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Development of Diorama Media as an Innovation in Water Cycle Learning in Science Subjects Assisted by Worldwall

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Articles Information

Keywords:

Diorama media; Water Cycle; Science learning

Abstrak

Penelitian ini bertujuan untuk mengembangkan media diorama sebagai alat bantu pembelajaran siklus air pada mata pelajaran Ilmu Pengetahuan Alam (IPA) bagi siswa kelas V di SDN Tanah Kalikedinding I/251 Surabaya. Penelitian ini menggunakan metode Research and Development (R&D) dengan mengadaptasi model pengembangan 4D (Define, Design, Develop, dan Disseminate). Media diorama yang dikembangkan divalidasi oleh dua ahli materi dan dua ahli media berdasarkan kriteria keakuratan isi, kejelasan visual, serta keterlibatan pengguna. Hasil validasi memperoleh skor rata-rata 91% (sangat valid), sehingga layak untuk diujicobakan. Uji coba lapangan dilakukan terhadap 53 siswa dari satu sekolah, yang menjadi keterbatasan dalam hal validitas eksternal dan generalisasi temuan. Hasil pretest menunjukkan rata-rata nilai 62 (cukup), sedangkan nilai posttest meningkat menjadi 84 (baik), dengan nilai N-Gain sebesar 0,58 (efektif sedang). Respon siswa terhadap media juga sangat positif, dengan 95% menyatakan bahwa diorama mudah dipahami dan membuat pembelajaran lebih menarik. Observasi pelaksanaan menunjukkan 92% aktivitas pembelajaran berjalan sesuai rencana. Keefektifan media diorama ini sejalan dengan teori perkembangan kognitif Piaget, konstruktivisme Bruner dan Vygotsky, serta teori multimedia Mayer yang menekankan pentingnya pengalaman konkret, visualisasi, dan interaksi sosial. Dengan demikian, meskipun cakupan sampel terbatas, media diorama ini memiliki potensi sebagai inovasi pembelajaran yang efektif untuk meningkatkan pemahaman konsep siswa sekolah dasar tentang siklus air.

Abstact

This study aims to develop diorama media as a learning aid for the water cycle in Natural Science (IPA) among fifth-grade students at Tanah Kalikedinding I/251 Elementary School, Surabaya. The research employed a Research and Development (R&D) method, adapting the 4D development model (Define, Design, Develop, and Disseminate). The diorama media underwent expert validation involving two material experts and two media experts, who assessed the product using specific criteria related to content accuracy, visual clarity, and user engagement. The average validation score reached 91% (very valid), confirming the feasibility of the developed media. Field testing was conducted on 35 students from one school, which limits the external validity and generalizability of the findings. Pretest results showed an average score of 62 (sufficient), while posttest results increased to 84 (good), with an N-Gain value of 0.58 (moderate-effective). Student responses were also highly positive, with 95% agreeing that the diorama made learning easier and more engaging. Implementation observations revealed that 92% of learning activities proceeded as planned. The diorama's effectiveness aligns with Piaget's cognitive development theory, Bruner and Vygotsky's constructivism, and Mayer's multimedia

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learning theory, emphasizing the importance of concrete experiences, visualization, and social interaction. Therefore, despite its limited sample scope, this diorama media demonstrates potential as an innovative and effective tool for improving elementary students' conceptual understanding of the water cycle.

INTRODUCTION

Science education in elementary schools aims to develop students' scientific thinking, curiosity, and understanding of natural phenomena (Afifah et al., 2022; Azzahra et al., 2022). However, topics such as the water cycle are often delivered verbally or through two-dimensional visuals, which are inadequate for students in Piaget's concrete operational stage (ages 7–11) who require tangible, visual, and interactive experiences to grasp abstract processes like evaporation, condensation, and precipitation (Kadek Dwi Putra & Wayan Suniasih, 2021; Pamela, 2024). This pedagogical gap often results in misconceptions and low retention of scientific concepts.

Recent studies consistently emphasize that concrete learning media particularly dioramas can enhance students' conceptual understanding, motivation, and participation. Studies by Agustina et al. (2025) and Azizah et al. (2024) revealed that diorama media not only improved learning interaction and critical thinking but also received excellent validation scores from experts. In addition, quasi-experimental research by Wijaya and Mustika (2022) confirmed that classes using dioramas achieved higher post-test results than control groups. Dioramas provide spatial, three-dimensional representations that make invisible natural processes visible and relatable to students (Rahmadhani & Susanti, 2024).

Dioramas are an ideal choice of instructional media because they provide concrete, three-dimensional visual representations that are engaging and easily understood by elementary students. Numerous studies have demonstrated that diorama-based learning significantly improves conceptual understanding, learning motivation, and student participation in science education. Agustina et al. (2025) found that interactive diorama media enhanced students' engagement and critical thinking skills. Similarly, Azizah et al. (2024) reported that expert validation of diorama media achieved an "excellent" category and was highly accepted by learners. Moreover, a quasi-experimental study by Wijaya and Mustika (2022) revealed that students taught using dioramas obtained higher post-test scores than those in the control group. By visualizing abstract processes such as the water cycle into tangible and observable forms, dioramas effectively bridge the gap between real-world experiences and students' conceptual understanding, making learning more meaningful and enjoyable.

Based on this evidence, developing diorama media is considered an effective solution to strengthen students' conceptual understanding in science learning. This study aims to design, validate, and test the

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feasibility of a water cycle diorama for fifth-grade students at SDN Tanah Kalikedinding I/251 Surabaya using the 4D development model (Define, Design, Develop, and Disseminate). The research focuses not only on producing valid and practical media but also on measuring its effectiveness in enhancing student learning outcomes within real classroom contexts.

METHOD

This study employed a research and development (R&D) approach aimed at producing valid, practical, and effective diorama media for teaching the water cycle in fifth-grade science classes. The 4D model developed by Thiagarajan, Semmel, and Semmel comprising the Define, Design, Develop, and Disseminate stages was applied as the development framework.

The participants consisted of 53 fifth-grade students from SDN Tanah Kalikedinding I/251 Surabaya, divided into two classes: Class 5A (26 students) as the experimental group and Class 5B (27 students) as the control group. The students were selected using purposive sampling, considering their comparable academic achievement levels and age range (10–11 years old). Both groups had similar science learning backgrounds based on the teachers' diagnostic assessments. Furthermore, from the total of 53 students, a random sample of 25 students was selected to participate in a small-group trial of the Diorama Media. This stage aimed to obtain initial feedback regarding the media's practicality, clarity, and ease of use before its full implementation in the experimental class. The results of this small-group testing were then used as the basis for revising and refining the Diorama Media product.

The research adopted a quasi-experimental design with a non-equivalent control group pretest–posttest structure. Both groups were given identical pretests to measure their initial understanding of the water cycle, followed by different treatments. The experimental group was taught using diorama media integrated with interactive quizzes (via the Worldwall platform), while the control group received traditional instruction using textbooks and lectures. After the intervention, both groups completed the same posttest. The interval between pretest, treatment, and posttest was one week. To control confounding variables, the same teacher, duration (2 × 35 minutes per session), and learning objectives were maintained for both groups.

Validation and reliability procedures involved two material experts and two media experts. The experts assessed the diorama based on five criteria: (1) content accuracy, (2) visual clarity, (3) interactivity, (4) suitability for elementary students, and (5) usability. Each criterion was rated on a 4-point Likert scale (1 = poor to 4 = excellent). The mean validation score reached 91% (very valid). Instrument reliability was tested using Cronbach's Alpha, yielding a coefficient of 0.87, which indicates high consistency.

Data collection techniques included:

1. Observation sheets to evaluate the practicality of media implementation.

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2. Validation questionnaires to assess the feasibility of the product.
3. Concept comprehension tests comprising pretests and posttests to measure cognitive improvement.
4. Student response questionnaires to gauge engagement and ease of use.

Data analysis covered three aspects:

1. Validity analysis based on expert ratings categorized as very valid, valid, fairly valid, or invalid.
2. Practicality analysis derived from teacher and student response percentages.
3. Effectiveness analysis measured using the N-Gain score (Hake, 1999) to classify learning improvements into low (<0.3), moderate (0.3–0.7), and high (>0.7) effectiveness categories.

RESULT AND DISCUSSION

The research began with the development of Diorama Media as an Innovation in Water Cycle Learning in Science Subjects in Grade V of Tanah Kalikedinding I/251 Public Elementary School, which was carried out in 4 stages, namely:

1. Media Diorama Prototype Creation. After the design stage was completed, a diorama prototype was created based on the design that had been prepared. This diorama medium is three-dimensional and interactive, can be viewed from various angles, and allows students to manipulate or point directly to the stages of the water cycle.

Figure 1. Diorama Media

2. Validation Results. Subject Matter Expert Validation: average score of 3.6 out of 4, with a rating of "Very Good". Input: add an explanation of the infiltration and groundwater recycling process.

3. Media Expert Validation: average score of 3.5 out of 4, with a rating of "Good." Suggestion: enlarge the visual elements and label the diorama components directly so that students can recognize them more easily.

4. Product Revision. Based on the validation results, several improvements were made:

   a. Adding small labels to each component of the diorama (e.g., "clouds," "precipitation," "infiltration").

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b. Enhancing the colors and size of the images to make them clearer from a distance of 1–2 meters.

c. Revising the student worksheets to include more questions on scientific process skills.

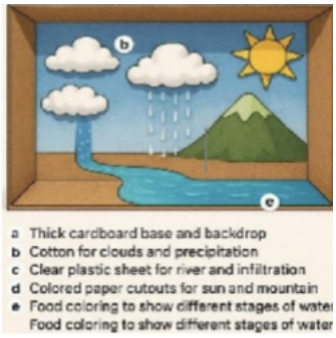

Figure 2. Revision of Diorama Media

a. Disseminate: Implementing the product with fifth-grade students at SDN Tanah Kalikedinding I/251 and evaluating the results.

(1) Diorama Media Implementation

Science learning for fifth grade students at Tanah Kalikedinding I/251 Public Elementary School in Surabaya. The learning was conducted in two sessions, each lasting 40 minutes, using a scientific learning model.

(2) Effectiveness Data Collection

To determine the effectiveness of the media, an evaluation was conducted through:

i. A pretest and posttest with multiple-choice and essay questions to measure the increase in understanding of the water cycle concept.

Test Results

Table 1. Table of Student Pretest Results Categories

Nr.	Rating Score	Category	Number of Students	Percentage
1	86 – 100	Very Good	2 Students	8.0%
2	76 – 85	Good	5 Students	20.0%
3	66 – 75	Fairly Good	6 Students	24.0%
4	56 – 65	Fair	7 Students	28.0%
5	46 – 55	Poor	3 Students	12.0%
6	≤ 45	Very Poor	2 Students	8.0%
	Average	Fair	25 Students	100%

The results show that most students in this class achieved outcomes within the fair to fairly good categories, indicating that their understanding of the material was still at a moderate level.

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Only a small portion of students reached the good and very good categories, while a few others remained in the poor and very poor ranges. This pattern suggests that, although some students demonstrated adequate comprehension, the overall learning process had not yet fully optimized conceptual understanding. The dominance of students in the middle achievement range highlights the need for more interactive and visual learning strategies to strengthen students' grasp of the subject matter and minimize the performance gap among them.

ii. Posttest results with multiple choice and essay questions to measure improvement in understanding of the water cycle concept

Table 2. Student Posttest Results Category Table

Nr.	Rating Score	Category	Number of Students	Percentage
1	86 – 100	Very Good	7 Students	26.9%
2	76 – 85	Good	10 Students	38.5%
3	66 – 75	Fairly Good	5 Students	19.2%
4	56 – 65	Fair	3 Students	11.5%
5	≤ 55	Poor / Very Poor	1 Student	3.9%
	Average	Good	26 Students	100%

The results indicate that most students in the experimental class achieved good to very good learning outcomes, showing a clear improvement in understanding the water cycle material. Only a few students remained at the fair level, and very few showed low performance, suggesting that the intervention effectively supported conceptual mastery. This overall pattern reflects a positive shift compared to pre-intervention conditions, where more students had moderate or low comprehension. The improvement suggests that the use of diorama media successfully enhanced student engagement and comprehension by transforming abstract scientific processes into concrete and visually interactive experiences.

iii. N-Gain Score: 0,58 (medium category – effective)

1) Pre-test and Post-test Score Data Number of students: 35 Maximum score: 100

Pre-test average: 62

Post-test average: 84

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2) N-Gain Score Formula

$$\mathbf{N-Gain} = \frac{\mathbf{Skor\ post\ test - Skor\ pretest}}{\mathbf{Skor\ maskimal - Skor\ pretes}}$$

$$\mathbf{N-Gain} = \frac{84-62}{100-62} = \frac{22}{38} \approx \mathbf{0,58}$$

3) Interpretarion N-Gain Score

Table 3. Interpretation of N-Gain Score

Rate N-Gain	Category
≥ 0,70	High
0,30 – 0,69	Medium
< 0,30	Low

Based on calculations, the average increase in student learning outcomes from the pretest to the posttest showed an N-Gain of 0.58. This value is in the moderate category, which means that the use of diorama media in teaching the water cycle proved to be quite effective in improving the understanding of fifth-grade students at Tanah Kalikedinding I/251 Public Elementary School.

iv. Independent sample t test on the experimental and control classes

After determining the gain scores of students' learning outcomes in the experimental class, an independent samples t-test was then conducted to examine whether there was a significant difference in learning outcomes between the experimental and control classes.

Table 4. Group Statistics of Students' Learning Outcomes

Class	N	Mean	Std. Deviation	Std. Error Mean
Experimental	26	83.8077	3.52158	0.69064
Control	27	70.1481	2.72741	0.52489

The results of the Group Statistics analysis indicate a noticeable difference between the two classes. The mean score of students' learning outcomes in the experimental class was 83.81, while the control class achieved only 70.15. Moreover, the standard deviation in the experimental class (3.52) was slightly higher than that of the control class (2.73), suggesting a reasonable variation in scores due to the use of different instructional media. Overall, these findings suggest that the use of diorama media had a positive effect on improving students' learning outcomes, as those who learned with the help of dioramas achieved higher scores compared to students who received conventional instruction.

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Table 5. Independent Samples Test

Test	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2-tailed)
Equal variances assumed	1.655	.204	15.823	51	.000
Equal variances not assumed	—	—	15.747	47.109	.000

The results of the independent samples t-test show a significant difference in mean scores between the experimental and control classes ($t = 15.823$, $p < 0.001$). This indicates that the use of diorama media had a statistically significant positive effect on students' learning outcomes.

Table 6. Independent Samples Effect Sizes

Effect Size Type	Standardizer[a]	Point Estimate
Cohen's d	3.14189	4.348
Hedges' Correction	3.18906	4.283
Glass's Δ (Delta)	2.72741	5.008

The effect size values (Cohen's d = 4.348; Hedges' g = 4.283) indicate an extremely large effect, suggesting that the use of diorama media had a very strong positive impact on students' learning outcomes compared to conventional teaching methods.

v. Student response questionnaire to measure the practicality and appeal of the media. Student response: 95% stated that the media was easy to understand and made learning more interesting.

Number of students who completed the questionnaire: 35 students Rating scale:

4 points (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree)

Aspects assessed:

a. The media is easy to understand.
b. The media makes learning more interesting.
c. The media helps me understand the water cycle.
d. I want to use this media again for learning.

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Table 4. Summary of Response Results

Statement	**Agree + Strongly agree**	**Percentage**
Media is easy to understand.	34 students	97.1%
Media makes learning more interesting.	33 students	94.3%
Media helps me understand the water cycle.	33 students	94.3%
I want to use this media again for learning.	32 students	91.4%

Of the four indicators, the average number of students who agreed or strongly agreed was approximately:

$$\frac{97.1+94.3+94.3+91.4}{4}$$

Approximately 95% of students stated that diorama media is easy to understand and makes the learning process more interesting.

vi. Observation of learning implementation by the accompanying teacher observer. Implementation observation: 92% of learning activities were carried out according to plan. Learning Implementation Observation Data

Number of indicators observed: 12 Criteria:

a. Score 1 = Not implemented
b. Score 2 = Poorly implemented
c. Score 3 = Partially implemented
d. Score 4 = Implemented as planned
e. Observer: Assistant teacher/class V observer

Total maximum score: 12 indicators × 4 (maximum score) = 48

$$\frac{44}{48} \; x \; 100\% = 91.67\% \approx 92\%$$

Percentage of Implementation Calculation

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Table 5. Observation Results

Nr	Observed Aspects	**Score**
1	The teacher opens the lesson with a sparking question.	4
2	Students observe the diorama media with the teacher's guidance.	4
3	The teacher facilitates group discussions.	3
4	Students actively write down their observations on the LKPD.	4
5	The teacher reinforces the students' answers.	4
6	The explanation of the water cycle is linked to the media.	4
7	Students re-explain the stages in their own words.	3
8	The teacher concludes the lesson together with the students.	4
9	The worksheets are discussed together as a class	4
10	Students are given feedback on their answers	4
11	Learning time is used effectively	3
12	The teacher closes the lesson with a simple reflection	3

Based on the observation results, 92% of learning activities were carried out according to plan, indicating that the use of diorama media was practically applied in the classroom and supported optimal student engagement.

b. Conclusion of the Dissemination Stage

The diorama media developed is feasible, practical, and quite effective in improving fifth-grade students' understanding of science concepts about the water cycle. Learning becomes more interactive, and students show increased enthusiasm and critical thinking skills.

The results of the study indicate that the use of diorama media in teaching the water cycle has a significant impact on improving the conceptual understanding of fifth-grade students at Tanah Kalikedinding I/251 Public Elementary School. This is reflected in the comparison of pretest and posttest scores, which increased from an average of 62 (fair category) to an average of 84 (good category). The N-Gain Score of 0.58 places the effectiveness of learning in the moderate but effective category, according to Hake's (1999) classification.

This improvement is in line with the characteristics of fifth-grade students who are in the concrete operational stage according to Piaget's cognitive development theory. At this stage, students learn more optimally through visual and manipulative media. The diorama media developed allows students to observe, manipulate, and reflect on the water cycle process in a concrete manner. This is in line with the findings of Agustina (2021), Putra & Suniasih (2021), and Fitriani et al. (2023), which confirm that real media greatly helps in understanding abstract science concepts.

The development of learning media, such as dioramas, is interesting and effective in improving student learning outcomes because it is supported by several learning theories relevant to the characteristics of elementary school students. According to Jean Piaget (1972), fifth-grade students are in the concrete operational stage, where they begin to be able to think logically but are still very dependent on real

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experiences and objects that can be manipulated directly. Diorama media that present abstract concepts such as the water cycle in three-dimensional visual and spatial forms are very suitable for this need. Through real physical representations, students can gradually build understanding through observation and direct manipulation of media elements.

In addition, the constructivist theories of Jerome Bruner (1966) and Lev Vygotsky (1978) emphasize that meaningful learning occurs when students actively construct knowledge based on experience and social context. In this context, diorama media supports active and contextual learning, as students are encouraged to observe, discuss, and reconstruct their understanding through social interaction and direct visual experience. Vygotsky's concept of scaffolding is also relevant, as this medium serves as a visual aid to bridge students' understanding from their actual zone of development to their potential zone of development. Thus, students' cognitive engagement increases, which ultimately strengthens knowledge retention and transfer.

Furthermore, Richard E. Mayer's Cognitive Theory of Multimedia Learning (2001) explains that learning is more effective when information is conveyed through a combination of text, images, and visual simulations, because the brain processes information better through two channels: verbal and visual. The use of cotton to depict clouds, clear plastic as rivers, and dyes to show the different stages of water in diorama media allows students to process complex information such as evaporation and condensation in a more concrete and meaningful way. This is in line with the dual-channel and limited capacity principles in Mayer's theory, which suggests that information should be presented in a balanced manner between visual and verbal to avoid excessive cognitive load. Thus, the development of diorama media is in line with the principles of modern educational psychology that emphasize experience-based learning, active engagement, concrete visualization, and social interaction. This makes diorama media not only interesting, but also effective in significantly improving students' conceptual understanding and learning outcomes.

Qualitatively, the questionnaire results show that 95% of students responded positively to the use of this media. They stated that diorama media is easy to understand and makes learning more interesting. This reinforces the role of media as a visual aid and a source of learning motivation. The visualization of the water cycle in three dimensions also helps students to logically and sequentially connect each stage, such as evaporation, condensation, precipitation, and infiltration.

Furthermore, observations of the implementation of learning show that 92% of activities were carried out according to plan. This reflects that diorama media is easy to implement in the classroom, both by teachers and students. Teachers can also facilitate discussion, exploration, and group presentation activities more effectively because of the support of this concrete media. Thus, diorama media not only functions as a learning aid but also as a pedagogical strategy that can improve the quality of science learning processes, especially in water cycle material. These results support previous studies such as Afifah et al. (2022) and Lutfiyaturr Rohmah (2020), which show the effectiveness of diorama media in increasing student engagement and understanding.

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Despite the improvement in learning outcomes from media development, this study has several limitations that need to be considered when interpreting the results and formulating follow-up actions. First, the scope of the study is still limited because it was only conducted in one school, namely SD Negeri Tanah Kalikedinding I/251, and in one grade, namely grade V. This limits the generalization of the results to other schools with diverse social, geographical, and educational resources. Second, the sample size used was relatively small, namely only 35 students. This number provides a limited picture of the variation in cognitive abilities of students at the elementary school level in general, so the findings cannot be generalized to a wider population.

Third, the short duration of the intervention was another limitation. The diorama media was only applied in a few meetings, which was not enough to assess the long-term impact on concept retention, in-depth understanding, or knowledge transfer to other science subjects. Fourth, the learning media validation process is still limited because it only involves two experts, one from the subject matter field and one from the media field. This process does not yet include triangulation validation involving science teachers from various schools or other basic education experts, which could strengthen the accuracy and feasibility of the product. Finally, the focus of media development is still limited to one topic, namely the water cycle. The effectiveness of the media has not been tested on other abstract science topics, such as the digestive system, the life cycle of living things, or the concept of energy, so there is still much room for further development.

Based on the limitations of this study, several suggestions can be made for further development. First, it is recommended that similar studies be conducted in other schools with different social and geographical characteristics to test the consistency of the effectiveness of diorama media in a broader context. This is important to improve the generalization of results and adapt the media to the local needs of each educational unit. Second, the use of a larger sample, as well as involving several schools in a cluster or region, can provide a more representative picture of the general level of understanding of elementary school students.

Third, it is necessary to develop a research design with long-term intervention in order to assess the impact of diorama media on students' concept retention and ability to transfer knowledge to other science subjects. Fourth, the validation process should be expanded to involve more learning practitioners, such as science teachers from other schools, education supervisors, or curriculum experts so that the resulting product is stronger in substance and implementation. Fifth, the effectiveness of the diorama media developed needs to be tested on various abstract materials in science, such as the life cycle of animals, the digestive system, or force and motion, to expand its benefits in science learning in elementary schools.

The implication is that if these suggestions are implemented, it will strengthen the position of diorama media as a learning innovation that is not only applicable to one subject, but also has the potential to become part of a sustainable contextual learning solution in supporting the Merdeka Curriculum. Thus, teachers have an effective, interesting, and relevant alternative medium to help students understand science concepts in a more concrete and meaningful way.

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CONCLUSION

The use of diorama media in teaching the water cycle has been proven to have a positive and significant impact on improving the conceptual understanding of fifth-grade students at Tanah Kalikedinding I/251 Public Elementary School. The diorama medium successfully bridged students' understanding gaps by transforming abstract scientific concepts into concrete, three-dimensional visual experiences. Mayer's Multimedia Learning Theory further reinforces that combining text, visuals, and interaction enhances comprehension and retention.

This study contributes to the field by providing empirical evidence on the integration of concrete, three- dimensional media within elementary science instruction, extending previous research on multimedia-based learning by focusing specifically on diorama implementation for abstract topics such as the water cycle. The findings also offer practical insights for educators seeking to develop contextual, interactive, and culturally adaptable learning tools for young learners. However, this study has several limitations. The sample was limited to a single school with 53 students, which may affect the generalizability of the findings.

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