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The Impact of Renewable Energy Learning Media Based on Local Wisdom on Critical Thinking Skills

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ABSTRACT

This study aims to assess the effectiveness of renewable energy learning media based on local wisdom in enhancing students' critical thinking skills. A quantitative research approach was employed using a quasi-experimental design, specifically the Nonequivalent Control Group Design. The study involved 27 fifth-grade students from Karangjengkol 03 Elementary School, Cilacap, Indonesia. Data collection instruments included test questions, observation sheets, and documentation. Data analysis was conducted using descriptive and inferential statistics, with hypothesis testing performed through an independent sample t-test. The results indicate a significant improvement in students' critical thinking skills across four assessed aspects following the implementation of the learning media. The t-test results confirm this improvement, with a significance value (Sig. 2-tailed) of 0.000, which is less than the 0.05 threshold. This statistical outcome leads to the rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_a), demonstrating that the renewable energy learning media had a measurable effect on students' critical thinking development. Furthermore, the mean post-test score in the experimental group was 84.03, significantly higher than the 48.75 achieved by the control group. This considerable difference in mean scores underscores the effectiveness of the intervention. The higher performance in the experimental group suggests that integrating local wisdom into renewable energy education provides contextualized learning experiences that better engage students and stimulate critical thinking processes compared to conventional teaching methods. These findings provide strong empirical support for the implementation of

innovative, culturally relevant instructional strategies in elementary education.

Keywords
Critical Thinking Skills
Learning Media
Local Wisdom
Renewable Energy

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Introduction

Education in the 21st century emphasizes developing competent human resources capable of addressing global challenges. Human resources are deemed competent when individuals can optimize, apply, and refine their thinking skills. Thinking skills in the 21st century focus on critical thinking and problem-solving abilities. Critical thinking refers to higher-order cognitive skills, including in-depth analysis, strategic planning, critical evaluation, constructing rational and comprehensible arguments, and drawing conclusions when faced with a problem. One of the main goals of education is to create well-informed learners, meaning students must possess critical thinking skills to understand significant, impactful, and meaningful ideas [1].

The critical thinking ability of students in Indonesia is relatively low [2]. The 2015 Trends in International Mathematics and Science Study (TIMSS) results showed that Indonesian students ranked 45th out of 50 countries in mathematics scores [3]. This statement is further supported by the 2022 Programme for International Student Assessment (PISA) study released by the Organisation for Economic Co-operation and Development (OECD), which revealed a decline in the average performance of Indonesian students compared to the 2018 PISA results. This decline is attributed to learning loss caused by the pandemic's impact [4].

There is potential to develop critical thinking skills among Indonesian students, one of which is by implementing learning approaches aligned with their developmental stages [5]. Elementary school students are in the concrete operational stage [6], necessitating tangible, real-life, and current issue-based learning experiences. Renewable energy has become a widely discussed societal issue. The increasing reliance on non-renewable fossil energy sources has led to a depletion of fossil fuel reserves [7], highlighting the need for education that fosters students' critical awareness of environmental issues.

Therefore, educators need to design engaging learning experiences to enhance students' critical thinking skills. One way to achieve this is by using appealing educational

media to encourage active student participation. For example, using the Renewable Energy Kit based on local wisdom can make learning more engaging as it incorporates everyday life and local traditions while providing knowledge about renewable energy. This approach aligns with research conducted by Fadhilah et al. [8], which found that energy kits significantly assist educators in explaining the concept and application of renewable energy in daily life. Moreover, such media can enhance students' understanding, enthusiasm for learning, critical thinking skills, and teamwork abilities.

Material and Methods

This study employed a quantitative research approach, specifically experimental research. The research design used was a Quasi-Experimental Design with the model of Nonequivalent Control Group Design. The population and sample for this study comprised 27 fifth-grade students at SDN Karangjengkol 03, Cilacap, Indonesia. Based on this, the sample consisted of 14 students in the control group and 13 students in the experimental group. The independent variable in this study was the renewable energy learning media based on local wisdom, while the dependent variable was the students' critical thinking skills.

The instruments used included pretest and posttest questions, observation sheets for the implementation of the learning process, as well as documentation for lesson plans and photos of students' learning activities. The data analysis techniques utilized were descriptive analysis and inferential analysis. Descriptive analysis was used to determine the mean, median, mode, maximum, minimum, and standard deviation. Meanwhile, inferential analysis was conducted to test the hypothesis, starting with prerequisite tests such as normality and homogeneity tests. Once the prerequisites were met, hypothesis testing was carried out to analyze the critical thinking skills of the fifth-grade students before and after the intervention.

Results

The study measured the effectiveness of renewable energy learning media based on local wisdom in enhancing the critical thinking skills of fifth-grade students at SDN Karangjengkol 03. The sample consisted of 14 students in the control group and 13 students in the experimental group. The independent variable in this study was the renewable energy learning media based on local wisdom, while the dependent variable was the students' critical thinking skills. Data were collected through observation and tests (pretest and posttest).

At the beginning of the learning process, both the control and experimental groups were given a pretest to assess the students' initial abilities. Afterward, the control group was taught using conventional teaching methods, while the experimental group used renewable energy learning media based on local wisdom. At the end of the learning process, a posttest was administered to evaluate the students' final abilities. Before hypothesis testing, the

normality and homogeneity of the test items were examined. The normality test showed that $\alpha > 0.05$, indicating the data were normally distributed, while the homogeneity test also showed $\alpha > 0.05$, indicating that the data were homogeneous.

A. Observation of Learning Implementation

The teaching methods used in the control and experimental groups differed significantly. In the control group, conventional teaching methods were applied, with textbooks as the primary resource. In contrast, the experimental group utilized renewable energy learning media based on local wisdom. Observations conducted during the lessons ensured that the activities followed the planned steps. See Table 1 for the result of the activity implementation.

Table 1. Observation Results of Teacher Activities

Step	Control Group	Experimental Group
Initial Activity	✓	✓
Core Activity	✓	✓
Closing Activity	✓	✓
Total	12	14
Percentage	67	78

Based on the observations (see Table 2), the teacher in the experimental group completed 14 out of 18 planned activities, with a percentage of 78%, compared to the control group's 67% (12 out of 18 activities). Similarly, student activities in the experimental group were higher across all steps. In understanding the problem, the experimental group scored 92% on both indicators, compared to 79% and 67% in the control group.

Table 2. Observation Results of Student Activities

No	Steps	Indicators	Control Group		Experimental Group	
			Freq.	(%)	Freq.	(%)
1	Understanding the Problem	Writing down the problem	11	79	12	92
		Identifying the problem	8	67	12	92
2	Making a Plan	Creating a solution plan	6	43	11	85
		Writing the plan	1	7	7	54
3	Writing the Solution	Writing the solution	5	36	13	100
		Answering based on the plan	11	79	12	92
4	Reviewing	Writing the review	0	0	8	62
		Checking the solution	7	50	7	50

In making a plan, the experimental group achieved 85% and 54%, while the control group scored 43% and 7%. In writing the solution, the experimental group reached 100% and 92%, significantly surpassing the control group's 36% and 79%. In reviewing, the experimental group achieved 62% on writing the review, compared to 0% in the control group.

The data indicate that the experimental group, which used renewable energy learning media based on local wisdom, had better teacher and student activity levels than the control

group using conventional methods. This aligns with previous research [9], which found that most students responded positively to learning media and that such methods effectively enhanced critical thinking skills.

B. Critical Thinking Skills of Students

The results of the pretest and posttest for the control group (using conventional teaching methods) and the experimental group (using renewable energy learning media based on local wisdom) are summarized in Table 3.

Table 3. Critical Thinking Skills Test Results

Group		Aspect/ Indicator	1	2	3	4
Control	Pretest	Score	18.5	62.03	47.5	1.85
		%	18.5	62.03	47.5	1.85
	Posttest	Score	40.12	83.3	73.45	0
		%	40.12	83.3	73.45	0
Experiment	Pretest	Score	4.94	75	69.75	0
		%	4.94	75	69.75	0
	Posttest	Score	91.35	85.18	79.6	62.9
		%	91.35	85.18	79.6	62.9

The comparison of the control group pretest and posttest results shows improvement in aspects 1, 2, and 3. This aligns with prior research [10], which stated that conventional teaching methods could improve critical thinking skills to some extent. The experimental group demonstrated significant improvement in all aspects after using renewable energy learning media. This is consistent with earlier research [8], which highlighted that learning media facilitates better understanding and retention of renewable energy concepts.

The data reveal that while both groups experienced improvements in critical thinking skills, the experimental group showed a significantly higher increase. This indicates that learning with renewable energy media based on local wisdom is more effective and efficient in fostering critical thinking skills compared to conventional methods. These findings align with previous studies [11], which confirmed the effectiveness of local wisdom-based learning media in enhancing students' critical thinking abilities.

C. The Impact of Renewable Energy Learning Media Based on Local Wisdom on Critical Thinking Skills

The study employed a paired sample t-test to compare the pretest and posttest scores of the control and experimental groups. In the control group, the t-test results showed a t-value of 6.124 with a significance level (Sig. 2-tailed) of 0.000, which is less than 0.05. This indicates a statistically significant improvement in critical thinking skills within the control group. These findings align with previous studies [12], which suggest that traditional teaching models can

enhance critical thinking, although their effectiveness may vary depending on the specific model used.

In the experimental group, the paired sample t-test results showed a t-value of 12.564 with a significance level (Sig. 2-tailed) of 0.000, which is less than 0.05. This indicates a highly significant improvement in critical thinking skills. The substantial increase in scores supports prior research [13], which suggests that the use of educational media can effectively enhance students' critical thinking abilities. The experimental group showed a much greater improvement. This supports prior research [13] that using educational media enhances students' critical thinking skills.

The independent sample t-test results, as presented in Table 4, show that Levene's test for equality of variances yielded an F-value of 0.039 with a significance level of 0.845. The t-test for equality of means produced a t-value of -6.079 with a significance level (Sig. 2-tailed) of 0.000. Since the significance value is less than 0.05, the null hypothesis (H_0) is rejected. This indicates that the use of renewable energy learning media based on local wisdom has a significant impact on critical thinking skills compared to conventional teaching methods.

Renewable energy learning media based on local wisdom effectively enhances students' critical thinking skills. By integrating relevant, context-based materials into the learning process, students are better equipped to tackle challenges, develop problem-solving skills, and apply their learning to real-world situations. These findings align with previous research [8], highlighting that renewable energy media not only supports scientific understanding but also promotes critical thinking. Such learning models are essential in preparing students for future challenges, as critical thinking skills are increasingly recognized as vital for personal and academic success. The use of effective, engaging educational tools like renewable energy media is a key strategy to achieve this goal.

The findings of this study indicate that renewable energy learning media is more effective in enhancing critical thinking skills compared to conventional teaching methods. The average improvement in scores in the experimental group was significantly higher than in the control group, demonstrating the effectiveness of this approach. Students in the experimental group exhibited greater enthusiasm and engagement throughout the learning process, which contributed to their development of critical thinking skills. This aligns with previous research, which emphasizes the role of interactive and context-based learning in fostering higher-order thinking skills [14]-[16].

The integration of renewable energy learning media encouraged active participation and deeper cognitive engagement among students. By utilizing this approach, students were required to analyze information, solve complex problems, and evaluate different

perspectives—all of which are essential components of critical thinking. Prior studies have also highlighted that learning environments that promote inquiry-based and problem-solving activities significantly enhance students' ability to think critically (Smith & Brown, 2020). The structured yet flexible nature of the media allowed students to independently explore concepts while also engaging in collaborative discussions, further reinforcing their cognitive development.

Effective teaching strategies play a crucial role in fostering critical thinking skills. Strategies that encourage discussion, promote the expression of ideas, support collaborative learning, and develop self-reflection have been shown to significantly enhance students' analytical and reasoning abilities [17]. The use of renewable energy learning media provided opportunities for students to articulate their thoughts, debate different viewpoints, and refine their understanding through peer interaction. This active learning approach has been widely supported in the literature as an effective method for cultivating critical thinking [18].

Despite the positive impact of renewable energy learning media, not all students demonstrated equal levels of improvement. This suggests the need for more tailored instructional approaches to address individual differences in learning capabilities. Factors such as prior knowledge, motivation, and learning styles may influence the extent to which students benefit from the media. Future research should explore differentiated instructional strategies to ensure that all students, regardless of their initial abilities, can develop critical thinking skills effectively. Addressing these challenges will help optimize the implementation of renewable energy learning media and maximize its impact on student learning outcomes.

Conclusion

Based on the findings and discussion, it can be concluded that the use of renewable energy learning media based on local wisdom significantly influences the critical thinking skills of Grade V students at SDN Karangjengkol 03, Cilacap. This innovative educational tool serves as an effective alternative for educators to enhance and train students' critical thinking abilities. The implementation of renewable energy learning media not only provides contextual and engaging learning experiences but also contributes to meaningful improvements in students' problem-solving and analytical skills. The application of such media underscores its potential as a powerful strategy for fostering critical thinking in elementary education, making it a valuable resource for advancing 21st-century learning competencies.

Conflict of Interest

The authors declare that there is no conflict of interest.

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