Immersive Virtual Reality: Unlocking Students' Elementary School Science Literacy

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Abstract: This study investigated the impact of field trip-based virtual reality learning media on improving elementary school students' science literacy. The research method used was a quasi-experiment with a non-equivalent post-test group design. The research participants were 60 elementary school students in East Jakarta who were divided into two groups, namely the experimental group (Class A) with 30 students and the control group (Class B) with the same number. The instrument used in this study was the multiple-choice test. Data analysis was conducted using an independent sample t-test. The research findings indicated a significant difference between the group that received virtual reality-based learning and the control group. This result illustrates that using virtual reality learning media based on field trips positively influences elementary school students' science literacy. The implications of this study underscore the importance of utilizing technology in education to stimulate the understanding of scientific concepts and science literacy at the basic education level.

Keywords: elementary school, literacy science, virtual reality

1. INTRODUCTION

Science literacy is a vital competency that every student must acquire for a nation to embrace the mantle of education. Its significance lies in its potential to cultivate critical thinking and innovative problem-solving abilities, fostering a skill set crucial for navigating the complexities of the modern world (Rachmadtullah et al., 2020; Sharon & Baram-Tsabari, 2020). Unfortunately, Indonesia's PISA (Program for International Student Assessment) assessment results show that students' science literacy skills are below the international average (Sholikah & Pertiwi, 2021). These results are unfortunate because neighboring countries have experienced significant improvements.

Schools play a crucial role in improving science literacy. However, conventional science learning often fails to capture students' interest (Parno et al., 2020; Setiawan

et al., 2022). One contributing factor is the suboptimal use of media, where the majority relies on video-based interactions, limiting the learning environment's effectiveness. Given that current students belong to the Alpha generation and are closely connected to technology, there is a need for digital-based learning media (Rachmadtullah et al., 2023; Suša Vugec & Stjepić, 2022). Preliminary studies conducted in elementary schools in Jakarta and East Java have revealed several factors contributing to low science literacy, including inappropriate use of learning media, student misconceptions, non-contextual learning, and common interest in science (Setiawan et al., 2022; Utomo et al., 2021). To address these challenges, researchers have taken the initiative to develop the IVR-Trip technology.

The use of Virtual Reality (VR) technology is still rarely implemented. The characteristics of VR technology that can be used anytime and anywhere at a low cost make it easy for VR technology to be implemented in Indonesia (Iasha et al., 2020; Xiong et al., 2021). In addition, the concept of VR technology that presents 3D real objects virtually makes it easier for students to understand abstract scientific phenomena. Then, VR technology also answers the needs of the Alpha generation, who collaborate with digital technology in the learning process to increase student interest in learning. The field trip Model is a learning model that invites students to a certain place or object outside the school to study/investigate the thing (Iasha et al., 2022; Schmitt Olabisi & Sidibé, 2023). Science learning with this model will create a more pleasant atmosphere because students can interact with the environment directly. In addition, the field trip model is in accordance with the characteristics of the Alpha generation, who like to interact directly with the environment.

The description above shows that virtual reality technology and field trip learning models have characteristics suitable for Alpha generation student learning. mengetahui pengaruh penggunaan media pembelajaran virtual reality berbasis field trip dalam peningkatan literasi sains siswa sekolah dasar.

2. METHODOLOGY

2.1.Research Design

This research used a quasi-experiment with the non-equivalent post-test group design. This quasi-experimental study aims to identify differences in treatment results on the characteristics of the subjects under study, referring to previous studies (Gopalan et al., 2020; Tarusu et al., 2022). This study categorized the participants into two groups, namely the experimental group and the control group. The experimental group received learning treatment through an immersive virtual reality-based field trip (IVR-Trip), while the control group received learning with conventional methods. All groups underwent pre-test and post-test stages to evaluate the effectiveness of the applied approach. Details of the research design can be found in Table 1.

Table 1.

Research design

Group	*Pre-test*	Treatment	*Post-test*
Experimental Class	O_1	X	O_2
Control Class	O_3	-	O_4

2.2.Participant

The sampling method applied in this study is simple random sampling, in which a small segment of individuals or members is randomly selected from the whole population (Setiawan et al., 2022). The location of this study was an elementary school in East Jakarta, Indonesia. The sampling process results showed that Class A was selected as the experimental group of 30 students. In comparison, Class B served as the control group, also consisting of 30 students.

2.3.Instrument Data

This study utilized a multiple-choice test as the main instrument. This multiple-choice test has been well designed, containing 20 questions that measure students' science literacy level. This instrument is a powerful tool to identify the extent to which students can understand scientific concepts. This multiple-choice test evaluates students' science literacy skills after the learning treatment using IVR-Trip media.

2.4.Data Analysis

In analyzing the data of this study, the independent sample t-test method was used. The analysis process begins with the normality and homogeneity tests, which aim to ensure that the data used in the t-test analysis meet the basic assumptions required. The normality test aims to measure the extent to which the data distribution is close to a normal distribution, while the homogeneity test tests whether the variances between the groups being compared have significant differences. These initial steps are important in ensuring the validity and reliability of the results of the t-test analysis carried out at a later stage.

3. FINDING/RESULT

3.1.Analysis Requirements Testing

The initial similarity test of the samples was used to measure the potential of each sample before the investigation was conducted. For each sample, normality, and homogeneity tests were conducted. Normality tests are used to determine whether or not the distribution of data within a group of data or variables is normally distributed. On the other hand, the homogeneity test tests the similarity of variances of two or more distributions (de Gois et al., 2020). The results of this test were used to calculate the participants' midterm exam scores. The Lilliefors method was used to determine the samples' normality; the results are shown in Table 4 with a significant degree of < 5%.

Table 2.

The normality test result

Category Class	$L_{Observation}$	L_{table}

Experiment	0.152	0.161
Control	0.139	0.161

Based on Table 2, it can be seen that the Lobservation of the experimental class and control class has a $L_{observation}$ greater than the L_{tabel}. This situation indicates that both classes are evenly distributed (Yap & Sim, 2011). Bartlett's method was then used to conduct a homogeneity test to determine whether the samples came from a homogeneous population. The calculation results ($X^2_{count} = 0.214 < X^2_{table} = 3.841$) show that X^2_{count} has a lower value than X_{2table}. This indicates that both samples come from a uniform population (Conover et al., 2018).

3.2. Students' Scientific Literacy Skills

Data regarding students' scientific ability was collected using a multiple-choice assessment administered to each student individually. Ten multiple-choice questions on scientific literacy were part of the exam and included questions on application (C3) and analysis (C4). Table 3 displays the results of this exam.

Table 3.

Results of student scientific literacy data

Category Class	N	Max Value	Min Value	Average	Deviation Standart
Experiment	30	81	63	74.82	3.86
Control	30	75	55	69.15	4.35

Table 3 shows how immersive virtual reality in the experimental class affected students' science literacy scores. The maximum, minimum, and mean scores on the students' science literacy test for the experimental class were 81, 63, and 74.82, respectively. On the other hand, the maximum, minimum, and mean scores on the student science literacy test for the control class were 75, 55, and 69.15. Data analysis showed that the experimental class had better mean scores on the science literacy test than the control class.

3.3.Hypothesis Testing Results

The comparison approach for independent samples was used to test the hypothesis in this study (independent sample t-test). Students' science literacy test results from the experimental and control classes were used as data and calculated at a 5% significant level. Table 4 displays the findings of the hypothesis test.

Table 4.

Comparative test result data

		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	2.843	.095	2.841	60	.000	8.61597	1.46921	5.68340	11.54853

Equal variances not assumed	2.841	64.383	.000	8.61597	1.46425	5.69113	11.54080

Table 4 shows that Levene's test has an F count of 2.843 and a significant level of 0.095. It can be concluded that the variances are equal because the significant result has a value of more than 0.05 (0.095 > 0.050). Therefore, the data used is Equal variances assumed. Based on the assumption of equal variance, the t value of the data is 2.841, more significant than the t_{table} value (t_{count} = 2.841 > t_{table} = 1.670). This indicates that H_a is accepted but H_0 is rejected. In addition, the significance value is 0.000 to 0.050. These findings indicate that there is a difference between the experimental and control classes in terms of students' mean scores on the science literacy test.

DISCUSSION

The analytical results obtained from this study revealed a significant difference in the science literacy skills of students involved in classes that used IVR-Trip learning media. This finding provides a strong indication that the application of IVR-Trip technology has an influential impact on improving students' ability to understand and apply scientific concepts. This significant difference underscores the effectiveness of the Virtual Reality (VR) technology-based learning approach in the context of science literacy.

Through IVR-Trip, students can access a more immersive and interactive learning experience. They can explore science concepts in a realistic virtual environment, which in turn can strengthen their understanding of the subject matter. This allows students to grasp the material easily (Rachmadtullah et al., 2020). In addition, by experiencing the situation first-hand and engaging in 3D exploration, students are exposed to a more convincing and relevant learning experience. This helps students understand science concepts theoretically and relate them to practical applications in the real world (Iasha et al., 2022).

In addition, the significant difference in science literacy ability between the class using IVR-Trip and the control group highlights the potential of VR technology in creating more inclusive and personalized learning. The interactivity of IVR-Trip media allows students with various learning styles and backgrounds to be more involved in the learning process. Students can overcome barriers and build solid understanding through unique visual and kinesthetic experiences (Iasha et al., 2020).

Utilizing virtual reality media in the learning process has been proven to help develop student criticality in various aspects (Ikhsan et al., 2020). Science literacy skills are fundamental for students to undergo science learning effectively (Shaffer et al., 2019). Science education has a central role in providing students with a strong foundation to face the challenges in the modern world. Science literacy, or scientific

literacy, refers to students' deep understanding of science (Huber et al., 2019). In addition, adequate science literacy also encourages students to have sensitivity to the environment and the ability to solve everyday problems. Science literacy is a skill that enables students to draw conclusions and make decisions based on their observations and knowledge (Kwangmuang et al., 2021).

The importance of science literacy in the context of learning is further emphasized in the application of scientific knowledge to improve students' science literacy skills. This ability plays a role in the scope of learning and significantly impacts students' daily lives and their environmental awareness (Ke et al., 2021). Through learning that improves science literacy, students are invited to develop analytical, critical, and contextual thinking skills, which are valuable for the classroom and real-life situations. Therefore, integrating science literacy into education is vital in shaping students into individuals with in-depth knowledge, sensitivity to global issues, and the ability to make rational decisions.

CONCLUSION

Research to investigate the impact of using field trip-based virtual reality learning media on improving the science literacy of elementary school students has been successfully conducted. The results showed a significant difference between the groups given virtual reality-based learning and conventional learning. This indicates that the use of field trip-based virtual reality learning media is potentially effective in improving the science literacy of elementary school students. This research makes an important contribution to educational approaches, underscoring the positive role of technology in learning. The implications of these findings can be applied to design more dynamic and interactive learning strategies, providing opportunities for students to understand science concepts better through immersive visual experiences. This conclusion offers a foundation for improving the quality of education through the development of learning media that focuses on science literacy.

ACKNOWLEDGEMENT

This research was supported by the Ministry of Education, Culture, Research and Technology, Indonesia (grant number:183/E5/PG.02.00.PL/2023)

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