studied the characteristics of the students and the results of the analysis of the characteristics of the students showed that the exhaust emission system lesson was still relatively low. Learning media for the catalytic converter exhaust emission system is still not available.

Third, task analysis (task analysis). At this stage, it contains assignments that will be given to students. Individual assignments contain knowledge test questions and group assignments contain problem analysis related to exhaust emission systems (4) Concept analysis (concept analysis). The results of the analysis of the concept of cutting catalytic converters are in the form of a framework listed in the planning stage. (5) Formulation of learning objectives (specifying instructional objectives). The purpose of this step is to find out changes in students after carrying out learning activities with catalytic converter media.

Planning Phase (Design)

The planning stage aims to design learning tools with the following stages:
(1) Preparation of test standards (criterion-test construction). Reference tests are arranged based on the specification of learning objectives and analysis.

Table 6. Preparation of knowledge test standards

Indicator	No Item	Item Quantity
Pollution and the basic function of the exhaust	1,2,4,5, 8,9	6
Introduction and understanding of catalytic converter	10,11	2
Application of catalytic converters on motorcycles	7,12,13	3
Gas catalytic converter analysis	14, 16, 17, 18,	4
Synthesis of components and functions of the catalytic converter	3,6,15	3
Evaluation of catalytic converter materials on motorcycles	19,20	2

Several tests are needed to prepare for the knowledge test instrument to be suitable for use. The results of the instrument reliability test got a score of 0.623. These results are included in the high category. The results of instrument validation, the indicator is above the standard r table 57, namely >

0.266 which indicates that the instrument indicator is valid.

Next, *Test frequencies. Test frequencies* serve to see the level of difficulty of the items and analyze the different power of each item. The results of the difficulty of the questions can be seen in Table 7.

Table 7. Classification of problem difficulty levels

Score	Category	Question Points
0.00 – 0.20	Hard	3,12,14
0.21 – 0.70	Currently	5,6,7,8,9,16,19
0.71 – 1.00	Easy	1,2,4,10,11,13, 15,17,18,20

(2) Make a preliminary plan (*Initial design*). In the initial design stage, the researcher makes a design drawing and an initial product (prototype) or product design. This stage is carried out to create a media model that is by the learning objectives.

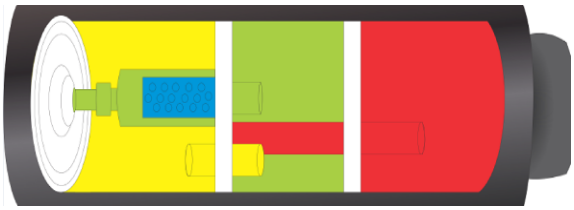

Figure 2. Design drawing

Figure 3. Media design (Prototype)

Development Stage

The development stage is carried out through two steps, namely expert judgment which includes the assessment of media experts and material experts. Media experts are carried out by 2 learning experts and 2 industry practitioners. The results of the assessment scores by media experts on the media being made include getting a score of 36 with a percentage of 90.00%. Thus, it can be said that the results of the validation by media experts indicate that the cutting catalytic converter learning media on the exhaust is in a good category. Suggested input from media experts for improvement is: adding cutting catalyst converter front and smoothing welding joints.

Material expert validation is carried out to obtain input about the material being developed. The results of the input are used to revise the questionnaire and test knowledge before being tested. The results of material expert validation obtained a score of 34 with a percentage of 88.00%, so the media developed was in a good category. Input from material experts that are suggested to be improved is knowledge test questions adjusted to the syllabus and adding the number of questions proportionally. After being revised, the results of the media to be tested can be seen in Figure 4.

Figure 4. Media revision results

After the learning media and material instruments have been revised, the next step is to conduct trials. The trial was conducted twice to measure the achievement of students' knowledge. The first test group was the control class and the experimental class with a total of 30 students.

The control class group involved 15 students of class VII A of TKR in SMK Muhammadiyah 1 Salam. While the experimental class trial involved 15 students of class VII B of TKR in SMK Muhammadiyah 1 Salam. The results of the knowledge test of the control class and the experimental class can be seen in Table 8 and Figure 5.

Table 8. Comparison of knowledge test results for control class and experiment class

Statistical Indicator	Control Class	Experiment Class
Amount	2170.00	2470.00
Average	65.72	88.28
Highest Score	95.00	100.00
Lowest Score	55.00	65.00
Standard Deviation	6.78	7.82
Mode	65.20	90.00
median	65.00	88.00
N	15	15

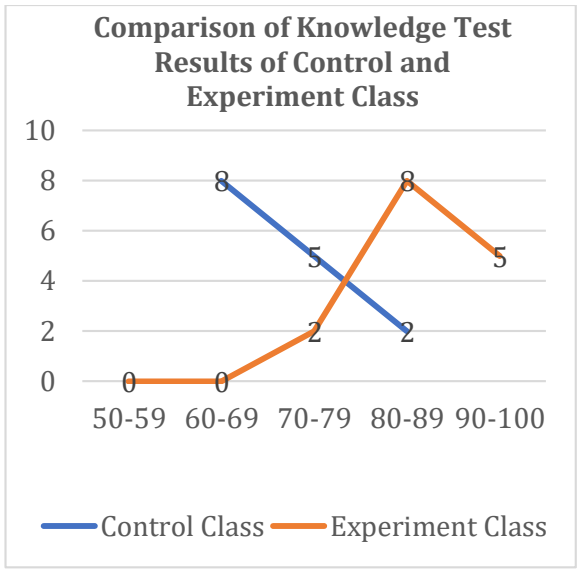

Figure 5. Comparison of knowledge test results of control and experiment class

Based on Table 8 and Figure 5, it is known that the average learning outcome for the control class is 65.73 and the average learning outcome for the experimental class is 88.28. after the t/different test showed that there was a significant increase using the learning media of the catalytic converter exhaust gas emission system. The results of the knowledge test are in line with several research results which conclude that the development of a catalytic converter exhaust emission system is needed for competency development [44][45] and can increase student knowledge [37][46][44][36].

After the trial process with several revisions related to the design, a learning media for the catalytic converter exhaust gas emission system was produced which is ready to be disseminated to the general public. The results of the final media product can be seen in Figure 6.

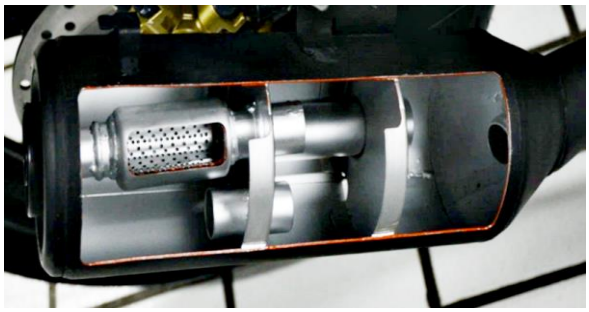

Figure 6. Final product of catalytic converter exhaust gas emission system learning media

Stage of Dissemination (Disseminate)

In the context of media dissemination, it is carried out by socializing learning media for the catalytic converter exhaust gas emission system in the form of scientific publications in national journals so that it can be used by the general public.

CONCLUSION

Learning media developed through 4 stages for-D device development model which includes; Defining Phase (Define), Planning Phase (Design), Development Phase (Develop), and Dissemination Phase (Disseminate). Learning the media of catalytic converter exhaust gas emission systems can significantly increase students' knowledge.

Learning media provides a new perspective for learning. This learning media displays a more open form (cutting) so that each part can be understood how it works and the specifications are more in-depth so that students learn more easily.

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