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EFFECT OF AUGMENTED REALITY ASSISTED PROBLEM BASED LEARNING ON STUDENTS' CRITICAL THINKING SKILLS

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Abstract. The critical thinking ability of third-grade elementary school students is still low, especially in analyzing problems and drawing logical conclusions, due to learning that has not encouraged active student involvement. This study aims to determine the effect of the Problem Based Learning (PBL) model assisted by Augmented Reality media on the critical thinking ability of third-grade students at SDN Wangisagara 03. The study used a quantitative approach with a quasi-experimental method and a non-equivalent control group design. The study population consisted of 56 students divided into an experimental class (28 students) and a control class (28 students). Data collection techniques were carried out through a critical thinking ability test in the form of 15 multiple-choice questions given at the pretest and posttest stages. Data were analyzed using the Shapiro-Wilk normality test, Levene's homogeneity test, and the Mann-Whitney hypothesis test with the help of IBM SPSS Statistics 27. The results showed that the critical thinking ability of students who participated in PBL learning assisted by Augmented Reality media was better than students in the control class. Thus, the PBL model supported by Augmented Reality media has a positive effect on the critical thinking ability of elementary school students.

Keywords: Problem Based Learning; Augmented Reality; Critical Thinking Skills; Elementary School Students

Abstrak. Kemampuan berpikir kritis siswa kelas tiga sekolah dasar masih rendah, terutama dalam menganalisis masalah dan menarik kesimpulan secara logis, akibat pembelajaran yang belum mendorong keterlibatan aktif siswa. Penelitian ini bertujuan untuk mengetahui pengaruh model Pembelajaran Berbasis Masalah (*Problem Based Learning*/PBL) yang dibantu media Augmented Reality terhadap kemampuan berpikir kritis siswa kelas tiga di SDN Wangisagara 03. Penelitian menggunakan pendekatan kuantitatif dengan metode kuasi-eksperimental dan desain kelompok kontrol non-ekuivalen. Populasi penelitian terdiri atas 56 siswa yang dibagi menjadi kelas eksperimen (28 siswa) dan kelas kontrol (28 siswa). Teknik pengumpulan data dilakukan melalui tes kemampuan berpikir kritis berupa 15 soal pilihan ganda yang diberikan pada tahap pretest dan posttest. Data dianalisis menggunakan uji normalitas Shapiro-Wilk, uji homogenitas Levene, dan uji hipotesis Mann-Whitney dengan bantuan IBM SPSS Statistics 27. Hasil penelitian menunjukkan bahwa kemampuan berpikir kritis siswa yang mengikuti pembelajaran PBL berbantuan media Augmented Reality lebih baik dibandingkan siswa pada kelas kontrol. Dengan demikian, model PBL yang didukung media Augmented Reality berpengaruh positif terhadap kemampuan berpikir kritis siswa sekolah dasar.

Kata Kunci: Pembelajaran Berbasis Masalah; Realitas Tertambah; Keterampilan Berpikir Kritis; Siswa Sekolah Dasar

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INTRODUCTION

Education is a fundamental process that supports individuals in developing knowledge, maturity, and higher-order thinking skills, including critical thinking (Rahman et al., 2020). Critical thinking is one of the core competencies in the 21st-century skills framework, alongside creativity, communication, and collaboration. At the elementary school level, critical thinking plays a crucial role because it enables students to analyze information, solve problems, and make reasoned decisions in everyday contexts (Fitriani et al., 2022). Early development of critical thinking skills is therefore essential to support students' academic growth and lifelong learning capacity.

However, various indicators show that Indonesian students' critical thinking and scientific reasoning skills remain relatively low. The Programme for International Student Assessment (PISA) 2022 reported that Indonesia's average science literacy score was 383, placing it far below the OECD average (OECD, 2023). Science literacy is closely related to critical thinking because it involves reasoning, evaluating evidence, and applying scientific concepts to solve real-world problems (Abbas et al., 2023). These findings highlight an urgent need for learning approaches that explicitly foster critical thinking skills, particularly in science learning at the elementary level.

Classroom conditions further reinforce this concern. Preliminary interviews with third-grade teachers at SDN Wangisagara 03 indicated that a substantial proportion of students experienced difficulties when answering questions that required reasoning and explanation. Although students could recall information presented by the teacher, their justifications tended to be brief and lacked logical depth. This situation is closely related to the dominant use of teacher-centered instructional practices and limited utilization of concrete learning media. Direct instruction that emphasizes information transmission and memorization has been shown to be less effective in developing students' critical thinking skills because it positions learners as passive recipients rather than active problem solvers (Burhana et al., 2021).

To address this issue, learning models that promote active engagement and meaningful problem-solving are required. One model that aligns with these needs is Problem Based Learning (PBL). PBL encourages students to learn through real-life problems, fostering inquiry, collaboration, and critical reasoning throughout the learning process (Prasetyo & Kristin, 2020). Through its structured stages, PBL trains students to identify problems, investigate possible solutions, and reflect on their reasoning, which are essential components of critical thinking.

In addition to learning models, instructional media also play a significant role in supporting

effective learning experiences. Augmented Reality (AR) media allow students to interact with three-dimensional virtual objects integrated into real environments, making abstract concepts more concrete and easier to understand (Putri et al., 2025). Several studies have reported that AR-based media can increase student engagement and conceptual understanding (Hidayat & Mulyani, 2020; Nurfadhillah et al., 2021). Nevertheless, most existing studies tend to examine the effects of PBL or AR media separately, while empirical research that integrates PBL with AR to specifically enhance elementary students' critical thinking skills remains limited.

This gap indicates the need for further investigation into how the integration of the PBL model with Augmented Reality media can support the development of critical thinking skills in elementary school contexts. Therefore, this study aims to analyze the effect of the Problem Based Learning model assisted by Augmented Reality media on the critical thinking skills of third-grade elementary school students.

METHOD

This research employed a quantitative approach using a quasi-experimental method. Quasi-experimental research was selected because it involves a control group but does not allow full control over all external variables that may influence the experiment (Sugiyono, 2023). The research design applied was the nonequivalent control group design, which involves two groups, namely an experimental class and a control class, both of which are given pretests and posttests to measure changes resulting from the treatment (Abraham & Supriyati, 2022).

The study was conducted at SDN Wangisagara 03, located in Wangisagara Village, Majalaya District, Bandung Regency, West Java. The research took place over three days, from May 11 to May 13, 2026. During this period, the experimental class received instruction using the Problem-Based Learning model assisted by Augmented Reality media, while the control class was taught using direct instructional learning. The population of this study consisted of all third-grade students at SDN Wangisagara 03, totaling 56 students. A saturated sampling technique was employed, meaning that all members of the population were included as research samples (Suriani et al., 2023). Class III A, consisting of 28 students, was assigned as the experimental class, and Class III B, also consisting of 28 students, served as the control class.

Data were collected using a test technique. The research instrument was a set of objective multiple-choice test items designed to measure students' critical thinking skills. The test was administered twice, namely as a pretest before the implementation of the learning treatment

and as a posttest after the learning activities were completed. The instrument was validated prior to use to ensure that it measured the intended indicators of critical thinking skills.

Data analysis was carried out using IBM SPSS Statistics 27 software. The analysis began with a normality test using the Shapiro–Wilk test to determine whether the data were normally distributed. This was followed by a homogeneity test using Levene's test to examine the equality of variances between the experimental and control groups. Based on the results of these prerequisite tests, hypothesis testing was conducted. Because the data did not fully meet the assumption of normal distribution, the Mann–Whitney U test was used to determine whether there was a significant difference in students' critical thinking skills between the experimental and control classes.

RESULTS AND DISCUSSION

The implementation of learning in the experimental class (III A) applied the Problem Based Learning model assisted by Augmented Reality media with five Problem Based Learning syntaxes, while the control class used the direct instructional learning model. Test instruments in the form of pretest and posttest questions were given to students in the experimental class and control class to measure students' critical thinking skills before and after treatment. The results of the descriptive statistical analysis of pretest and posttest data in the experimental class and control class, tested using IBM SPSS Statistics 27 software, are presented in Table 1 below.

Table 1. Results of descriptive statistical analysis

Data	Class	Min	Max	Mean	Std. Deviation
Pretest	Experimental	13	87	42.89	20.42
	Control	7	60	39.04	11.99
Posttest	Experimental	20	93	58.54	17.69
	Control	20	60	40.25	10.66

Based on Table 1, the average pretest score of the experimental class was 42.89 and the control class was 39.04. After being given treatment, the average posttest score of the experimental class increased to 58.54, while the control class only reached 40.25. This difference in averages indicates that the application of the Problem Based Learning model assisted by Augmented Reality media had a greater impact on students' critical thinking skills compared to the direct instructional learning model. The results of this study are in line with research conducted by Zulfa et. al., (2023, p. 2106) which shows that the Problem Based Learning model can improve students' critical thinking skills through problem-solving

activities that require students to actively analyze and find solutions. In addition, research by Purnama, et. al., (2024, hlm 173-174) proves that the use of Augmented Reality media combined with the Problem Based Learning model can create contextual, interactive, and meaningful learning experiences, thus having a positive impact on student learning outcomes.

This finding is also supported by the opinion of Prasetyo & Kristin (2020, hlm 13-27)that the Problem Based Learning model aims to help students master the material, stating that the Problem Based Learning model is effective in developing critical thinking skills because students are faced with real problems that must be solved through an investigation process. In addition, Hidayat & Mulyani (2020, p. 2) explain that Augmented Reality media can increase student engagement and help them understand concepts more deeply through interactive visualization. Thus, the Problem Based Learning model and Augmented Reality media are proven effective in improving critical thinking skills of elementary school students. These results indicate that students who learn using the Problem Based Learning model assisted by Augmented Reality media obtained better improvement in critical thinking skills compared to students who learn using the direct instructional model, because the learning provides opportunities for students to be actively involved in the problem-solving process and understand the material more concretely. Before testing the hypothesis, a normality test was conducted to determine whether the research data were normally distributed or not as a basis for determining the type of hypothesis test to be used. The test was conducted using IBM SPSS Statistics 27 software and presented in Table 2 below.

Table 2. Results of shapiro-wilk normality test

Data	Class	Sig.	Conclusion
Pretest	Experimental	0.369	Normal
Pretest	Control	0.483	Normal
Posttest	Experimental	0.745	Normal
Posttest	Control	0.134	Normal

The normality test was conducted using the Shapiro-Wilk method, which is most effective for small to medium samples Sianturi (2025, p. 1). Based on Table 2, all significance values are greater than 0.05, so it can be concluded that all pretest and posttest data for both the experimental class and control class are normally distributed. These results indicate that the critical thinking skills of students who received learning using the Problem Based Learning model assisted by Augmented Reality media are better than students who received direct instructional learning.

This finding is in line with research by Zulfa et. al., (2023, hlm. 2106) which shows that the application of the Problem Based Learning model can improve students' critical thinking skills through problem-solving activities that require students to think actively. In addition, research by Purnama, et. al., (2024, pp. 173-174) proves that the use of Augmented Reality media can create contextual and interactive learning experiences, thus supporting the improvement of students' critical thinking skills. The results of this study are also supported by the opinion of Hakim, (2022, p 1311-1316) who states that the Problem Based Learning model trains students to use critical thinking skills in solving problems and increases student activeness during the learning process. Furthermore, Putri et. al., (2025, p. 875) explain that Augmented Reality media allows students to observe three-dimensional objects directly, thus helping students understand learning concepts more concretely and deeply.

Thus, the application of the Problem Based Learning model assisted by Augmented Reality media is proven effective in improving students' critical thinking skills. Based on the normality test results, all pretest and posttest data in both the experimental and control classes were normally distributed because the significance values were greater than 0.05. In addition to using the Shapiro-Wilk test, data normality was also analyzed through Q-Q Plot graphs to visually see the distribution of data against the normality line. The Q-Q Plot results of pretest and posttest data in both classes are presented in Figure 2 below.

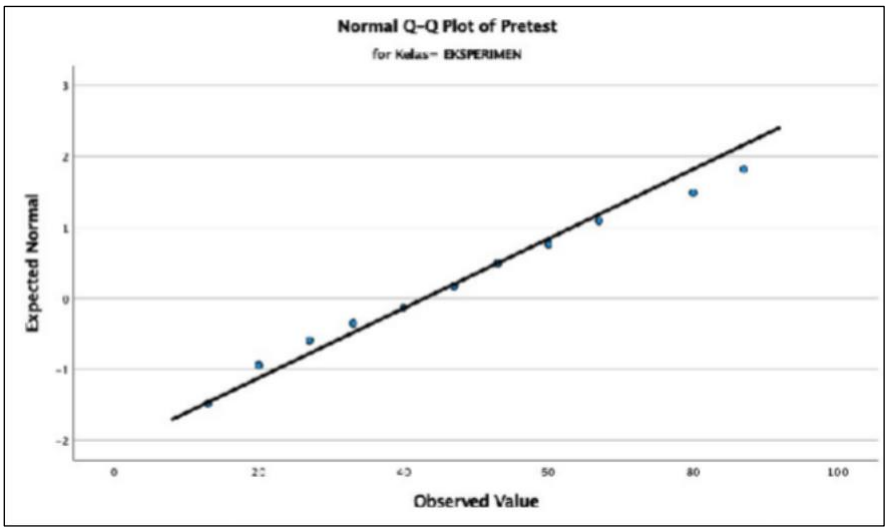

Figure 2. Q-Q plot of pretest data for experimental class

Based on the Normal Q-Q Plot of the experimental class pretest, it can be seen that the data points are scattered around the diagonal line and follow the direction of the line. Most of the points are close to the diagonal line although there are slight deviations at some points. This indicates that the pretest data of the experimental class tends to be normally distributed, thus fulfilling the normality assumption. Thus, based on a sample of 28 students using the Shapiro-

Wilk test, the Shapiro-Wilk test result obtained a significance value of 0.369 > 0.05, so the pretest data of the experimental class is declared normally distributed. In addition, the pretest data for the control class can be examined in the Q-Q Plot graph.

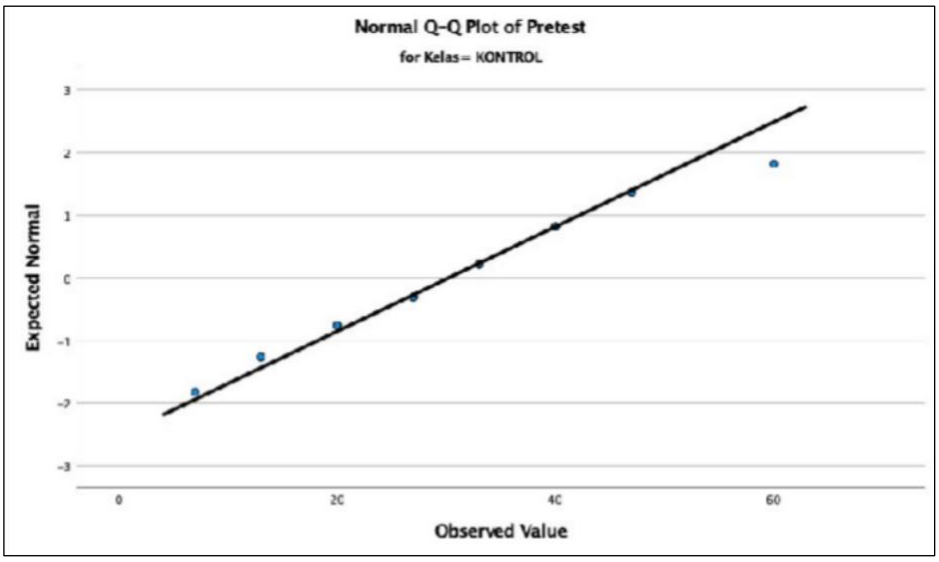

Figure 3. Q-Q plot of pretest data for control

Class Based on the Normal Q-Q Plot of the control class pretest, it can be seen that the data points are scattered around the diagonal line and follow the direction of the diagonal line. The distribution of data points is relatively even and does not show significant deviations. Thus, the pretest data of the control class can be said to be normally distributed and fulfill the normality assumption. The Shapiro-Wilk test result shows a significance value of 0.483 > 0.05, so the pretest data of the control class is declared normally distributed. In addition, the posttest data for the experimental class can be examined in the Q-Q Plot graph, which can be seen in Figure 4.

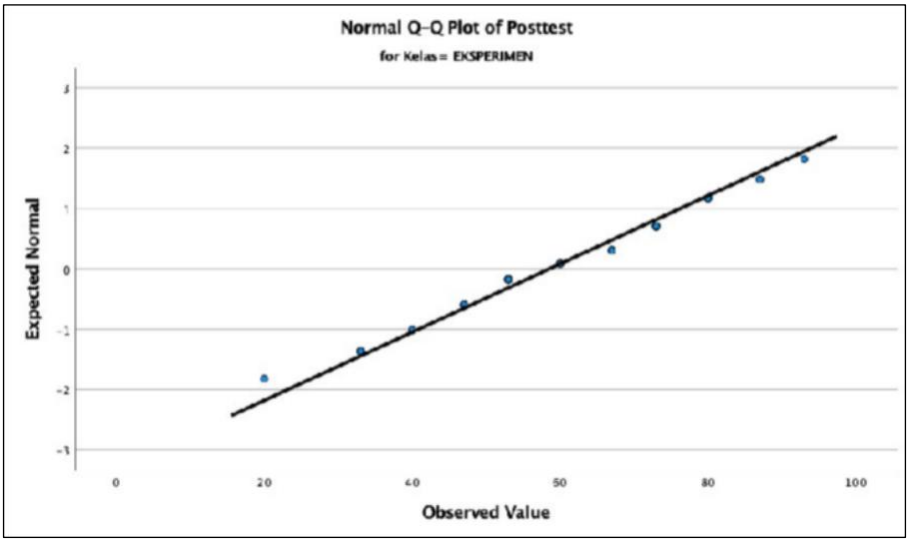

Figure 4. Q-Q Plot of posttest data for experimental class

Based on the Normal Q-Q Plot of the experimental class posttest, it can be seen that the data points are scattered around the diagonal line and follow the direction of the line. Almost all points are close to the diagonal line with very small deviations. This indicates that the distribution of posttest data for the experimental class tends to be normal, thus fulfilling the normality assumption. These results are strengthened by the Shapiro-Wilk test which obtained a significance value of 0.745 > 0.05, so the posttest data of the experimental class is declared normally distributed. In addition, the posttest data for the control class can also be examined through the Q-Q Plot graph, which can be seen in Figure 5.

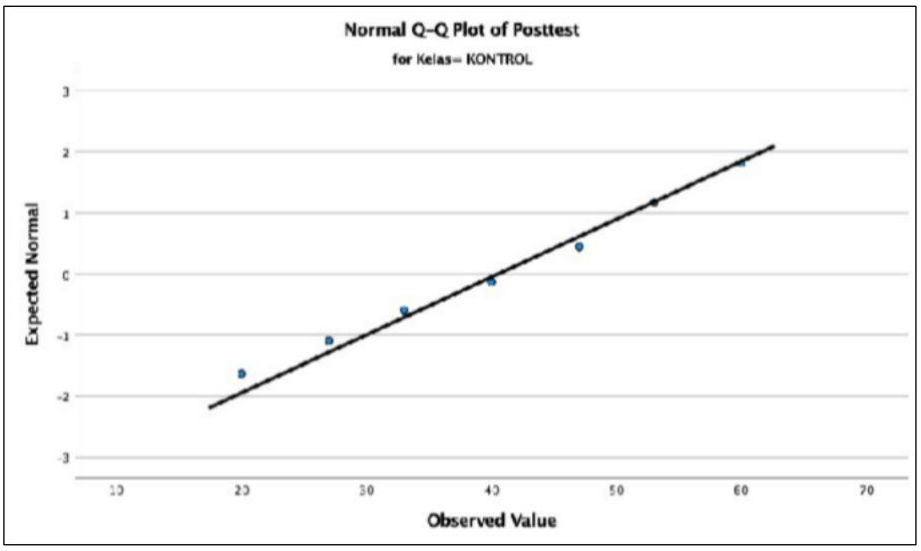

Figure 5. Q-Q plot of posttest data for control class

Based on the Normal Q-Q Plot of the control class posttest, it can be seen that the data points are scattered around the diagonal line and follow the direction of the diagonal line. The distribution of data points appears quite even without any significant deviations. Thus, the posttest data of the control class can be said to be normally distributed and fulfill the normality assumption. The Shapiro-Wilk test result shows a significance value of 0.134 > 0.05. Therefore, the posttest data of the control class is declared normally distributed. Thus, the next hypothesis testing will be determined based on the results of the next prerequisite test, namely the homogeneity test, using IBM SPSS Statistics 27 software.

Table 3. Results of Levene homogeneity test

Data	Sig. Levene	Significance Level	Conclusion
Pretest	0.005	0.05	Not Homogeneous
Posttest	0.005	0.05	Not Homogeneous

Based on Table 3, the Levene test significance values for both pretest and posttest data of both classes are 0.005 < 0.05, so the data are declared not homogeneous. Because the homogeneity assumption is not met, even though the data are normal, the hypothesis test is continued using a nonparametric statistical test, namely the Mann-Whitney test, as a substitute for the t-test which

requires both normality and homogeneity assumptions to be met. These results are in line with research conducted by Irianfi et. al., (2025, p. 296) which used the Mann-Whitney test because the research data did not meet the homogeneity assumption, even though the data were normally distributed. In addition, research by Purnama et. al., (2024, pp. 173-174) also shows that the use of nonparametric tests is an appropriate alternative when one of the parametric statistical assumptions is not met. Sugiyono, (2023, pp. 60-90) explains that nonparametric statistics can be used when research data do not meet one of the basic assumptions of parametric statistics, so that the analysis results remain valid and can be accounted for scientifically

Based on the results of the homogeneity test, the pretest and posttest data of both classes were not homogeneous, so hypothesis testing continued using nonparametric statistics, namely the Mann-Whitney test. Furthermore, the hypothesis test was conducted using the Mann-Whitney test to determine the difference in critical thinking skills between the experimental class and the control class. Data analysis was conducted with the help of IBM SPSS Statistics 27 software.

Table 4. Results of Mann-Whitney Hypothesis Test

Statistic	**Value**
Mann-Whitney U	157,000
Wilcoxon W	563,000
Sig. (2-tailed)	0,000
Decision	H_0 Rejected, H_1 Accepted

Based on Table 4, the significance value (2-tailed) of 0.000 is less than 0.05, so H_0 is rejected and H_1 is accepted. These results indicate a significant effect of the application of the Problem-Based Learning model assisted by Augmented Reality media on the critical thinking skills of third-grade elementary school students compared to learning using the direct instructional model. The average posttest score for students in the experimental class reached 58.54, higher than the average score of 40.25 in the control class. This difference indicates that learning that emphasizes problem-solving and interactive visualization can encourage students to think more deeply.

The findings of this study align with those of Purnama et al. (2024), who stated that the integration of Problem-Based Learning with Augmented Reality media makes learning more interactive and contextual, encouraging students to analyze problems and propose solutions critically. Theoretically, Problem-Based Learning positions students as active subjects engaged

in higher-order thinking processes, such as analyzing, evaluating, and concluding, as emphasized by Zulfa et al. (2023). This process strengthens critical thinking skills because students not only receive information but also construct knowledge through meaningful learning experiences.

Furthermore, Rachman et al. (2025) explain that Problem-Based Learning is effective in increasing student engagement and the quality of interactions during learning, which directly contributes to the development of critical thinking skills. The use of Augmented Reality media in this study also strengthens this aspect, as three-dimensional visualizations help students understand concepts more concretely. This aligns with the opinion of Retnaningtiyas et al. (2021), who stated that Augmented Reality can increase student participation and facilitate conceptual understanding through engaging and interactive visual displays.

Thus, the results of this study not only demonstrate statistical differences but also support the theory that the combination of Problem-Based Learning and Augmented Reality media can create active, meaningful learning that is oriented toward developing students' critical thinking skills. The process of teacher assistance in facilitating groups of students observing three-dimensional objects using Augmented Reality in the classroom is clearly shown in Figure 1.

Figure 1. Student mentoring activity in exploring Augmented Reality based learning media in the classroom

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the Problem-Based Learning model assisted by Augmented Reality media has a significant effect on the critical thinking skills of third-grade elementary school students. This is evidenced by the higher average posttest score of the experimental class (58.54) compared to the control class (40.25), as well as the Mann-Whitney test significance value of $0.000 < 0.05$, indicating that H_0 is rejected and H_1 is accepted. Therefore, the Problem-Based Learning model assisted by

Augmented Reality media can be recommended as an innovative learning approach to improve elementary school students' critical thinking skills. Future research is recommended to examine the effectiveness of this model in different subjects or at different educational levels

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