International Conference on Teaching and Learning Proceeding
Faculty of Education and Teacher Training – Universitas Terbuka
UTCC, South Tangerang, Banten, November 18th 2023
Vol. 1, pg. 335 - 345
ISSN: 3046-594X

THE INFLUENCE OF THE USE OF AUGMENTED REALITY MEDIA ON THE STEM LITERACY OF PRIMARY SCHOOL STUDENTS

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Abstract: The development of the digital-based technology era requires elementary school students to master STEM literacy. However, based on literature reviews and initial measurements of elementary school students' STEM abilities, innovation is needed to improve. This research aims to determine the effect of augmented reality media on elementary school students' STEM literacy. This research is a quasi-experiment using a nonequivalent control group design. This research was carried out on 50 elementary school students. This research shows that the Independent Sample T Test produces a significance value (two-tailed) < 0.05. This result indicates a difference in the average STEM literacy between elementary school students who use augmented reality learning media and elementary school students who use conventional learning media. The intermediate understanding of STEM literacy for students in classes that use learning media is higher than for students who learn through traditional media. These findings prove that using augmented reality learning media effectively increases elementary school students' STEM literacy. This research implies that augmented reality media can be an alternative solution for increasing elementary school students' STEM literacy.

Keywords: augmented reality, literacy, media, STEM

Accepted: October 1, 2023 Approved: November 10, 2023 Published: March 26, 2024

INTRODUCTION

The development of the modern world is marked by rapid advances in science and technology, which fundamentally change the demands and goals of society. The development of this era occurs in the current era, namely the 21st-century era, which requires individuals to have various broad, deep, and integrated abilities. One of these abilities is a broader comprehensive ability in science, technology, engineering, and mathematics, known as STEM. STEM is a concept that combines science, technology, engineering, and mathematics. An understanding of STEM fields must be developed. This comprehensive understanding of STEM is called STEM literacy. STEM literacy includes an in-depth understanding of the application of science, technology, engineering, and mathematics in an integrated manner, which is the basis for individuals to adapt to complex and significant changes in modern society.

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ISSN: 3046-594X

Mastering STEM literacy is something that individuals must master. Individuals must be able to think critically to solve various problems collaboratively using STEM concepts. Understanding scientific concepts will help individuals understand nature and phenomena around them. Understanding technology will help individuals use their knowledge to create innovative solutions. An individual's understanding of engineering will become the basis for individuals to build infrastructure in modern society.

In contrast, mathematics becomes a means and tool for individuals to formulate and solve problems. So, mastering STEM literacy will equip individuals to face challenges and problems in the present and the future. Mastery of STEM literacy is not only related to related STEM concepts, but mastery of STEM is related to implementing STEM to create change in life processes. Therefore, STEM literacy needs to be developed for elementary school students. However, the literature review stated that the STEM literacy level of elementary school students could have been more optimal. Many elementary school students need help understanding STEM concepts and developing STEM skills. This literature review is supported by measuring elementary school students' initial STEM literacy abilities, which obtained an average score of 54.87 in the low category. This result proves that elementary school students' STEM literacy abilities still need to be improved. One of the problems elementary school students face in developing STEM literacy is the difficulty elementary school students have in understanding abstract problems. The study of scientific problems, mathematical operations, and technological principles are concepts that are difficult to understand if not appropriate learning for elementary school students.

Apart from that, STEM learning that is not interactive and less interesting is also one of the causes of low STEM literacy in elementary school students. Monotonous learning and not involving students in the learning process are also part of what hinders the development of STEM literacy. Therefore, efforts are needed to improve the STEM literacy skills of elementary school students. One effort that can be made is to use technology-based learning media. Technology-based learning media is learning media that can visualize abstract concepts in STEM naturally. This process will make it easier for elementary school students to understand the principles easily but still do it scientifically. In technology-based learning media, there are also interactive elements so that students can be active in the learning process, understand for themselves, and interact directly with STEM concepts. Using this technology-based learning media, STEM learning in elementary schools can be more effective, exciting, and appropriate to the development level of elementary school students.

One technology-based learning media that can be used is Augmented Reality (AR). AR is a technological medium that combines the physical world with digital components to produce a more immersive and rich interaction experience. In AR, virtual components such as three-dimensional objects, sounds, and images are combined into real-world dimensions so that AR users will feel like they are in an actual virtual situation. This process allows elementary school students to interact using digital objects and information systems in the real world. In this AR application, various devices like AR glasses or smartphones interact with virtual components in a physical environment. AR is currently becoming a trend in the learning process. AR technology in the learning process facilitates students to be actively involved in the learning process. Students can directly interact using the digital elements displayed. AR also makes it easier for students

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to understand abstract concepts. Through AR, abstract concepts can be visualized concretely. AR also facilitates students to apply knowledge concepts practically. Students can solve problems, design solutions, and understand the results of student processes in cyberspace.

AR also provides exciting learning. Students will be more motivated to learn because students will be directly involved in a fun and exciting digital technology-based learning process. AR can also be a means to carry out a problem-based learning process. Students will be presented with problems to solve using AR. This process will help students understand the relationship of learning material to students' real world. Therefore, from this statement, researchers believe AR media can improve elementary school students' STEM literacy skills. Research related to efforts to improve STEM literacy skills has begun to be carried out. Research conducted by Aninda et al. (2020) examined the implementation of project-based learning on environmental pollution material, which can increase high school students' STEM literacy. The research results state that project-based learning can improve high school students' STEM literacy.

Research conducted by Widiyanti et al. (2021) examined the development of UKBM using the Engineering Design Process (EDP) approach to increase high school students' STEM literacy. The research results state that the Engineering Design Process (EDP) approach can improve high school students' STEM literacy. Research conducted by Farida (2021) examined the development of a virtual STEM laboratory to improve high school students' science process skills and stem literacy on stoichiometry material. The research results state that high school students' STEM literacy skills can be increased by implementing STEM laboratories. From the results of previous research, there have been efforts to improve students' STEM abilities. However, the efforts still use learning models that do not fully involve technology. Apart from that, STEM literacy development is still being developed at various levels. This research is different from the research that the researcher conducted in that the researcher used learning media based on AR technology to improve the STEM literacy skills of elementary school students. This research aims to determine the effect of AR media on elementary school students' STEM literacy abilities.

It is essential to carry out this research to study and explore the effect of using AR on increasing elementary school students' STEM literacy skills. AR is expected to impact elementary school students' interest in learning and understanding STEM concepts in the learning process. This research aims to explore the extent to which AR can act as an effective and innovative learning tool in increasing elementary school students' STEM literacy. Researchers hope that the data and results of this research will provide valuable guidance for educators and policymakers in efforts to develop more exciting and efficient STEM learning methods.

METHOD

This research is a type of quasi-experimental research that uses a nonequivalent control group design. Participants in this study consisted of 100 elementary school students who were divided into two groups, namely 50 elementary school students in the control group and 50 elementary school students in the experimental group. STEM

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literacy is measured using eight essay questions adapted to STEM literacy indicators. The STEM literacy indicators are (1) Developing questions and identifying problems, (2) Building explanations (science) and designing solutions (engineering), (3) Applying mathematics, information technology, computers and computational thinking, (4) Creating and using models, (5) Plan and carry out investigations, (6) Collect, evaluate, and convey information, (7) Engage in evidence-based arguments, (8) Analyze and interpret data.

The exam questions have been created based on the indicator guidelines that have been outlined and have undergone a validation process. Relevant experts have checked the content validity of the questions, while the construct validity has been tested using product moment correlation calculations. The content validity results show that the questions can be considered valid and ready to be used. In contrast, the construct validity results show that each question gets an r value more significant than the r value listed in the table, indicating an adequate level of validity. The reliability of the questions was also assessed, and the results showed a very high level of reliability, namely 0.964. The data analysis process was carried out with the help of SPSS version 26 software and included the steps of descriptive test, normality test, homogeneity test, and paired test. Sample t-test and independent t-test, which are relevant for analyzing data with a statistical approach.

RESULT AND DISCUSSION

Result

Each class receives appropriate treatment. After the actions are implemented in both experimental and control classes, the next step is to analyze the data. The initial stage of data analysis includes data tabulation to facilitate data processing. The following are the tabulation results of the resulting data.

Table 1. Data Tabulation Results for Experimental Class and Control Class

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Pre-Test Experiment	50	55	61	56,47	2.472
Post-Test Experiment	50	88	100	87,39	4. 329
Pre-Test Control	50	53	60	55,48	2.328
Control Post-Test	50	57	61	56,32	1.328
Valid N (listwise)	50				

From Table 1 above, you can see the essential data measured for the four classes. This data will be processed in the next step. We carry out a normality test to evaluate whether the collected data follows a normal distribution. The results of the normality test can be

seen in Table 2.

Table 2. Normality Test Results

Tests of Normality							
	Class	Kolmogorov-Smirnov [a]			Shapiro-Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
STEM Literacy	Pre-Test Experiment	.238	50	.016	.934	50	.017
	Post-Test Experiment	.138	50	.012	.844	50	.018
	Pre-Test Control	.238	50	.026	.745	50	.096
	Control Post-Test	.244	50	.076	.756	50	.053
a. Lilliefors Significance Correction							

From Table 2, each class has a sig value > 0.05. This result result indicates that the data distribution in each class is expected. The next stage involves the use of a paired sample t-test. This test is used to determine the average difference between two paired samples. This test's main aim is to answer whether the use of AR media significantly impacts elementary school students' STEM literacy abilities. The following are the results of the paired sample t-test that was carried out.

Table 3. Paired Sample Test Results

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Dev	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test Experiment - Post-Test Experiment	-16.182	3.362	.273	-18.261	-12.292	-65.323	49	,000
Pair 2	Pre-Test Control - Post-Test Control	-1.236	1.039	.211	-1.109	-1.128	-7.311	49	.051

Table 3 illustrates that in the first pair, the sig value. (2 failed) less than 0.05. This result indicates an average difference between the pre-test and post-test in the experimental class regarding elementary school students' STEM literacy. However, in the second pair, where the sig. (2 failed) is more significant than 0.05, indicating no difference in the average between the pre-test and post-test in the control class regarding university students' understanding of disaster mitigation. The next step is to carry out a homogeneity test to assess whether the experimental and control class post-test have similar or different levels of homogeneity. The results of this homogeneity test can be

seen in the following table.

Table 4. Homogeneity Test

Test of Homogeneity of Variance					
		Levene Statistics	df1	df2	Sig.
STEM Literacy	Based on Mean	125.373	1	98	.348
	Based on Median	94.437	1	98	.443
	Based on Median and with adjusted df	94.429	1	98	.343
	Based on trimmed mean	124.392	1	98	.259

From Table 4, the sig value for "based on mean" is 0.382, exceeding 0.05. This result indicates that both groups of data have uniform variance. Next, an independent sample t-test was conducted to answer whether there was a difference in STEM literacy abilities between elementary school students who used AR media and students who used conventional learning media. The results of this test can be found in the following table.

Table 5. Independent Sample Test Results

Independent Samples Test										
		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
STEM Literacy	Equal variances assumed	123,323	,000	65,462	98	,000	35,483	,441	33,382	88,383
	Equal variances not assumed			64,484	113,372	,000	33,431	,441	33.312	87,937

From Table 5, the sig. (two-tailed) < 0.05. This result shows a significant difference in the average literacy skills between elementary school students who use AR and conventional learning media. To get a more detailed picture of the significance of elementary school students' STEM literacy abilities, average data from the control and experimental classes can be found in the following table.

Table 6. Average Data for The Control Class and Experimental Class

Group Statistics					
	Class	N	Mean	Std. Deviation	Std. Error Mean
STEM literacy	Experimental Class Post-Test	50	87.39	4. 329	.221
	Control Class Post-Test	50	56.32	1.328	.219

From table 7, the average literacy ability of elementary school students in the experimental class is higher than those in the control class. This shows that the application of AR media is effective in improving elementary school students' STEM literacy skills.

Discussion

The findings state that the application of AR media is efficacious in improving elementary school students' STEM literacy skills. This finding is supported by previous research conducted by Bursali and Yilmaz (2019), which examined the influence of AR on junior high school students' reading comprehension and student learning permanence. The research results stated that junior high school students who learned to read using AR media were higher than those who used conventional media. Another research was conducted by Sahin and Yilmaz (2020), which examined the influence of augmented reality technology on the achievements and attitudes of middle school students toward science education. The research results stated that junior high school students who studied using AR had higher learning achievements and learning attitudes than students who studied conventionally. Research conducted by Akçayır et al. (2016) studied the impact of augmented reality on students' laboratory skills and attitudes toward science laboratories. The research results show that students who study using AR have higher laboratory skills and attitudes than those who study in conventional classes. Petrov and Atanasova's (2020) research examine the influence of augmented reality on student learning performance in STEM education. The research results stated that students who studied using AR had higher STEM learning outcomes than those who studied using conventional classrooms. The results of previous research show that using AR in the learning process can improve the quality of learning, such as reading comprehension, learning achievement, scientific attitudes, and science skills for middle school and university students. However, it is a new finding in this research that AR impacts elementary school students' STEM literacy.

The increase in elementary school, students' STEM literacy in AR media is caused by several scientific factors. AR is an interactive and visual learning media. AR can create interactive and visual learning experiences by combining digital elements with the real world. Elementary school students can observe objects or environments using AR. Elementary school students can view additional information digitally that is integrated with the natural physical environment. This fact provides benefits for elementary school students to be able to develop their cognitive abilities. In terms of STEM literacy, visual and interactive approaches have proven to be very effective, especially when dealing with students at the elementary school level. Students at this level tend to understand complex

concepts better when they can see and experience the subject matter directly, not just through text or verbal explanations. AR allows them to see and interact with STEM concepts directly. For example, in science learning, students can use AR to explore three-dimensional models of human cells. They can rotate, zoom in, or zoom out these models to understand how cells interact in the body. This approach is much more interesting than just looking at static images in a textbook.

Additionally, AR allows students to see how STEM concepts are applied in real-world situations. This fact makes STEM material more relevant and easier to understand for students. In terms of cognitive development, students in elementary school are at a stage where direct experience and physical interaction are significant for understanding the world around them. AR allows them to involve their senses, such as eyes and hands, in learning. This approach aligns with how students at this age learn and understand STEM concepts better through hands-on experiences involving their five senses. Thus, AR is essential in building a solid foundation for elementary school students' STEM literacy.

AR media also provides problem-based learning. A problem-based approach can be applied efficiently in the context of using AR as a learning tool. This approach confronts students with real situations that give rise to challenges and problems that require critical thinking and problem-solving skills. With AR, students interact in a real-world environment enriched with digital elements. They may face a task or problem that must be solved by utilizing the information available in the AR environment. This condition encourages students' cognitive development, including their ability to analyze, solve problems, and recognize essential patterns. Students must process existing information, identify relevant relationships or patterns, and design strategies to solve the problem. Therefore, AR provides a more immersive and interactive learning experience that supports students' cognitive development, helping them practice their analytical, problem-solving, and ability to recognize essential patterns. In addition, this problem-based approach also makes learning more exciting and relevant for students in elementary school, helping them relate STEM concepts to the real world with meaning.

Many elementary school children today are accustomed to using digital devices, such as smartphones, tablets, and computers. They often use these devices to play, communicate, or access information. In digital technology-based learning, such as AR, teachers utilize devices and media that have become commonplace in children's lives. Therefore, when technology such as AR is used in learning, children feel more comfortable and familiar with these devices and media. They no longer face difficulties using devices or interacting with these media because they already have previous experience with similar technologies. This process is essential in STEM literacy because children can focus more on understanding STEM concepts and participate actively in learning without wasting much time understanding how to operate the technology. In other words, using media that is already familiar to children. Children simplify the learning process and help them be more efficient in developing STEM literacy. This fact can also increase children's interest in learning more about science, technology, engineering, and mathematics because learning becomes more exciting and accessible through media they are already familiar. So overall, there has been an increase in elementary school students' STEM literacy skills after using AR teaching media. The use of AR in the STEM learning process for elementary school students can create a learning

experience that is more interactive and relevant and supports their cognitive development. This process will play a role in improving students' STEM literacy skills and equip them to face future STEM challenges.

CONCLUSION

Students need STEM literacy skills to ensure their future learning achievements are maintained. Therefore, efforts are needed to improve STEM literacy skills in elementary school students. The research concluded that AR learning media can significantly improve elementary school students' STEM literacy skills. The research results also indicate that increasing STEM literacy in elementary school students is related to the interactive, visual, and contextual nature, the relevance of AR media to everyday life, and the implementation of a problem-based approach to learning. Therefore, it is recommended that adequate technological facilities are available for teachers and students in carrying out this research. It is also necessary to train teachers and students to use AR media better in the learning process. This research also recommends that AR media be used as an alternative to improve elementary school students' STEM literacy skills.

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