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The effect of android-based augmented reality lab coats on students with different academic abilities on understanding of skeletal system

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ABSTRACT

The understanding of students' concepts of SMP Negeri 1 Kandangan on the material of the skeletal system is still low. This study aims to determine the effect of applying Android-based Augmented Reality laboratory coats to students with different academic abilities on understanding the concept of skeletal system material for students of SMP Negeri 1 Kandangan. This research is a quasi-experiment or quasi-experiment with a pretest-posttest control group design. The population used in this study were all seventh-grade students of SMP Negeri 1 Kandangan. In contrast, the samples in this study were class VII A as the control class and class VII B as the experimental class, which would be treated as applying an Augmented Reality Android-based. The sample was determined using a purposive side technique. The ANCOVA test results show a significant difference in student's conceptual understanding of the skeletal system material between the control and the experimental, with a significance value or p of 0.006, which is <0.05. Meanwhile, the follow-up test results showed that the use of android-based Augmented Reality Laboratory Coat learning media significantly differed in understanding the concepts of seventh-grade students of SMP Negeri 1 Kandangan. So it can be concluded that the android-based Augmented Reality Laboratory Coat affects increasing the understanding of the concepts of students with different academic abilities at SMP Negeri 1 Kandangan as a learning medium on skeletal system material to provide a better visualization effect in observing bony structures in the passive motion system (bones).

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INTRODUCTION

Science and technology in the 21st century are overgrowing. Almost all areas of life use technology (Pertiwi et al., 2018). The development of this technology also has an impact on the world of education. One is the rapid development of media to assist contextual learning activities. Learning media is crucial because it can increase learning motivation (Febrita & Ulfah, 2019). Learning media is one of the efforts to create quality learning (Yulianti et al., 2017). Learning media is used as a tool to convey messages in a lesson so that it can stimulate students' minds and interest in learning so that students can achieve learning goals (Ariyanto et al., 2018).

Biology is one of the sciences that has a broad scope and discussion of all creatures that live in nature (Celik et al., 2020; Dogan & Ay, 2013). Most biological concepts and objects are abstract and not easy to observe (Ariyanto et al., 2018). Biology material has a complex nature, so it needs to be facilitated with learning media to make it easier for students to understand (Aripin & Suryaningsih, 2018).

Augmented Reality (AR) is a technology that can be used in Biology learning with complex and abstract objects and material concepts. Augmented Reality is a technology created using a computer device that produces 2D and 3D visual depictions of an object (Rini et al., 2022). AR technology offers a new method in the learning process with mobile devices (Grubert & Grasset, 2013). The purpose of using AR is to combine reality with a virtual environment to allow users to interact with both objects so that there is no boundary between the natural and virtual worlds (Aripin & Suryaningsih, 2018). According to Azuma (1997), AR has three characteristics: combining the real and virtual worlds, real-time interactions with users, and 3D. AR technology can be accessed using a smartphone as an android application (Rini et al., 2022). Some advantages of Augmented Reality are the support for seamless interaction between real and virtual environments, natural interface metaphors for object manipulation, and the ability to transition between Reality and virtuality (Billinghurst, 2002).

The results of previous studies showed that the developed Augmented Reality Laboratory suit focused on the passive (bone)/skeletal motion system material. In addition to laboratory coats, an Android-based application has also been developed that can recognize trigger images on the surface of the laboratory coat to provide visualization of the passive (bone) movement device system. The limited- scale validation and test results show that AR media in the form of laboratory coats and android-based applications meet the qualifications and are declared very feasibly. The results of the limited-scale test indicate that the product is suitable for use in Biology learning for passive locomotor (bone) material.

The lecture method applied by the teacher provides little opportunity for students to discuss and solve problems (Wirabumi, 2020). Based on the results of observations at SMP Negeri 1 Kandangan, during learning, students are only given material, assignments, and evaluation questions by the teacher, so students tend to be bored and not interested. This impacts students' common conceptual understanding of the material for passive locomotor systems (bones), which are difficult to see in the real world. The PISA and TIMSS surveys show that students' conceptual understanding in Indonesia is low (Diana et al., 2020). Reisberg (2019) states that understanding concepts are part of cognitive abilities. Concept understanding becomes the basis for learning as students can explain and re-express what has been communicated to students (Unaenah & Sumantri, 2019; Alighiri et al., 2018). Unaenah & Sumantri (2019) explained that a low level of conceptual understanding could result in limited use of students' ideas, skills, and knowledge.

According to research conducted by Marzouk et al (2013), using AR learning media with game techniques for Biology learning about human anatomy can create a fun, collaborative, and attractive learning atmosphere. AR in education can increase motivation and learning outcomes, create a positive impression on learning, and help students build concepts from material better (Morales & Sanches, 2018). The use of application-based AR technology follows the idea of constructivist learning, which can improve students' ability to learn and manipulate objects that are not real to understand learning materials (Wang, 2012).

The results of Aripin & Suryaningsih's research (2019) show that the development of Biology learning media using Android-based Augmented Reality (AR) technology is feasible and effective for studying the nervous system. Mauludin et al (2017) apply technology augmented Reality to learning Biology on digestive system material by utilizing textbooks and Android applications. The results of his research show that this learning media can help convey the Digestive System Lesson material to

students. Therefore, an innovation that can be applied is the use of learning media by utilizing laboratory coats as an appropriate alternative media, then integrated with Android application-based Augmented Reality technology for passive movement system material (bones). The application of an Augmented Reality laboratory coat based on an android application is expected to improve students' conceptual understanding of the passive (bone) system material.

METHODS

Research Design

This research is a quasi-experimental or a quasi-experimental study with a pretest-posttest control group design. This study used two classes as a group, one class as an experimental class which was treated in the form of applying Augmented Reality and the other as a control. Data collection in this study will be done twice before and after treatment (Hastjarjo, 2019). The following are the details of the research design used in Table 1.

Table 1
Research Design

Class	Initial Measurement (Pretest)	Treatment	Final Measurement (Posttest)
Experiment	X1	Application of Android-Based Augmented Reality Lab Coat	X1'
Control	X2	Application of Android-Based Augmented Reality Non-Coat Lab	X2'

Source: Sugiyono, 2013

Description:
X1 = Understanding the initial concept of the experimental class
X1' = Understanding the final concept of the experimental class
X2 = Understanding the initial concept of the control class
X2' = Understanding the final concept of the control class

Population and Samples

The population used in this study were all seventh-grade students of one of junior high schools, totaling 251 students. The sample was determined using a purposive side by selecting two existing classes, where each class consisted of 30 students. At the same time, the samples in this study were class VII A as the control class and class VII B as the experimental class. However, because learning is carried out in a hybrid manner (half the classes study at school and the other half study from home), the sample used is only students who study at school as many as 15 students.

Instrument

The instrument in this study was the form of a test instrument used to measure students' conceptual understanding of variables. This test consisted of 20 multiple-choice questions and five description questions. Each of these questions is developed based on the Skeletal System material indicators. Before being used, the instrument was tested for validity, reliability, difficulty level, and differentiating power with the help of SPSS Statistics 22. Some of these tests were carried out to reveal how the quality of the items will be used to determine the level of understanding of students' concepts (Loka Son, 2019).

Table 2
Results of Instrument Analysis

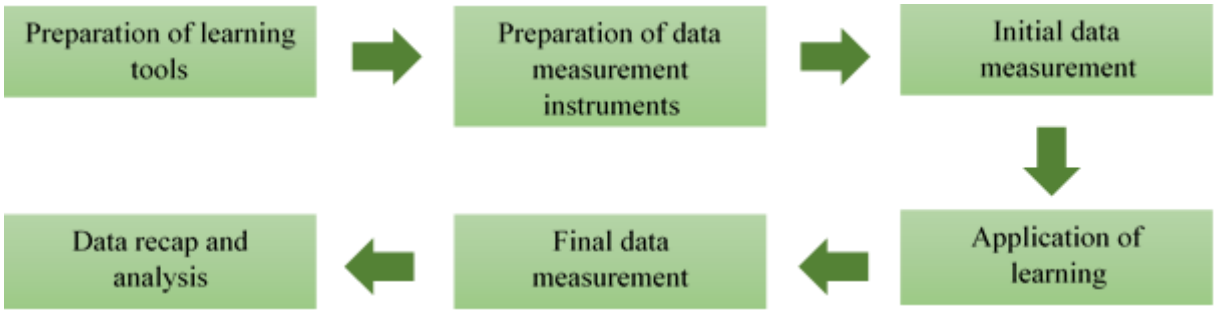
Validity	Reliability	Level of Difficulty	Differential Power
Valid	Reliable	Medium and difficult	Very good, good, and enough

The results of the multiple-choice validity test showed that all questions were valid because the p-value > 0.05. The multiple-choice test reliability test results are 0.89, indicating that the questions are reliable. At the same time, the results of the validity test of the descriptions showed that all

questions were valid because the p-value> 0.05. The reliability test results of the question description are 0.599, indicating that the questions are reliable.

Procedure

This research was carried out in several stages. The first step is to develop learning tools through lesson plans, learning media, and learning infrastructure. The second stage is compiling data measurement instruments and testing their validity, reliability, difficulty level, and differentiating power. The third stage measures the initial data by conducting pretest-assisted learning in Augmented Reality in the experimental class. The fifth stage is measuring the final data by doing a posttest. The sixth stage is to recap and analyze the study's results using the ANCOVA method. The flow of research stages is presented in the figure below.



Data Analysis Techniques

The data analysis technique used in this study is the ANCOVA test with the help of SPSS Statistics 22. Before the ANCOVA test is carried out, there are prerequisite tests that must be carried out, namely the normality test and homogeneity test. After the data obtained are typically distributed and homogeneous or can be said to meet the requirements, they can only be analyzed using the ANCOVA test. If the results of the ANCOVA test are significantly different, then it is continued with a further test using the LSD test.

RESULTS AND DISCUSSION

The application of an Android-based Augmented Reality Laboratory Coat begins with observing the needs of students in learning Biology at SMP Negeri 1 Kandangan. Based on the observations, it is known that learning Biology still uses the lecture method, and there are no learning media that supports student learning activities. Students tend to feel bored and uninterested. The results of previous studies stated that the Augmented Reality Laboratory Coats learning media based on Android focused on passive motion system material (bones). Based on this, the AR Laboratory Coat media application is intended for passive movement (bone) system learning for seventh-grade students of SMP Negeri 1 Kandangan. This material was chosen because understanding of the structure of passive locomotion is low due to its abstract nature and is difficult to visualize (Wicaksono et al., 2020). AR Laboratory Coats for this material is also considered adequate because it makes it easier for teachers and students to observe bones without using skeleton props.

Understanding students' concepts are obtained based on the achievement of the pretest and posttest. The instrument used at the time of measurement was a test that contained questions about the Skeletal System material consisting of 20 multiple-choice questions and five description questions.

Table 3
Average Pretest and Posttest

Class	Pretest Average Results	Standard Deviation	Posttest Average Results	Standard Deviation
VII A	60,14	6,42	78,78	7,46
VII B	66,28	4,87	87,35	4,89

Based on the results of the average pretest and posttest between class VII A (control class) and VII B (experimental class), it can be seen that the increase in the experimental class is more significant

than the control class. This proves that students' understanding of concepts is still low. The common understanding of students' concepts is due to the motion system material that is difficult to see directly in the real world, so students have difficulty imagining what they are learning (Romadhon et al., 2017). While in the learning process, students are only given material, assignments, and evaluation questions by the teacher, so students tend to be bored and uninterested.

The results of research by Thahir & Kamaruddin (2021) state that Augmented Reality or AR-based learning media can affect student learning outcomes in class X virus material at SMA Negeri 1 Gowa. The results of the average posttest in class VII A and class VII B prove that students' understanding of concepts has increased. The increase in class VII B as the experimental class was more significant than in class VII A as the control class. The average score posttest in the experimental class, which are higher than the control class, can prove that Augmented Reality improves students' conceptual understanding of skeletal system material.

In addition to analyzing the results of the average pretest and posttest scores, the research was also conducted by analyzing the results of the data using the ANCOVA test. Before carrying out the ANCOVA test, the normality test and homogeneity test were first carried out. The normality test shows the value of Sig. > 0.05 both in the Kolmogorov-Smirnov test and at the Shapiro-Wilk test, which is 0.20 in the Kolmogorov-Smirnov test and 0.26 in the Shapiro-Wilk test. Then H_0 was accepted and H_1 was rejected. Thus, it can be concluded that the residual data in this study was normally distributed.

The homogeneity test is carried out using the Levene test. The Levene test shows the value of Sig. > 0.05 which is equal to 0.52; then H_0 is accepted and H_1 is rejected. Thus, it can be concluded that the variance of the two groups in this study had the same or homogeneous diversity. Once it is known that the research data are normally distributed and homogeneous, then proceed with the ANCOVA test.

Table 4
ANCOVA Test Results

Results		Conclusion
df1	1	There is a significant difference
df2	25	
F	8,946	
Sig.	0,006	
Partial Eta Squared	0,264	

ANCOVA test showed a significance value of p = 0.006, which was <0.05. Therefore, it can be said that there is a significant difference in students conceptual understanding of the skeletal system material between the control class and the experimental class. The results of this test enormously strengthen the statement that Android-based Augmented Reality Lab Coats can affect the level of understanding of students' concepts on skeletal system material. Based on the results of the data analysis, it is known that the data obtained in this study are significantly different, so it must be continued with a further test using the LSD test.

Table 5
LSD Test Results

Results			Conclusion
Sig.	0,006		Real Different
	Kontrol	**Eksperimen**	
Peningkatan	31%	32%	
Rerata Terkoreksi	78,91	87,24	

The results of the LSD test showed that the data obtained were significantly different because the significance value was <0.05. In addition, the corrected mean result in class VII B was more significant than in class VII A, with 87,24 in class VII B and 78,91 in class VII A. Meanwhile, the increase between the pretest and posttest in class VII A as a control class was 31%, and an increase in class VII

B as the experimental class by 32%. This shows that the experimental class improved more than the control class.

Hurst (2020) states that AR learning media can improve students' understanding through visualizing 3D objects in science learning. According to Lu & Liu (2015), AR learning media can create a fun learning environment and increase student activity in learning. In addition, this android-based AR learning media, biology learning material for passive motion systems (bones), can improve communication between students and teachers. This is in line with Akçayır & Akçayır (2016) that the use of AR can increase interaction between students and students and teachers in the learning process. AR-based multimedia can help students find data or information that helps students understand the material more deeply (Sirakaya & Sirakaya, 2018; Chang & Hwang, 2018; Yuliono et al., 2018; Kurniawan et al., 2018). This is relevant to the results of previous studies, which explained that the development of textbooks with augmented reality technology on the concept of the digestive system could improve students' ability to analyze problems related to the concept of digestion (Amir, 2017).

Skeletal system material in human was taught in science subjects in junior high schools. The delivery of material tends to be conventional, namely through pictures in books, while this material is difficult to see directly because it is located inside the body. The existence of augmented reality technology can be used as a learning medium because it can display 3D objects, and this technology can combine virtual objects into a real sphere (Mauludin et al., 2017). Then, these virtual objects can be projected in real time through the medium in the form of markers directed at the camera. The lab coat can be used as a medium that can project the structure of the skeletal system onto human when it is used by students. So that the structure of the skeletal system can be seen in human. However, not all students carry Android mobile phones at school, even though lab coats are based on Android. So, this is one of the obstacles when this research was carried out.

CONCLUSION

Android-based Augmented Reality Laboratory Coats can be used as a learning medium for skeletal system material to provide a better visualization effect in observing skeletal structures in passive (bone) motion systems. It can be seen from the results of the average posttest value of the experimental class of 87.25, while the average value of the control class is 78.78. In addition, based on the ANCOVA test, there is a significant difference in student's conceptual understanding of the skeletal system material between the control class and the experimental class, with a significance value or p of 0.006, where this value is <0.05. After further testing, it turned out that the use of the Android-based Augmented Reality Laboratory Coat learning media was significantly different to the understanding of the concepts of seventh-grade students of SMP Negeri 1 Kandangan. The development of learning media with augmented reality technology can support learning progress, especially in Biology material to observe Biology objects that are abstract and difficult to understand.

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