Application of Learning Media Using Virtual Reality to Improve Learning Outcomes of Electronic Circuit Application Subjects in Vocational Schools

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Abstract
The purpose of this study was to determine how the Application of Learning Media Using Virtual Reality can improve the activities, learning outcomes, and responses of students in class X TKJ SMK Negeri 10 Makassar in the learning process. This research is a Classroom Action Research which is a process of studying learning problems in the classroom through self-reflection to solve these problems by taking various planned actions in real situations. Application of Learning Media Using Virtual Reality can increase the activity of students in class X TKJ SMK Negeri 10 Makassar in the learning process, Application of Learning Media Using Virtual Reality Can Improve Learning Outcomes of the application of electronic circuits of students in class X TKJ SMK Negeri 10 Makassar, and the response of students in class X TKJ SMK Negeri 10 Makassar to the application of Learning Media Using Virtual Reality in the Productive learning process is positive.

Index Terms— **Virtual Reality, Media, Learning Outcomes, Application of Electronic Circuits, Vocational School**

I. INTRODUCTION

The development of learning technologies in the technological era 4.0 has changed the way we learn and teach [1]. In this era, technology has become an integral part of the learning process, enabling wider access and flexibility in getting education [2]. With learning technology, we can easily access educational resources online. Digital learning platforms [3] provide a wide range of learning materials, from interactive learning videos, downloadable learning modules, to online discussion forums and games [4]. This allows us to learn anytime and anywhere, without being limited by time and space constraints. In addition, learning technology also allows collaboration between students and teachers virtually. Through video conferencing applications, students can interact directly with their teachers and classmates, share ideas, and discuss materials.

Students enter the Metaverse World through exciting and innovative virtual learning experiences [5]. Using advanced technology, they can explore virtual environments that resemble the real world in incredible detail. Through virtual learning, students can expand their knowledge in various disciplines, from science to arts and culture. They can interact with virtual objects and characters, conduct experiments, and even collaborate with other students around the world. The Metaverse world provides new opportunities for students to develop their skills and prepare themselves for an increasingly digital future [6]

Along with the rapid development of technology, more and more software is available online to enhance learning. However, the presence of many of these software can also affect students' learning concentration. One of the negative impacts of this abundance of software is the disruption of students' learning focus. In this digital era, students can easily access various educational software through the internet. While this is a positive thing, students often become too dependent on the software. Students tend to spend a lot of time exploring the software rather than actually focusing on learning. In addition, the sheer amount of software available online can also cause confusion for students. With so many options available, students can feel overwhelmed and find it difficult to choose the most suitable software for their learning needs. This can lead to students not making the most of the software to improve their understanding in learning. Furthermore, the abundance of educational software available online can also interfere with students' social interactions. Students tend to spend a lot of their time in front of computers or gadgets to use the software, rather than interacting directly with classmates or teachers. This can affect students' ability to communicate and work in teams, which are important social skills in everyday life.

However, this does not mean that all online educational software has a negative impact. If used wisely and purposefully, they can be effective tools in supporting student learning [7]. It is important for students and educators to choose software according to students' learning needs, as well as manage the time of its use so as not to disrupt learning concentration. Virtual reality is a very innovative learning solution in this era of advanced technology. By using virtual reality technology, students can experience a more immersive and interactive learning experience. They can enter realistic virtual worlds and participate in engaging simulations, thus allowing them to learn in a more practical and enjoyable way [8].

In learning using virtual reality, students can visit physically distant places, such as museums, planetariums, or even to historical places that cannot be reached directly. They can see and explore objects or phenomena that are difficult to understand through pictures or textbooks alone. Thus, virtual reality helps improve students' understanding and engagement in the learning process.

Teaching basic skills practice needs to use certain strategies so that students understand, both cognitively and at the same time motorically the basic steps of a vocational work skill and one of the learning strategies for working on basic vocational skills is the learning strategy using virtual reality. The method is expected to improve student learning outcomes in the Application of Electronic Circuits subject in SMK includes various concepts and practices related to the use and application of electronic circuits. In this subject,

students will learn about the basic principles of electronic circuits, the components used, and how to assemble and test a functioning electronic circuit. In addition, this subject will also discuss the application of electronic circuits in various fields of industry [9]; [10], communication, automatic control, and information technology. Students will be taught how to design and modify electronic circuits according to the needs and specifications given. The application of the right learning model in a learning process greatly affects student learning outcomes. In the learning process that takes place in class X TKJ, students pay less attention to the material explained by the subject teacher. This happens because the learning process is less effective and unpleasant so that students are bored in the classroom.

Students must play an active role in the learning process with the support of systematic planning from the teacher so that the learning process can run effectively [11]. The teacher's ability to create a comfortable, conducive learning atmosphere and the selection of appropriate learning methods so that students do not feel bored in the learning process greatly determines the success of the learning process.

II. LEARNING MEDIA

Learning is basically not only conveying information or knowledge, but also conditioning students, because the main purpose of learning is that students learn. The learning materials compiled in the learning plan should resemble life situations as much as possible. At this time many students complain and get bored with the learning methods used in teaching and learning activities. Learning activities are perceived as monotonous and this lasts for a long time, so teachers are required to develop expertise in choosing learning methods that are suitable for the subjects that will be delivered to students so that the learning process can run well.

Learning is a process in which a person's environment is intentionally managed to enable learning to occur in the learner. Learning is a specialized set. Learning is a teacher's effort that aims to help students learn. Learning is a set of events that influence the learning process of students [12].

According to [13], learning is the process of actively seeking knowledge or the process of formulating knowledge, not the process of disclosing knowledge alone. Meanwhile, [14] explained that in the context of learning, the success criteria of the learning process are not measured by the extent to which students have mastered the subject matter, but are measured by the extent to which students carry out the learning process.

Based on the explanation above, it can be concluded that learning is a process that contains a series of implementations by teachers and students on the basis of reciprocal relationships that take place in educational situations to achieve certain goals.

III. VIRTUAL REALITY

Virtual reality is a technology that allows users to experience a fully digitized environment. Using devices such as VR headsets and motion controllers, users can enter virtual worlds that feel real and interactive. In a virtual reality world, users can perform various activities such as exploring distant locations, playing immersive games, or even participating in realistic simulation training. This technology has been used in various industries such as entertainment, education, healthcare, and business. One of the main advantages of virtual reality is its ability to create immersive and engaging experiences [15]; [16]. By utilizing realistic graphics and high-quality sound, users can experience sensations similar to the real world. In addition, virtual reality also has great potential in enhancing learning and training.

The role of virtual reality in learning is very important in the face of the industrial revolution 4.0. This technology allows students to experience a more immersive and interactive learning experience. By using VR headsets, students can enter into a virtual world that resembles the real environment, so they can learn abstract concepts in a more concrete way [17].

Virtual reality learning for the subject of Application of Electronic Circuits in SMK is an innovation that combines advanced technology with traditional learning. By using virtual reality technology, students can experience a more interactive and in-depth learning experience. In virtual reality learning, students will be brought into a virtual world that resembles the real environment. They can interact with electronic components directly, learn how to assemble electronic circuits, and conduct experiments virtually. This allows students to understand basic concepts better and reinforce their understanding. In addition, virtual reality learning can also increase students' learning motivation. With an interesting and fun learning experience, students will be more motivated to actively participate in learning and try to understand the concepts given. They will feel directly involved in the learning process and have a greater drive to seek deeper understanding.

Virtual reality learning can also improve collaboration between students. In a virtual environment, students can work together in groups to complete tasks or projects. They can communicate and interact with fellow students through their avatars, thus sharing information and supporting each other in the learning process. This can improve students' ability to work in teams and develop their social skills.

IV. LEARNING OUTCOMES

Learning is closely related to changes in a person's behavior obtained from a learning process. To understand the meaning of learning, first what needs to be known is the definition of learning itself. There are several definitions of learning that will be described in this discussion.

The definition of learning according to [18] is "change. In this case what is meant by learning is an effort to change behavior. These changes are not only related to knowledge, but also in the form of skills, skills, attitudes, understanding, self-esteem, interests, character, and self-adjustment ". Meanwhile, the definition of learning according to [19] is "the process of changing one's behavior or personality based on interactions between individuals and their environment which are carried out formally, informally, and non-formally".

Furthermore, [20] defines that "learning is a process of change in human personality, and these changes are displayed in the form of an increase in quality and quantity such as increased skills, knowledge, attitudes, habits, understanding, skills, thinking power and other abilities. Meanwhile, [21] expressed his opinion that "learning is a process, and not a result. Therefore, learning takes place actively and interactively by using various forms of action to achieve a goal".

[22] states that "learning outcomes are manifestations of abilities due to changes in behavior made by educational efforts". Learning outcomes are influenced by student experiences as a result of interactions with the physical world and the environment. A person's learning outcomes depend on what the student already knows, concepts, goals, and motivation that influence interactions with the material being studied. [23] argues that learning outcomes consist of three things which include: (a) scientific matters and knowledge, concepts or facts (cognitive); (b) personal matters, personality or attitudes (affective); and (c) matters of behavior, skills or performance (psychomotor).

Based on the definitions of learning stated above, it can be concluded that learning is a process of cognitive, psychomotor and affective changes that are meaningful to the learner and involve the five senses in learning.

V. RESEARCH METHODS

This research is a Classroom Action Research which is a process of studying learning problems in the classroom through self-reflection in an effort to solve these problems by taking various planned actions in real situations and analyzing any effects of the treatment. This classroom action research planning consists of two cycles using four components of action research (Planning, Action, Observation and Reflection) in an interrelated system. This class action research carried out several types of actions. The first action taken was holding a pre-test. Giving a pre-test to be used as a benchmark for student learning outcomes before and after the application of Learning Media Using Virtual Reality.

The population in this study were all students of class X TKJ at SMK Negeri 10 Makassar consisting of 4 classes with a total of 122 students, while those used as subjects in this study were students of class X TKJ SMK Negeri 10 Makassar totaling 31 people using Purposive Sample technique, as stated by Sugiyono "Purposive sampling is a sampling technique with certain considerations". The collected data were grouped and analyzed quantitatively and qualitatively. Quantitative analysis is used to describe the average value, standard deviation and percentage of learning outcomes. While qualitative analysis is used to describe the activities and responses of students in the learning process by using Learning Media Using Virtual Reality. The application of Learning Media Using Virtual Reality can be said to improve learning outcomes if ≥80% of the number of students get a minimum score of 70, as for the category used to determine learning outcomes based on student report cards.

VI. RESEARCH RESULTS

VI.a Research Results

This research was conducted in two cycles. Each cycle has procedures or research steps consisting of planning, action, observation, and reflection.

Researchers observed all students during the learning process, observations were made with reference to the observation sheet, as for the results of observations of student activity during the process of Application of Learning Media Using Virtual Reality can be seen in table 3 and table 4 there is an increase in the average from 63.37 to 71.25 (Table 4) below:

Table 3. Results of Observations of Attendance and Student Activities in Cycle I

No.	Components observed	Cycle I								Average (%)
		Meeting								
		1	%	2	%	3	%	4	%	
1	Students who are present during the learning process.	26	83.87	30	96.77	29	93.54	31	100	93.54
2	Students who ask questions to the teacher.	9	34.61	10	33.33	12	41.37	10	32.25	35.39
3	Students who answer teacher/student questions.	8	30.76	10	33.33	10	34.48	-	-	32.85
4	Students who do other activities in the learning process such as playing around, making noise.	5	19,23	6	20.00	5	17.24	4	12.90	17.34
5	Students who take notes on the lesson material.	21	80.76	24	80.00	25	86.20	-	-	82.32
6	Students who follow the practicum earnestly.	-	-	25	83.33	26	89.56	-	-	86.44
7	Students who cooperate in practicum.	-	-	24	80.00	24	82.75	-	-	81.37
8	Students who submit assignments	-	-	18	69.23	-	-	25	86.20	77.71
	Number of Average Values									63.37

The average value of student activity from the eight components observed during observation in cycle I was 63.37%.

Table 4. Observation results of attendance and student activities in cycle II

No.	Components observed	Cycle II								Average (%)
		Meeting								
		1	%	2	%	3	%	4	%	
1	Students who are present during the learning process.	30	96.77	29	93.54	30	96.77	31	100	96.77
2	Students who ask questions to the teacher.	10	33.33	15	51.72	17	56.66	14	45.16	46.71
3	Students who answer teacher/student questions.	10	33.33	16	55.17	15	50.00	-	-	46.16
4	Students who do other activities in the learning process such as playing around, making noise.	4	13.33	2	6,89	2	6,89	-	-	9,03

5	Students who take notes on the lesson material.	26	86.66	27	93.10	30	100	-	-	93,25
6	Students who follow the practicum earnestly.	-	-	26	89.65	28	93,33	-	-	91,49
7	Students who cooperate in practicum.	-	-	28	96.55	27	90.00	-	-	93.27
8	Students who submit assignments	-	-	27	90.00	-	-	29	96.66	93.33
Number of Average Values										71.25

The average value of student activity from the eight components observed during observation in cycle II was 71.25%.

Student learning outcomes before the application of Learning Media Using Virtual Reality are obtained after researchers give pre-test questions that will be used as a comparison of student learning outcomes before and after the application of Learning Media Using Virtual Reality, as for the statistical data of student learning outcomes before application, Cycle I, and II Learning Media Using Virtual Reality can be seen in the table below.

Table 5. Statistical Data of Student Learning Outcomes during Pre Test, Cycle I, and Cycle II

STATISTICS	Pretest Score	Cycle I	Cycle II
Subject	31	31	31
Ideal score	100	100	100
Average score	60.41	66.67	83.45
Median	70	73	88
Mode	70	73	100
Standard Deviation	15.02	14.59	14.42
Variance	225.78	212.95	208.05
Maximum Score	80	93	100
Minimum Score	25	38	50
Reach	55	55	50

From the analysis results obtained an average score of 60.41 with a standard deviation of 15.02, this indicates that the score of student learning outcomes before the action is centered on a score of 60.41 and from the results of the analysis also obtained a median of 70, this illustrates that 22.5% of the number of students obtained scores above 70 and 48.3% others obtained scores below 70, then obtained a range of 55 means that the distribution of data is not too far from the average value.

If the score of the learning outcomes of the Application of Electronic circuits before the application of Learning Media Using Virtual Reality is grouped into 4 categories, the frequency distribution and percentage of scores shown in table 6 are obtained.

Table 6. Frequency Distribution of Student Learning Outcomes Before the Application of Learning Media Using Virtual Reality

Value Range	Category	Cycle I		Cycle II	
		Frequency	Percentage (%)	Frequency	Percentage (%)
90-100	Very good	1	3.22	11	35.45
80-89	Good	5	16.12	8	25.80
70-79	Simply	13	41.93	7	22.58
0-69	Less	12	38.7	5	16.12
Total		31	100	31	100

In cycle I (Table 6) only 19 students (61.29%) out of 31 students passed, 1 student (3.22%) passed in the excellent category, 5 students (16.12%) passed in the good category and 13 students (41.93%) passed in the fair category and 12 students (38.7%) who did not pass because they did not meet the Minimum Completeness Criteria (KKM) in cycle I. because students who reached the Minimum Completeness Criteria (KKM) were only 19 students (61.29%) and had not reached the Minimum Learning Competency Standards (SKBM) which were ≥80% of the total number of students, the researcher would continue to the cycle II stage. Furthermore, in cycle II (Table 5) there were 26 students (83.87%) out of 31 students who passed, 11 students (35.45%) passed with a very good category, 8 students (25.80%) who passed with a good category, 7 students (22.58%) who passed with a sufficient category and 5 students (16.12%) who did not pass because they did not meet the Minimum Completeness Criteria (KKM) in cycle II, because students who reached the Minimum Completeness Criteria (KKM) were 26 students (83.87%) and had exceeded the Minimum Learning Competency Standards (SKBM) which were ≥80% of the total number of students, so the research could be ended in cycle II.

The reflection of the activities is as follows: In the implementation of cycle I, the problems that occurred during the learning process were found as follows: 1) There are still many students who have not reached the Minimum Completeness Criteria (KKM); 2) When other groups were practicing there were several students doing things that had nothing to do with the lesson, these students did not pay attention to the group that was practicing and did not want to record things that were considered important; 3) Students lacked questions, even though they did not understand; 4) There were still students who hesitated to answer questions, only certain students actively asked and answered.

Problems during the learning process as mentioned above occur because students are not accustomed to learning with Learning Media Using Virtual Reality, the method is still new to students and some students assume that what they do does not have an impact on their grades later, thus researchers feel the need for new actions taken to find a way out of the problem. The actions taken include: 1) Asking the teacher to explain to students that the learning outcomes of this research are part of their grades later because the material taught is part of the syllabus and will not be taught again by the teacher; 2) Reducing the number of students in each group and adding practical tools and materials; 3) Increasing the number of simulations for material topics; 4)

Encouraging and directing students to ask questions about things they do not understand, and explaining the importance of communication skills both among students and others.

After carrying out actions in Cycle II against the problems that occurred in cycle I, the problem was slightly resolved and the learning outcomes in Cycle II had passed the Minimum Learning Competency Standards (SKBM) so that this research could be declared successful in cycle II and this research could be stopped.

IV.b Discussion

The results of data recapitulation regarding student learning outcomes on the Application of Learning Media Using Virtual Reality to Improve Learning Outcomes in the Application of Electronic Circuits in Vocational Schools before and after the application of Learning Media Using Virtual Reality which was carried out as many as 2 cycles, namely cycle I and cycle I stated that there was an increase in student learning outcomes from an average score of 60.41 before the application of Learning Media Using Virtual Reality to 66.67 in cycle I then increased to 83.45 in cycle II.

Empirical facts regarding the improvement of learning outcomes [24] and student activity show that the method of applying learning media using virtual reality to improve learning outcomes in the application of electronic circuits in vocational schools can help students develop their skills and cognitive abilities, this is in line with the theory that states that learning media using virtual reality in building meaningful skills and can integrate in everyday life [25]

Another interesting phenomenon occurs in student responses, where most of the items in the response received positive responses from students, there are even some items all students gave positive responses such as increasing cooperation in the learning process. This particular finding indicates that in general, students' interest in learning with Learning Media Using Virtual Reality is optimally developed because it provides opportunities for students to more actively express abilities related to student skills [25].

Based on this research, it is found that learning by using Learning Media Using Virtual Reality affects classical learning achievement [26] This learning process emphasizes student involvement to actively interact so that they can construct their own knowledge [27]. The results of the study illustrate that Learning Media Using Virtual Reality used in the learning process can improve learning outcomes [28].

VII. CONCLUSSION

1. The application of Learning Media Using Virtual Reality is able to increase the activity of students in class X TKJ SMK Negeri 10 Makassar in the learning process.
2. The Application of Learning Media Using Virtual Reality Can Improve Learning Outcomes in the application of electronic circuits for students in class X TKJ SMK Negeri 10 Makassar.
3. The response of students of class X TKJ SMK Negeri 10 Makassar to the application of Learning Media Using Virtual Reality in the Productive learning process is positive.

VIII. ACKNOLEDGEMENT

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