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Augmented Reality with STEAM through Blended Learning for Elementary School

Endang Widi Winarni[1], Endina Putri Purwandari[2]

[1]Department of Primary Education, Graduate School, University of Bengkulu, Bengkulu, Indonesia

[2]Department Information System, Engineering Faculty, University of Bengkulu, Bengkulu, Indonesia

ABSTRACT

Purpose: Students in elementary school have difficulty to understand difficult topics because they are still in the concrete operational stage. By visualizing complex concepts as three-dimensional objects, Augmented Reality (AR) enables interactive and real-time reality. This investigation employs an interdisciplinary approach to Science, Technology, Engineering, the Arts, and Mathematics (STEAM) using AR technology.

Patients and methods: The current study employs an interdisciplinary methodology that combines STEAM and AR with blended learning as pedagogical strategies in elementary education. The present study was conducted in Bengkulu, Indonesia, with a sample of forty elementary school students and six sixth-grade instructors.

Results: The results of N-gain indicate an improvement in the experimental class, indicating that the AR method is extremely effective at improving students' comprehension.

Conclusion: The research shows that AR integrated with STEAM-based blended learning has significantly increase student engagement in the classroom and improve the development of students' cross-disciplinary knowledge integration, problem-solving, and self-directed learning skills. Moreover, STEAM with AR is required for students to comprehend the course material and has assisted instructors in optimizing the use of media in classroom.

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KEYWORDS:
augmented reality, blended learning, elementary school, interactive learning, STEAM.

1. INTRODUCTION

[Elementary school students are presently in the concrete operational stage of cognitive development, which makes it difficult for them to comprehend complex ideas. The objective of this research was to examine the implementation of STEAM combined with blended learning in elementary schools. Although there has been some research on the use of AR in education to inform the development of specific educational applications. There has been limited research on the development of a pedagogical framework and the provision of resources for teachers to implement it effectively [1]–[3]. This study examines the experience of integrating AR and STEAM instruction with elementary school students. Due to the inadequacy and need for further improvement of the quality and originality of education at this stage, the research was conducted in elementary school.

The STEAM approach emphasizes the incorporation of multiple disciplines and the practical application of knowledge to real-world situations, Through the process of receiving feedback, students demonstrate a greater propensity to engage in the expansion and diversification of their learning, as well as develop an increased capacity in the acquisition of novel knowledge [4]. The objective of STEAM education is to impart problem-solving skills to students that can be applied in real-world situations [5].

STEAM is based on the attributes of elementary school students, who require a multidisciplinary understanding of a topic from multiple perspectives. Students with concrete operational reasoning can acquire a visual representation of abstract concepts through the use of augmented reality technology. The incorporation of STEAM education with augmented reality offers a variety of methods

Corresponding Author: Endang Widi Winarni

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for evaluating students' focus, organizational ability, and social engagement. The incorporation of novel features with AR and STEAM enabled learners to monitor their advancement and status during the learning process.]

II. METHOD

Blended learning is a pedagogical strategy that combines online and offline learning techniques. Students in sixth grade are at an important developmental stage. According to the theory of cognitive development devised by Jean Piaget, students at this grade level are in the concrete operational stage of cognitive development. They have mastered the fundamentals of inquiry psychology and inquiry skills. Blended content is being developed for the Animal Conservation theme, which integrates STEAM education and AR technology. Fig. 1 illustrates the framework for STEAM integrated with AR.

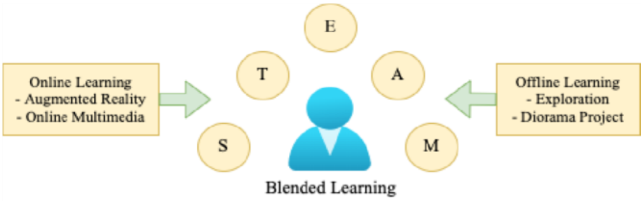

Fig. 1. The framework of blended learning using AR with STEAM Education

As depicted in Fig. 1, the fundamental concept of this pedagogical approach is a partnership between teachers and students to implement STEAM education through the use of integrated learning resources. Digital learning tools, such as multimedia and AR applications, are utilized by teachers to foster self-directed learning and interdisciplinary cognition among their students. The Diorama project serves as a tool for enhancing knowledge acquisition in students through offline learning by means of a guided inquiry process and the provision of concrete illustrations [21], [22]. Collaborative activities among students are employed to achieve objectives and acquire knowledge from other students.

The treatment's effectiveness was determined based on an evaluation of enhanced learning quality using a paired sample test. In contrast, the improvement in education quality has been observed via the normalized gain. The data were then analyzed utilizing the T-test for independent samples. The statistical calculations were performed using version 25 of IBM SPSS Statistics. If the p-value exceeds 0.05, the null hypothesis (H0) has been considered to be accepted. The formula for normalized gain is applied to determine the magnitude of an improve, as demonstrated in equation (1). Moreover, the value of normalized gain is determined by the criteria for achieving the gain requirements [23]. If the normalized gain is less than 0.3, it can be inferred that the student's achievement falls within the lower criteria. If the normalized gain falls within the range of 0.3 to 0.7, it can be inferred that the student's performance is moderate in terms of achievement. Moreover, when the normalized gain exceeds 0.7, it indicates that the students have achieved at a high criterion.

$$gain = \frac{posttest - pretest}{maximum\ value - pretest} \qquad (1)$$

III. DISCUSSION

All participants enrolled in the experiment were involved in the blended learning course during the educational exercises. Students remotely access digital resources and complete their AR assignments using online platforms. In contrast, the teacher assisted the students in the control group in completing their projects, workbooks, and conventional classroom presentations.

When face-to-face instruction is not possible, the teacher uses a diorama and AR to help students comprehend the topic. Boxes or crackers that had been cut to open like a book were used to construct the model. The interior of the box contained a reef with handcrafted aquatic life. Back of the box was a leaflet with a reproduction of an underwater landscape that identified and provided information about the marine life. The conservation of marine life was illustrated on the side of the carton.

Each student group was given two weeks to accomplish their assigned diorama projects. Two distinct educational tools utilized in sixth-grade elementary institutions for the purpose of animal conservation are shown in Fig. 2. Specifically, the tools include online AR applications (See Fig. 2(a)) and offline dioramas (See Fig. 2(b)).

(a) (b)

Fig 2. Learning media for animal conservation (a) AR and (b) Diorama

The t-test results indicate that the implementation of STEAM-based AR has a positive impact on the quality of science education, as evidenced by the learning outcomes. The t-test was performed after the prerequisite tests, namely the normality test to determine whether the data were normally distributed and the homogeneity test to determine whether the variance of the population was homogeneous. The normality test results indicate that the data have a normal distribution (see Table II). If the significance level between two classes exceeds 0.05, it can be concluded that both classes exhibit a normal distribution. The normality values of the control and experimental classes were 0.08 and 0.07, respectively, indicating that both classes exhibited normal distribution. Furthermore, the level of homogeneity among the samples in the control group is 0.54, while in the experimental group it is 0.38. Table 1 suggests that the two samples are homogeneous.

Table 1. Normality and homogeneity test

	Normality Test			Homogeneity Test			
Class	Statistic	df	Sig.	Levene	df1	df2	Sig.
control	0.18	20	0.08	0.38	1	38	0.54
experiment	0.18	20	0.07	0.79	1	38	0.38

As shown in Table 2 the results of the N-Gain test indicate that the mean N-Gain score for the control group is 0.25, which falls within the lower range of scores. In contrast, the N-Gain value for the experimental group is 0.70. The outcomes of the normalized gain analysis demonstrated a significant improvement in the scores obtained prior to and post the implementation of STEAM-based AR media. The calculation of normalized gain revealed a score of 0.79, which falls within the high category. Therefore, the use of AR significantly improves the understanding of students.

Table 2. The N-gain value

Class	Statistic	Std. Error
control	0.25	0.028
experiment	0.70	0.033

In addition, the SPSS software-based statistical analysis yielded a Sig. (2-tailed) value of 0.00 0.05, as shown in Table IV. As observed in the control group, there is a significant difference between students who engage in STEAM-based AR when combined with blended learning.

The experimental group of students who utilized AR technology got more significance on material understanding than the control group, who created dioramas. In elementary school classrooms, arts and crafts activities are predominantly focused on exploration and play, as compared to the production of art. Dioramas are a combination of artistic endeavor and a valuable tool for the promotion of scientific education [24]. In elementary school classrooms, arts and crafts activities are predominantly focused on exploration and play, as opposed to the production of art. Dioramas are an example of a creative process that is also a valuable tool for promoting scientific learning.

The success of a diorama project depends on detailed activity planning and effective project management. The discussion centered on the potential problems that can arise when using acrylic paint. As a precaution against accidental drips, drop cloths were placed on the painting table and the encircling floor. Sixth-grade students are permitted to use permanent acrylic paints once they have completely dried. The majority of incidents occurred as a result of students using excessive force when flicking, scrubbing, or creating distractions during the task. Shirts or aprons that have been decorated with paint are used to protect clothing. Diverse issues encountered during the creation of dioramas detract from the subject's fundamental theme. Teachers who intend to replicate this project should consider implementing group tasks and teacher-led mentoring sessions.

Table 3. The independent-samples of T-test

	F	Sig.	t	df	Sig. (2-tailed)
posttest	1.155	.289	-11.778	38	.000

The integration of AR technology with STEAM education has been found to enhance the academic performance of elementary school students in this particular case (see Table 3). The study's results indicate that the utilization of AR has the potential to effectively integrate virtual and real objects in order to optimize the educational experience [25]. The utilization of AR has the potential to facilitate social and cognitive activities, motivation, and critical thinking, while prioritizing physical mobility to ensure that students become fully engaged in the learning process. This approach enables teachers to experiment with novel pedagogical techniques to enhance the acquisition of knowledge [26]. Furthermore, prior studies have indicated that the utilization of AR has proven to be effective in aiding students with the comprehension of intricate and abstract concepts. [27]. The pedagogical approach begins by initiating a conversation on a specific case or problem, which encourages the students to undertake a project and identify relevant concepts, information, and resources. Subsequently, students utilize their newly acquired expertise and abilities to address practical challenges encountered in the real world. Furthermore, the integration of multiple disciplines in learning designs through STEAM presents an effective approach for students to develop scientific thinking, creativity, and experimental skills, which improves their level of collaboration [28].

STEAM approach is highly appropriate for elementary school learners, whose education is comprehensive and integrates various discipline [29]. This approach prioritizes physical movement, enabling students to actively participate in their education and obtaining teachers the opportunity to explore novel pedagogical strategies [10]. The provision of opportunities for students to develop scientific and creative thinking and engage in meaningful experimentation serves to increase their interest in the topic. The incorporation of AR as an instructional medium in blended learning has the potential to improve STEAM education by increasing student engagement and fostering a deeper understanding of the subject. The provision of supplementary guidance is necessary to facilitate the integration of imaginative and inventive initiatives into pedagogical methodologies [4], [30].

The integration of the STEAM approach into blended learning results in contextual learning, whereby students are tasked with comprehending events that take place throughout their own immediate environment [8]. As a result, STEAM education has been incorporated into the 2013 curriculum in Indonesia. According to the previous discussion, the STEAM disciplines represent a comprehensive educational approach that prioritizes the development of problem-solving skills through interactive learning experiences. The STEAM approach entails collaborative learning within the constructivist pedagogy framework, in which students actively construct their own understanding and knowledge. In education, blended learning accelerates the process of technology integration for both teachers and students, resulting in the development of 21stcentury skills.

IV. CONCLUSION

The results of the study indicate that the integration of AR with STEAM showed a significant improvement in the learning quality of elementary student. This was demonstrated by finding that the experimental class had a higher N-Gain score than the control class. AR technology is capable of integrating various forms of multimedia, facilitating interactivity, and presenting instructional content alongside realistic, captivating, and user-friendly objects. This has the potential to enhance the elementary school educational experience.

AR technology facilitates a visual connection between students and their physical environment, without necessitating direct physical contact. This technology allows students to delve deeper into STEAM learning. The integration of the STEAM model within a blended learning approach that incorporates AR is a crucial factor in facilitating students' understanding of the subject matter.

In the future, the organization involves proposing strategies to enhance teachers' proficiency and facilitate the implementation and advancement of STEAM-oriented education in academic institutions. Incorporating STEAM as a fundamental component and complementary approach in blended learning for elementary education can be considered a sound pedagogical strategy. In addition, it facilitates the implementation phase and promotes the development of pedagogical approaches for conveying 21st century competencies through STEAM education.

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