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Utilization of Augmented Reality in Automotive Subjects for Basic Competencies of Four-Wheeled Vehicle Brake Systems

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Abstract - In automotive learning, teachers generally use books and teaching aids as learning media. Automotive learning outcomes show the low value of learning outcomes. Thus a learning media is needed that can help improve learning outcomes. One way to overcome this problem is to use learning media that utilize augmented reality technology. In this study, a learning media using augmented reality technology based on android was developed to simulate the brake system on four-wheeled vehicles in 3 dimensions. The Augmented Reality work system used is marker based tracking, and uses 3D Max software and the Vuforia plug-in. In terms of pedagogy, this learning system uses the Modality Principle.
Participants are class XI students of SMK YPM 4 Taman. This research uses experimental research. The students involved were 44 students divided into 2 groups, with each group consisting of 22 students. Both groups received a pre-test and a post-test. The experimental group was given treatment with Augmented Reality-based learning media, while the control group did not use conventional learning media. After making comparisons, the results show less than optimal due to the pandemic period.
The results showed that the pre-test result between the control group and the experimental group was 49.32, and the post-test result for the control group was 62.73, while for the experimental group it was 73.18. So that from the difference in the difference in post-test scores between the experimental group and the control group shows that the treatment factor by providing Augmented Reality-based learning media in the experimental group has an influence. From observations and interviews, students were more active in learning activities and students were eager to take part in learning. This proves that students are interested in this media which can generate motivation to learn.

Keywords: Augmented Reality, Automotive Brake System, Learning Media.

I. INTRODUCTION

Vocational education is education that prioritizes the mastery of skills for graduates. Not only skills, but also knowledge to support these skills. Students must learn in order to get the knowledge in question. One of the skills in vocational education is light vehicle technology. Light vehicle technology graduates are required to master knowledge and skills in the field of light vehicle technology. One of the basic competencies found in light vehicle technology expertise is about brake systems, where students are expected to be able to identify and understand the mechanisms of the brake system itself.

For fun and interactive learning purposes, adequate learning media is needed. With adequate learning media it will help students' imagination in recognizing real objects and systems before students carry out practicum activities. Through the 3D object making software, components for the brake system itself are compiled, resulting in a 3-dimensional form of the brake system working mechanism which will be utilized by students in learning.

The components of the brake system are arranged in such a way through Augmented Reality (AR) technology so that they become interactive information that can facilitate the intended learning. AR is a concept that combines the virtual world with the real world to produce information from data taken from a system on the designated real object so that the boundary between the two becomes thinner. AR can create interactions between the virtual world and the real world, all information can be added so that the

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information is displayed in real-time as if the information becomes interactive and real.

To see how much influence with learning using this augmented reality, a division of groups is carried out where each group will receive a pre-test and post-test. The difference is that one particular group uses conventional learning (without augmented reality) and another group uses augmented reality.

According to Faieza Abdul Aziz [1] that the AR-based application developed has great potential in automotive maintenance training. And the results show the effectiveness of applications developed for training purposes.

II. USING AUGMENTED REALITY AS LEARNING MEDIA

Augmented Reality is a technology that combines two-dimensional and / or three-dimensional virtual objects into a real three-dimensional environment and then projects these virtual objects in real time [4].

The way AR works is divided into two types based on the method, namely:

a. *Augmented Reality Marker*
Marker is usually a black and white illustration of a square with a bold black border and white background. The computer will recognize the position and orientation of the marker and create a 3D virtual world, namely the point (0,0,0) and 3 axes namely, X, Y and Z.


Figure 1. Disc Brake Figure 2. Drum Brake

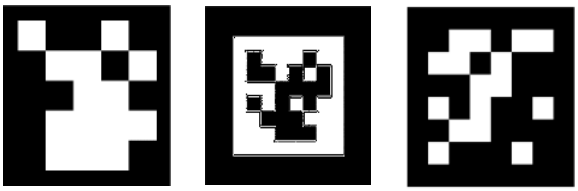

Figure 3. Marker

b. *Markerless Augmented Reality*
In this method, markers are not used to display digital elements. The development of markerless augmented reality can be markerless tracking, such as:

- *Face Tracking*
  Face tracking is markerless AR that uses an algorithm developed so that computers can recognize human faces in general by recognizing the position of the eyes, nose and mouth. And ignore other objects around it.

- *3D Object Tracking*
  Unlike face tracking, which only recognizes human faces in general, 3D object tracking techniques can recognize all forms of objects that are around

- *Motion Tracking*
  This technique captures motion, widely used in film productions that attempt to simulate motion.

- *GPS Based Tracking*
  This technique takes data from the GPS device and the compass and displays it in the desired direction.

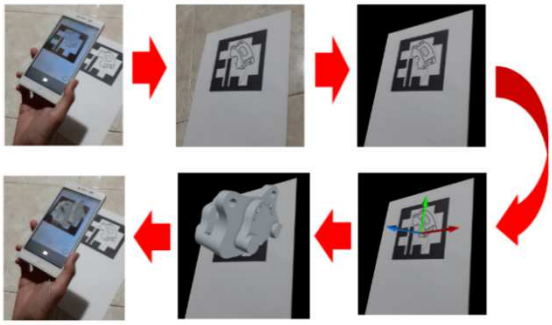

Figure 4. Augmented Reality

III. INTERFACE DESIGN

In developing this application there is an interface design, it can be seen in the pictures below.

Figure 5. Splashscreen

Figure 6. Main Menu

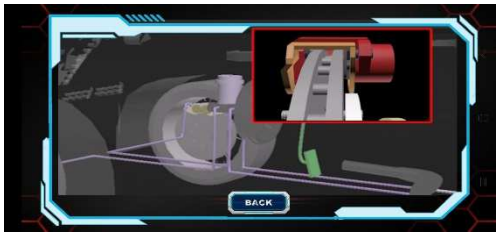

Figure 7. Intro Menu

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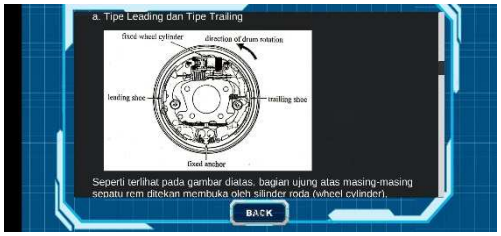

Figure 8. Basic Theory Menu

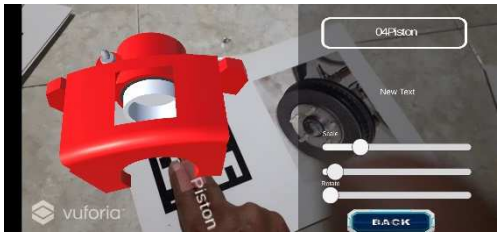

Figure 9. AR Menu

IV. RESULTS AND DISCUSSION

The testing process with pre-test and post-test was carried out to determine the level of difference before and after learning. The types of questions that will be given in the Pre-Test and Post Test are in the form of questions with cognitive, affective and psychomotor aspects. Meanwhile, to determine the level of usefulness of the system used a questionnaire based on the ISO 25010 standard on aspects of the Usability Test (Usability).

Table 1
Investigating Factor

Variable	Factor	Item Number	Number of Question
The level of understanding of class XI students of Light Vehicle Engineering towards learning with brake system material	Definition	10, 18	2
	Type	4, 6, 14, 16	4
	Component	2, 3, 5, 11, 15	5
	Mechanism	1, 7, 8, 9, 17, 12, 13, 19, 20	9
			20

The number of questions used to determine the level of understanding of students was 20 items with 5 (five) indicators of how the drum brake worked, 5 (five) drum brake components and disc brake components, 4 types of drum brakes and disc brakes. (four) items, 2 (two) false air exhausts, 2 (two) item brake shoe clearance adjustments, 2 (two) items on the strengths and weaknesses of drum brakes and disc brakes.

The mean value obtained from the pre-test results was for group A was 61.25 and for group B was 56.68. While the average score obtained from the post-test results for group A was 70.63 and group B was 79.50.

The increase in learning outcomes between group A and group B was 15.31% and 39.78%.

Table 2
Results of the Validity Test of Student Understanding

[1] Question	[2] r table	[3] r count	[4] Information
[5] Question 1	0,628	[7] 0,3	[8] Valid
[9] Question 2	] 0,427	1] 0,3	2] Valid
3] Question 3	] 0,643	5] 0,3	6] Valid
7] Question 4	] 0,734	9] 0,3	0] Valid
1] Question 5	] 0,394	3] 0,3	4] Valid
5] Question 6	] 0,457	7] 0,3	8] Valid
9] Question 7	] 0,581	1] 0,3	2] Valid
3] Question 8	] 0,310	5] 0,3	6] Valid
7] Question 9	] 0,322	9] 0,3	0] Valid
41] Question 10	42] - 0,119	3] 0,3	4] Invalid
45] Question 11	] 0,415	7] 0,3	8] Valid
49] Question 12	] 0,457	1] 0,3	2] Valid
53] Question 13	] 0,652	5] 0,3	6] Valid
57] Question 14	58] - 0,087	9] 0,3	0] Invalid
61] Question 15	62] - 0,032	3] 0,3	4] Invalid
65] Question 16	] 0,479	7] 0,3	8] Valid
69] Question 17	] 0,365	1] 0,3	2] Valid
73] Question 18	74] - 0,064	5] 0,3	6] Invalid
77] Question 19	] 0,573	9] 0,3	0] Valid
81] Question 20	] 0,417	3] 0,3	4] Valid

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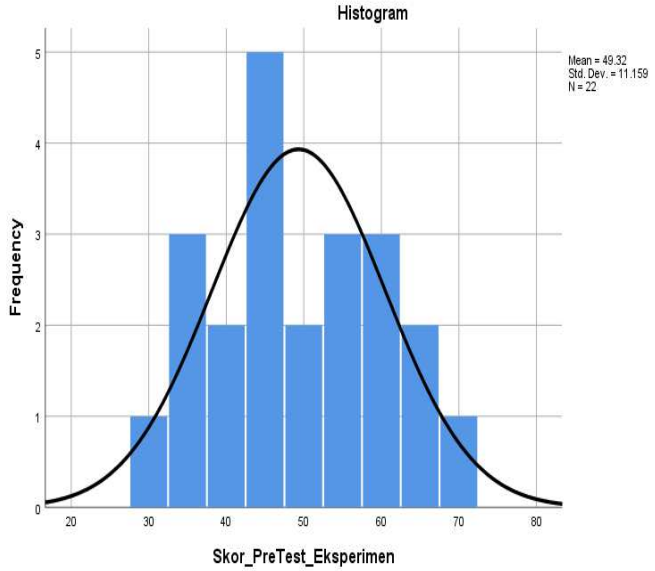

Figure 10. Experiment Class PreTest Score

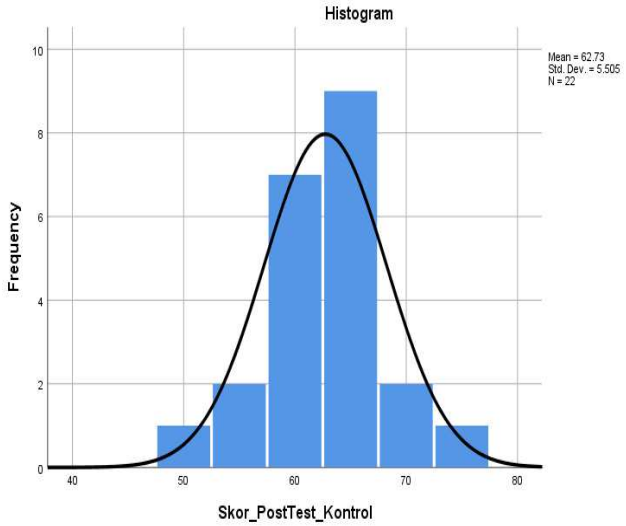

Figure 11. Control Class PostTest Score

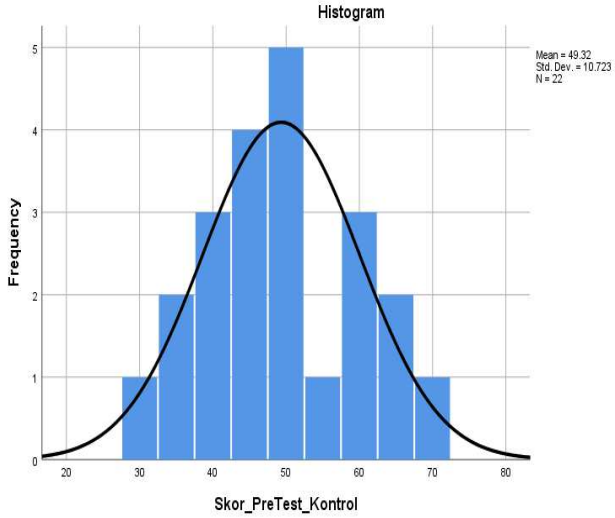

Figure 11. Control Class PreTest Score

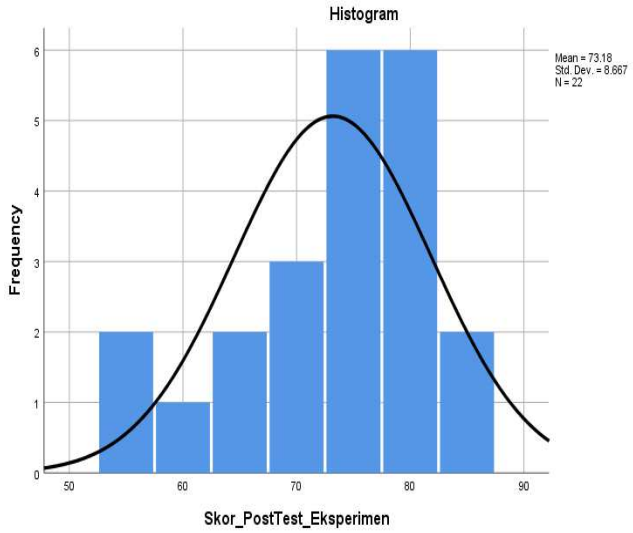

Figure 10. Experiment Class PostTest Score

V. CONCLUSION

The program trial during the Covid19 pandemic was carried out in several stages, the first stage was an experiment by class XI students at SMK YPM 4 Taman which was carried out at their respective homes, so that neither classroom teachers nor researches could directly observe and supervise participants students do the experiment. The second stage is an experiment conducted by the classroom teacher, and the result of the experiment concluded that the augmented reality-based application that was built could help students.

The test result using the latest smartphone, even with low lighting, the marker can be tracked quickly. And when using an older generation smartphone or using a tablet with low lighting, it will result difficult marker tracking process (tends to take a long time).

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