KnE Social Sciences

ICESRE
5th International Conference on Education and Social Science Research (ICESRE)
Volume 2022

Knowledge E
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Conference Paper

Flashcard-Based Augmented Reality To Increase Students' Scientific Literacy

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Published 21 December 2022

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICESRE Conference Committee.

Abstract.
Augmented Reality (AR) is a type of learning media that combines virtual and real worlds in real-time. It can make it easier for students to visualize the phenomena. This research aimed to measure flashcard-based AR's effectiveness based on scientific literature. This research used a quasi-experimental method using a post-test-only control group design, and the participants were 60 college students at Universitas PGRI Adi Buana Surabaya. Data in the research were collected through tests to determine students' scientific literacy skills, including aspects of knowledge and competence in analyzing scientific phenomena, connecting physics concepts to existing phenomena, and interpreting data or scientific evidence and questionnaires. The data were analyzed by calculating the average test score according to scientific literature and the percentage of user satisfaction. Based on the research, using flashcard-based augmented reality could increase the students' scientific literacy.

Keywords: augmented reality; learning media; scientific literacy

1. Introduction

The era of the 21st century makes the world's development faster and more complex. These changes aim to improve modern society's quality of life. The 21st century is marked by a massive transformation from an agrarian society to an industrial society and continues to be a knowledge society (1). In the tight challenges society faces, a paradigm shift in the education system is needed to provide a set of 21st-century skills needed by students to face every aspect of global life (2,3). From various studies on the concepts and characteristics of 21st-century education, there is no doubt that it has become a great demand and challenge for teachers in conducting learning. Teachers

like it or not, like it or not, agree or disagree, must balance the needs of the 21st century (4).

According to the World Economic Forum (WEF), there are 16 important skills needed in the 21st century that are divided into three categories: foundational literacy, competence, and character qualities. One of the fundamental aspects of 21st-century skills is the foundational literacy (5). Foundational literacy was divided into six categories: Literacy (language skills), Numeracy, ICT literacy, Financial literacy, Cultural and civic literacy, and Scientific literacy. Scientific literacy is the scientific ability of individuals to use their knowledge to identify problems, obtain new knowledge, explain scientific phenomena, and draw conclusions based on evidence related to scientific issues (6).

The current condition shows the weak ability of students in the field of science, especially scientific literacy, as evidenced by the results of the scientific literacy assessment at the international level organized by the Organization for Economic Co-operation and Development (OECD) through the Program for International Student Assessment (PISA) for young children. 15 years (7). Indonesia has participated in the PISA research since 2000. The results reported by the OECD (2003, 2004, 2007, 2010, 2013, 2016) related to the results of scientific literacy of Indonesian children can be seen in Table 1.

Table 1: The Position of Indonesian Children's Science Literacy in PISA Assessment (8,9).

No.	Years	Average Score of Indonesia	Average International Score	Position	Number of participating countries
1	2000	393	500	38	41
2	2003	395	500	38	40
3	2006	393	500	53	60
4	2009	383	500	57	65
5	2012	382	500	64	65
6	2015	403	493	62	70

Based on these data, it appears that Indonesia has always been in a low ranking from year to year. Therefore, a learning strategy is needed to increase Indonesia's ranking on the world stage. One way is to improve the quality of the learning process by providing appropriate learning media. Augmented reality is one of the kinds of learning media that can be used to solve this problem because of technology that combines the virtual world (virtual) and the real world (real) in a real-time (10). Various learning media based on AR have been developed in many different courses, including mathematics (11,12), science (13,14), language (15,16), social science (17), civic education (18), etc. On the other hand, the use of this technology significantly impacted the student's ability in the learning process. This technology could also improve 21st-century students' abilities,

namely critical thinking ability (19,20), problem-solving ability (21,22), Communication ability (23), collaboration (24), and scientific literacy (25).

From the facts that have been described, it is known that AR is one of the suitable media used in the learning process. From the information that researchers know, no research looks at the effect of using augmented reality learning media on students' scientific literacy. Therefore, researchers aimed to measure flashcards' effectiveness based on scientific literacy.

2. Method

2.1. Research Model

This research used a quasi-experimental method using a post-test-only control group design. The quasi-experimental method is a research method that, in its implementation, does not use random assignments but uses existing groups (26). The Post-test Only Control Group Design scheme is shown in table 2.

TABLE 2: The scheme or research method.

Class category	Treatment	Post-test
Experiment	X	O_1
Control		O_2

Information:

X : treatment of the use of augmented reality

O_1 : the post-test result from experiment class

O_2 : the post-test result from the control class

2.2. Participants

The sample in this study was 60 college students in the Department of Elementary School Teacher Education, Universitas PGRI Adi Buana Surabaya, divided into two classes, namely experimental and control classes. Both the experiment and control class have 30 college students that become the participants. The participants were chosen by purposive sampling method. Purposive sampling is a sampling technique that assesses the sample among the selected population (27).

2.3. Data Collection Tools

Data in the research were collected through tests to determine students' scientific literacy skills, including aspects of knowledge and competence in analyzing scientific phenomena, connecting physics concepts to existing phenomena, and interpreting data or scientific evidence and questionnaires. The research instrument in the form of a test is research measuring instrument used for complete data collection regarding understanding the concept by responding to a list of questions in the research data collection techniques (28).

2.4. Data Analysis

The students' scientific literacy ability data were collected using the multiple-choice test. The test is ten multiple-choice questions oriented to scientific literacy, including the cognitive level of applying (C3) and analyzing (C4). The data was analyzed by using an Independent sample t-test with the hypothesis shown below:

H_0 : There was no difference in the average results of students' scientific ability abilities between the experimental class and the control class

Ha : There was a difference in the average results of students' scientific ability abilities between the experimental class and the control class.

3. Result and Discussion

In this research, PhysAR, the android application based on augmented reality, was used as the learning media in Online learning. This android application provided a real learning experience about space object subjects for students and made the learning process more attractive than before Figure 1 showed the illustration of the PhysAR application.

3.1. Similarity Initial Test

Before the research began, the similarity initially of the samples to know the capability of each sample. The test that was used was the normality and homogeneity test for each sample. A normality test is a test carried out with the aim of assessing the distribution of data in a group of data or variables, whether the distribution of the data is normally distributed or not, while the homogeneity test is a test of whether or not the variances of

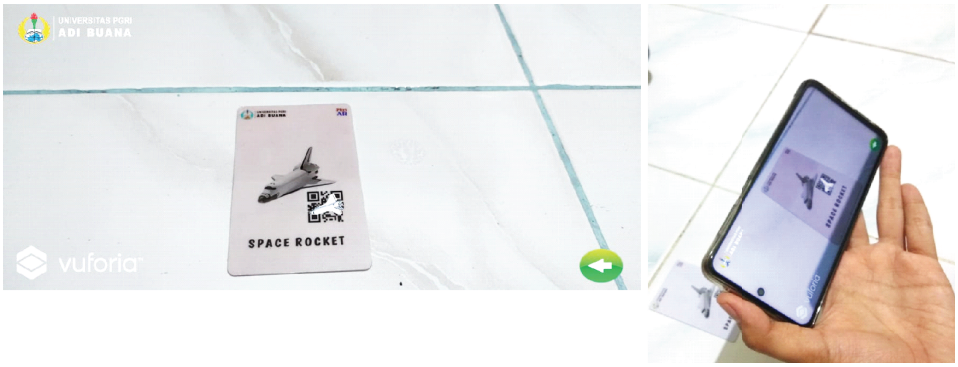

Figure 1: The PhysAR card 3D visualization.

two or more distributions are equal. (29). The data of this test was used for the midterm test scores from the participants. Lilliefors method with a significant degree (α) of 5% was used to know the normality of the sample and the result was shown in Table 3.

TABLE 3: The normality test result.

Class category	$L_{Observation}$	L_{table}
Experiment Class	0.131	0.161
Control Class	0.125	0.161

Based on table 2 shows that The $L_{obsveration}$ of both the experiment and control class has a higher L value than L_{table}. This condition indicates that the classes were normally distributed (30). Then, the homogeneity test was conducted using the Bartlett method to know if the sample have come from a homogeneous population. Based on the calculation shows that X^2_{count} has had a lower value than X^2_{table} (X^2_{count} = 0.103 < X^2_{table} =3.841). This indicates that both samples have come from homogeneous populations (31).

3.2. Students' Scientific Literacy Ability

The student's scientific ability data were obtained from individual student tests using the multiple-choice test. The test is ten multiple-choice questions oriented to scientific literacy, including the cognitive level of applying (C3) and analyzing (C4). The results of these tests are shown in Table 4.

TABLE 4: The result of students' scientific literacy data.

Class category	N	Max Value	Min Value	Average	Deviation Standart
Experiment	30	87	65	76	6.76
Control	30	75	57	64	5.34

Table 3 shows that the utilization of augmented reality in the experimental class impacts the result of students' scientific literacy. The experimental class has maximum, minimum, and average values of students' scientific literacy tests are 87, 65, and 76. On the other hand, the control class has maximum, minimum, and average values of students' scientific literacy tests are 75, 57, and 64. The data result showed that the experimental class has a higher average value for the scientific literacy test than the control class.

3.3. Hypothesis Testing Result

The hypothesis test in this research was tested using the comparative method for the free sample (independent sample t-test). The test scores of students' scientific literacy results for both the experimental class and control class were used as data and were calculated at a significant level of 5%. The results of the hypothesis test are shown in Table 5.

Table 5: The Comparative test result data for free samples.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Result Test	Equal variances assumed	2.653	.078	3.854	60	.000	8.61597	1.46921	5.68340	11.54853
	Equal variances not assumed			3.854	64.383	.000	8.61597	1.46425	5.69113	11.54080

Table 5 shows that the F count of Levene's test was 2.653 with a significant level of 0.108. Because the significant result has a value of more than 0.05 (0.108> 0.050) it can be concluded that the variance is the same. Therefore, the t-test analysis uses the assumption of equal variance assumed. Based on the equal variances assumed section showed that the t value from the data was 5.864 which value was higher than t_{table}(t_{count} = 3.854 > t_{table} = 1.670). This indicates that H_0 was rejected and H_a was accepted. In addition, the significance value obtained is 0.000 < 0.050. With these results, it can

be interpreted that there was a difference in the average results of students' scientific literacy abilities between the experimental class and the control class.

The use of augmented reality as learning media to increase students' scientific literacy has been conducted by several researchers. Ahied et.al. in their research reported that the use of augmented reality in distance learning during covid-19 increased the students' scientific literacy (32). Wahyu et.al. also reported that the application of STEM-based learning assisted by Mobile Augmented Reality is quite effective in increasing students' scientific literacy (33). Then, Techakosit, S. & Wannapiroon, P. reported that the learning Environment in the Augmented Reality Science Laboratory Enhance students' Scientific Literacy (25).

4. Conclusion

The research about measuring the effectiveness of flashcards based on augmented Reality application to the student's scientific literacy was successfully conducted. Based on the research, the utilization of flashcard-based augmented reality could increase the students' scientific literacy. These results were supported by an independent t-test where H0 was rejected, and Ha was accepted. With these results, it could be interpreted that there was a difference in the average results of students' scientific literacy abilities between the experimental and control classes. In addition, using Augmented Reality Media could make it easier for students to visualize the occurring phenomena. Augmented Reality media also made it easier for students to understand complex concepts and visualize abstract concepts to understand the structure of an object model. Thus, this learning media could be excluded, supporting students' learning and improving scientific literacy.

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