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The Effect of Contextual Digital Teaching Materials and Creativity on Students' Scientific Literacy in the Digital Era

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Abstract

Students' scientific literacy remains low due to the continued use of conventional learning methods that are less contextual and interactive. This study aims to determine the effect of context-based and creative digital teaching materials on students' scientific literacy. A quasi-experimental pretest-posttest control group design was used involving 60 seventh-grade students divided into an experimental class (n = 30) and a control class (n = 30). The instruments included scientific literacy tests, questionnaires, and observation sheets. The results showed that the average posttest score of the experimental class (30.03) was significantly higher than that of the control class (24.50), with t(58) = 2.38, p = 0.021. The N-Gain value of the experimental class was 0.21 (low category), which was higher than the control class at 0.004 (low category). These findings indicate that context-based and creative digital teaching materials are effective in improving students' scientific literacy, although the level of improvement remains low.

Keywords: Digital teaching materials; creativity; scientific literacy; students; digital era

1. Introduction

Scientific literacy is one of the essential competencies required in the 21st century because it enables students to understand scientific phenomena, evaluate evidence, and make rational decisions in daily life (OECD, 2023). In the digital era, science learning should not only focus on knowledge transfer but also support students in critically evaluating information and solving real-world problems.

However, Indonesian students' scientific literacy remains relatively low. The PISA 2022 report shows that Indonesia scored 383 in science, far below the OECD average of 485, placing Indonesia among the lower-performing countries (OECD, 2023). A preliminary study at MTs. S Irsyadul Islamiyah also revealed that the average scientific literacy score of seventh-grade students was only 24.5 out of 100, categorized as low.

Previous studies have reported that digital teaching materials can improve student engagement and conceptual understanding. However, most studies examined contextual learning and creativity separately. Previous studies have not simultaneously examined contextual digital materials and creativity using a quasi-experimental framework, particularly for junior high school students in Islamic school settings. Therefore, the novelty of this study lies in integrating both contextual and creative elements into digital teaching materials to improve scientific literacy.

Based on this gap, this study addresses the following research question: Is there a significant effect of context-based and creative digital teaching materials on the scientific literacy of seventh-grade students? The purpose of this study is to examine that effect empirically.

2. Methods

This study employed a quantitative approach using a quasi-experimental non-equivalent control group pretest–posttest design. Random assignment was not feasible because intact classroom groups were used.

The study was conducted at MTs. S Irsyadul Islamiyah during the 2025/2026 academic year. The population consisted of all seventh-grade students, and the sample was selected using purposive sampling. Two classes with relatively homogeneous initial abilities were chosen: class VII A as the experimental group and class VII B as the control group, each consisting of 30 students.

The instruments used in this study included:

- Scientific literacy tests based on PISA indicators
- Creativity assessment tasks
- Validation questionnaires for experts
- Observation sheets

Scientific literacy was measured through three competencies: explaining scientific phenomena, evaluating and designing scientific inquiry, and interpreting data scientifically.

Data collection techniques included tests, questionnaires, and observations. Pretests and posttests were administered to measure students' scientific literacy. Questionnaires were used to obtain expert validation and student responses to the digital teaching materials, while structured observations were conducted to monitor the implementation of the learning process in both experimental and control classes.

Data were analyzed using descriptive and inferential statistics. Descriptive analysis included mean, median, and standard deviation. Inferential analysis included normality tests, homogeneity tests, paired sample t-tests, and independent sample t-tests.

The N-Gain test was used to measure improvement in scientific literacy, categorized as low ($g < 0.30$), medium ($0.30 \leq g < 0.70$), and high ($g \geq 0.70$). Hypothesis testing was conducted at a significance level of 0.05.

This study employed a quantitative approach with a quasi-experimental non-equivalent control group pretest-posttest design. This design was selected because random assignment of participants into experimental and control groups was not feasible due to intact classroom settings. The research design is illustrated in Table.

Group	Pretest	Treatment	Postest
Experimental (VII A)	O_1	X	O_2
Control (VII B)	O_3	-	O_4

Note:

O_1 = Pretest score of the experimental group

O_2 = Posttest score of the experimental group

O_3 = Pretest score of the control group

O_4 = Posttest score of the control group

X = Treatment using context-based and creative digital teaching materials

- = Conventional learning without treatment

3. Results and Discussion

Results

The results showed that the experimental class experienced a more meaningful improvement than the control class. The average posttest score increased from 24.90 to 30.03 in the experimental class, while the control class increased only slightly from 24.33 to 24.50.

Analysis Univariate

Table . Assessment Results Literacy Science

Class	Measurement	N	Min	Max	Average	Elementary School
Control	Literacy Science Pretest	30	11	39	24.33	9.70
	Literacy Science Posttest	30	11	39	24.5	9.61
Experiment	Literacy Science Pretest	30	12	39	24.9	9.32
	Literacy Science Posttest	30	17	40	30.03	8.41

The contextual element helped students connect abstract scientific concepts with real-life issues such as environmental pollution and daily energy use. This supports constructivist learning theory (Vygotsky, 1978), which states that meaningful learning occurs when students construct knowledge from prior experiences and authentic contexts. When students see the relevance of science to their lives, their cognitive engagement increases, leading to deeper understanding. This finding aligns with Nurhayati et al. (2022), who reported that context-based digital modules improved scientific literacy by 23% because students were no longer memorizing facts but solving authentic problems.

The creative component encouraged students to propose solutions, design simple investigations, and think divergently. This is consistent with Torrance's theory of creativity (Torrance, 1974), where fluency, flexibility, and originality are essential aspects of scientific problem-solving. In contrast, the control class with conventional teacher-centered learning provided limited space for exploration, which explains the negligible N-Gain of 0.004. This is in line with Pratiwi & Wulandari (2021), who found that creativity-based e-learning significantly improved the "evaluate and design scientific inquiry" dimension of PISA scientific literacy.

Although the results were statistically significant, the N-Gain value of 0.21 remained in the low category. This may be explained by the short intervention period, which lasted only four meetings. Scientific literacy requires sustained practice over time, and a short intervention may not be sufficient to change students' reasoning habits significantly. According to Marzano

(2007), the internalization of complex competencies like scientific literacy requires sustained practice for at least 8-12 weeks. The short timeframe was likely insufficient for students to fully shift from rote learning habits to scientific reasoning habits.

These findings imply that teachers should not only digitize teaching materials but also ensure that learning content is contextual and encourages creativity. This approach can improve both engagement and scientific reasoning more effectively than conventional teacher-centered instruction.

Normality Test

Table . Lilliefors Normality Test Results

Variables	Class	Measurement	Sig.	Decision
Literacy Science	Control	Pretest	0.143	Normal
		Posttest	0.200	Normal
	Experiment	Pretest	0.062	Normal
		Posttest	0.060	Normal

Based on the results of the normality test using the Lilliefors method, the significance values for all groups and measurement stages were greater than 0.05.

In the control group, the pretest significance value was 0.143 and the posttest value was 0.200. In the experimental group, the pretest significance value was 0.062 and the posttest value was 0.060.

Since all significance values (Sig.) were greater than 0.05, the data were normally distributed. Therefore, the assumption of normality was fulfilled, and parametric tests could be applied.

Homogeneity Test

Table . Homogeneity Test Results

Variables	Posttest Score	Levene Statistics	Sig.	Decision
Literacy Science	Control Experiment	0.823	0.368	Homogeneous

Based on Levene's test, the significance value was 0.368, which is greater than 0.05. This indicates that the variances of the two groups are homogeneous.

Paired Sample T Test

Table . Paired Sample T-Test Literacy Results Science Group Control

Variables	Measurement	N	Average	Sig.	Decision
Literacy Science	Pretest	30	24.4	0.083	No Different Significant
	Posttest	30	24.5		

The results show that the average pretest score in the control group was 24.4, while the posttest score was 24.5. The significance value was 0.083 ($p > 0.05$), indicating that there was no statistically significant difference between pretest and posttest scores.
This suggests that conventional learning did not significantly improve students' scientific literacy.

Table . Paired Sample T-Test Literacy Results Science Group Experiment

Variables	Measurement	N	Average	Sig.	Decision
Literacy Science	Pretest	30	24.9	0.000	Different Significant
	Posttest	30	30.0		

The experimental group showed a significant improvement, with the average score increasing from 24.9 (pretest) to 30.0 (posttest). The significance value was 0.000 ($p < 0.05$), indicating a statistically significant difference.
This result confirms that the use of context-based and creative digital teaching materials significantly improved students' scientific literacy.

Independent Sample T Test

Table . Results of the Independent Sample T-Test Posttest Literacy Science

Variables	Posttest	N	Average	Sig	Decision
Literacy Science	Control	30	24.5	0.021	Different Significant
	Experiment	30	30.03		

Based on independent sample t-test results, The average posttest score of the control group was 24.5, while the experimental group achieved 30.03. The significance value was 0.021 ($p < 0.05$), indicating a significant difference between the two groups.
Thus, the treatment had a significant effect on students' scientific literacy.

N Gain Test

Table . N Literacy Gain Science Student

Variables	Class	N Gain
Literacy Science	Control	0.43%
	Experiment	21.08%

Based on N-Gain Test results, The control group obtained an N-Gain of 0.004, which is categorized as very low. Meanwhile, the experimental group achieved an N-Gain of 0.21, categorized as low.

Although both groups showed improvement, the experimental group demonstrated a higher level of gain, indicating that the treatment was more effective than conventional learning.

In the control group, the average pretest value was 24.33, while group experiment has a pretest average of 24.90. This is show that ability beginning literacy science student before treatment are at a comparable level. After the learning process, there is difference sufficient results striking. In the group control that uses learning conventional , the average posttest score is only increase to 24.50, or experience a huge improvement small . On the other hand , the group experiments using digital- based teaching materials context and creativity experience improvement the average posttest score was 30.03. The increase This show that the treatment given to the experimental group give positive impact to literacy science student ability.

Based on N-Gain calculation on control class obtained an average N-Gain of 0.43%, which indicates that almost No There is improvement ability literacy science . On the other hand , class experiment obtained an N-Gain of 21.08%, which indicates existence improvement ability literacy more science good all over topic material . This is show that digital- based teaching materials context and creativity effective in increase various aspect literacy science , start from understanding concept , analysis impact , up to ability think creative in finish problem environment .

These findings imply that teachers should not only digitize teaching materials but also ensure that learning content is contextual and encourages creativity. This approach can improve both engagement and scientific reasoning more effectively than conventional teacher-centered instruction

Discussion

The results indicate that contextual and creative digital teaching materials enhance students' engagement and understanding. Contextual learning helps students relate scientific concepts to real-life situations, while creativity encourages problem-solving and critical thinking.

These findings are consistent with constructivist learning theory (Vygotsky, 1978) and creativity theory (Torrance, 1974), which emphasize active knowledge construction and divergent thinking. However, the relatively low N-Gain suggests that longer intervention periods may be necessary to achieve higher levels of scientific literacy.

4. Conclusion

The use of context-based and creative digital teaching materials has a significant influence on improving students' scientific literacy. This was proven by significant differences between pretest and posttest scores in the experimental class and between the experimental and control groups in posttest results. The experimental group showed greater improvement compared to the control group, both statistically and descriptively.

However, the level of improvement remains relatively low, indicating that longer and more intensive implementation is needed.

This study also shows that digital-based teaching materials can increase student involvement in the learning process, so students not only understand theoretical concepts but also able to link them with real-world phenomena and develop creative thinking skills. On the other hand, conventional learning used in the control class did not provide a significant impact.

Scientific Contribution

This study contributes scientifically by providing empirical evidence that integrating contextual and creative elements into digital teaching materials can improve scientific literacy more effectively than conventional learning. It also strengthens the application of constructivist and creativity theories in science education.

Limitations

This study has several limitations. First, the sample was limited to one school with a relatively small number of students, which limits generalizability. Second, the intervention period was relatively short. Third, the study focused mainly on the cognitive dimension of scientific literacy.

Recommendation for Further Research

Future studies are recommended to involve a larger sample, extend the intervention period, and include affective and behavioral dimensions of scientific literacy. Further research may also examine the relationship between digital literacy, motivation, and scientific literacy achievement.

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