



Developing The 'Dios_Ar' Media to Improve 5th Grade Students' Understanding of Science Concepts

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Articles Information

Abstrak

Keywords:

Diorama;
Water Cycle;
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4D;

Digitalisasi pembelajaran mengaplikasikan teknologi dalam proses pembelajaran salah satunya dengan pengembangan media *augmented reality* (AR). Penggunaan teknologi dalam pembelajaran terbukti efektif meningkatkan motivasi dan pemahaman konsep siswa. Media 'DIOS_AR' yang dikembangkan diharapkan memecahkan masalah dalam meningkatkan pemahaman konsep siswa tentang siklus air dengan memberikan pembelajaran yang lebih bermakna dan menarik partisipasi siswa. Penelitian dilakukan pada siswa kelas 5 di Sekolah Dasar Al Falah Darussalam 2, Sidoarjo ini menggunakan model penelitian dan pengembangan 4D (Define, Design, Develop, dan Disseminate). Pengumpulan data dengan wawancara, observasi, tes, dan kuesioner. Dari data yang diperoleh dari validator media bahwa media sangat layak dengan prosentase 92 %, dan nilai tes diperoleh N-Gain 73,17 dikategori tinggi dan efektif sehingga media DIOS_AR dapat meningkatkan keterlibatan siswa, menarik perhatian mereka, dan meningkatkan pemahaman konseptual mereka tentang pembelajaran siklus air.

Abstact

Digitalization of learning applies technology in the learning process, one of which is by developing augmented reality (AR) media. The use of technology in learning has been proven effective in increasing students' motivation and conceptual understanding. The developed 'DIOS_AR' media is expected to solve problems in improving students' conceptual understanding of the water cycle by providing more meaningful learning and attracting student participation. The study was conducted on 5th grade students at Al Falah Darussalam 2 Elementary School, Sidoarjo using the 4D research and development model (Define, Design, Develop, and Disseminate). Data collection was carried out by interviews, observations, tests, and questionnaires. From the data obtained from the media validator, the media was very feasible with a percentage of 92%, and the test score obtained N-Gain 73.17 was categorized as high and effective so that the DIOS_AR media could increase student engagement, attract their attention, and improve their conceptual understanding of water cycle learning.



INTRODUCTION

In today's digital era, schools need to be creative and innovative to encourage student engagement and meet the needs of 21st-century learners. Learning that only involves texts and lectures is not enough to engage students and help them understand, especially in Natural Science (IPA) topics, which require concrete and visual understanding of concepts. The learning process has shifted from a teacher-centered approach to a student-centered one (Pertiwi et al., 2022). The latest curriculum requires schools to use Information and Communication Technology (ICT) in the classroom (Pebria Dheni Purnasari & Yosua Damas Sadewo, 2020). ICT is developing very rapidly today and has made significant progress in many areas, including how people learn. Furthermore, the utilization of learning materials is crucial in the educational process (Moto, 2019). Knowing how to use learning media properly can help students understand better, make the material more interesting, and make them more enthusiastic about learning (Yanto, 2019). Teachers need to know how to create media because teachers who can create appropriate media will help students understand what they are learning better, which will help them achieve learning objectives (Febriza et al., 2021). The use of technology in learning this water cycle material is necessary, especially in visualizing the stages of the water cycle using AR.

Researchers at Al Falah Darussalam 2 Elementary School in Waru District, Sidoarjo Regency, observed that the learning process did not utilize technology-based media, and conventional media were rarely used. As a result, students were disinterested in learning and did not respond well to teacher-led learning. Pebria Dheni Purnasari and Yosua Damas Sadewo (2020) stated that a teacher needs to plan and implement high-quality teaching and learning activities to achieve learning objectives. To do this, a teacher needs to understand various teaching methods and be proficient in using learning tools. The effectiveness of the learning process can be determined by how effectively the activities meet students' needs and are in line with global developments. To address this issue, we need new learning tools that can make ideas more realistic and engaging. The "Water Cycle AR Diorama" is one such media. A diorama is a three-dimensional visual medium that can realistically display an idea or process. Juliandi Siregar, Nadila, and Rita Destini (2020) stated that diorama media makes it easier for teachers to teach about the water cycle and students will be more engaged in learning, which will help them understand better. AR in interactive multimedia can enhance the learning experience by providing relevant and interesting knowledge, and help understand complex topics through authentic and direct visual interactions (Abdullah et al., 2022). Users can see two- or three-dimensional virtual objects as part of the real world thanks to augmented reality technology. Seeing the hydrological cycle will provide a direct and interactive experience for users, which will make learning more enjoyable for students (Syahputra & Arifitama, 2018). Augmented reality (AR) technology in education has been shown to increase student learning motivation and understanding of the concepts being studied (Purwanti et al., 2024) found that AR can combine the real and virtual worlds in the learning process, thereby encouraging a more interesting and interactive educational experience. According to Sugiyanto et al. (2024), students had positive reactions to the creation of interactive media based on augmented reality and were enthusiastic about participating in learning about the Water Cycle. Furthermore, Khudzaifah et

al. (2024) found that digital scrapbooks influenced the water cycle material through augmented reality, which had an impact on fourth-grade students' self-regulation. Furthermore, Damanik & Fajari, (2025) confirmed that interactive multimedia based on augmented reality can improve problem-solving skills and digital literacy in elementary school children. The researchers recognized the need to develop 'DIOS AR' learning media based on real-life education, specifically aimed at improving fifth-grade students' understanding of subjects related to the water cycle. One of the issues identified from the observation results was the importance of learning media Augmented reality (AR)-based water cycle dioramas in elementary education. Therefore, it is necessary to develop diorama media that can be accessed through the assembler edu application on smartphones (Sugiyanto et al., 2024). Based on the results of previous research, the use of AR in water cycle learning can improve students' conceptual understanding and create a learning environment that stimulates student participation.

Researchers conducted research to improve diorama media, resulting in augmented reality-based diorama media that is more interesting than traditional diorama media. The objectives of this research are to (1) help students better understand the concept of water cycle material, (2) make learning activities more meaningful for students, and (3) attract students' interest in learning activities. The difference between the developed media and traditional diorama media is that the developed media is technology-based, can be accessed at any time, and displays material that is very similar to the original diorama.

METHOD

This study employed development research, also known as R&D (Research and Development). This study employed a 4D development model, with the first stage being the definition stage, where the learning media used was a water cycle diorama using AR 'DIOS-AR'. This media consisted of two media combined into one: a diorama-shaped image of the water cycle stages and a paper toy-shaped diorama applied to AR. The second stage was the design stage, where the researcher developed the initial design and determined the technology used (AR). The third stage was the development stage, where the researcher designed and designed the innovative media to be developed. The fourth stage was the dissemination stage, where this media was used in two meetings in the first semester of science learning for grade 5. This method and model were chosen because the goal was to produce a product in the format of augmented reality diorama media. The resulting product was then evaluated for its practicality through validity assessment and product trials to determine the extent to which student engagement and learning outcomes improved after instruction with AR diorama media on the topic of the water cycle. The participants in this study consisted of educators and fifth-grade students from Al Falah Darussalam 2 Elementary School, located in Waru, Sidoarjo. The purpose of this development research is to develop a realistic water cycle diorama educational media augmented reality utilizing the Assembler Edu program. The research on the development of diorama media products for fifth-grade elementary school children was conducted in March 2025. This study used data collection approaches such as interviews with supervisors (1 person), expert teachers (4 people), observation, questionnaires, and documentation. Interviews and observations were used in the

initial stages of the study to ascertain existing issues in the field. Interviews were conducted with teachers of grades 5.1 to 5.2, and observations were conducted during the learning process. Questionnaires were used to collect data on student learning outcomes from pretests given at the beginning of learning and posttests conducted after the use of media in the learning process. Photo documentation was used to strengthen the facts in this study. Research data were collected using instruments in the form of questionnaires. The survey given to professionals and educators included a Likert scale that displayed five response options. Analysis of the validity and feasibility of the data was carried out using the following formula:

$$P = \frac{f}{N} \times 100\%$$

Description:

P = percentage

f = obtained score

N = maximum score

Next, the final scores from the validation and product feasibility results are interpreted based on Table 1 below

Table 1 Interpretation of final scores

Average Score	Decision	Description
80 % < x ≤ 100 %	Very worthy	No revision
60 % < x ≤ 80 %	Worthy	No revision
40 % < x ≤ 60 %	Quite worthy	Revision
20 % < x ≤ 40 %	Less worthy	Revision
0 % ≤ x ≤ 20 %	Very less worthy	Revision

Additionally, the final scores obtained from the validation and product feasibility tests will be analyzed. Data collection was conducted using a questionnaire consisting of a pre-questionnaire and a post-questionnaire administered to students to assess improvements in conceptual understanding. Student data was then evaluated using Microsoft Excel with the N-Gain formula.

$$g = \frac{S_f - S_i}{100 - S_i} \times 100\%$$

The calculation results from this formula will be interpreted into several categories, including:

Table 2. N-Gain level categories

Decision	Category	Value
$g \geq 0,7$	High	Height increase
$0,3 \leq g < 0,7$	Medium	Moderate increase
$g < 0,3$	Low	Low increase

RESULT AND DISCUSSION

Media, as a component in a system, functions as a means of non-verbal communication. As part of the system, media is crucial and must be utilized in every learning experience. The absence of any of these components will result in suboptimal results (Magdalena et al., 2021).

The research conducted to create a product called "DIOS_AR" in collaboration with assembler edu aims to engage students by utilizing technology-based media on smartphones to encourage active participation in learning activities, foster more meaningful educational experiences, and enhance understanding of the water cycle.

1. Results

The research to create a product called "DIOS_AR" aims to encourage student engagement by using smartphones to create technology-based media that will create a learning environment that stimulates student activity, makes learning activities more meaningful for them, and helps them better understand the water cycle. In the 4D development phase was defined, where the media was used for fifth-grade elementary school students and discussed the water cycle. Students could access the media by scanning the barcode on each image of the water cycle stages. After scanning the barcode, the stages of the water cycle would appear exactly as they were in real life.

In the second design phase, researchers used the media based on the learning materials created, including teaching modules and methods for assessing student learning. Then, a diorama was created to realistically represent the water cycle, and an AR application was used to display the three-dimensional animation. The 'Paper Toy Craft' and AR Diorama designs were made with simple materials and a framework created using Canva.



Figure 1. Diorama pattern design

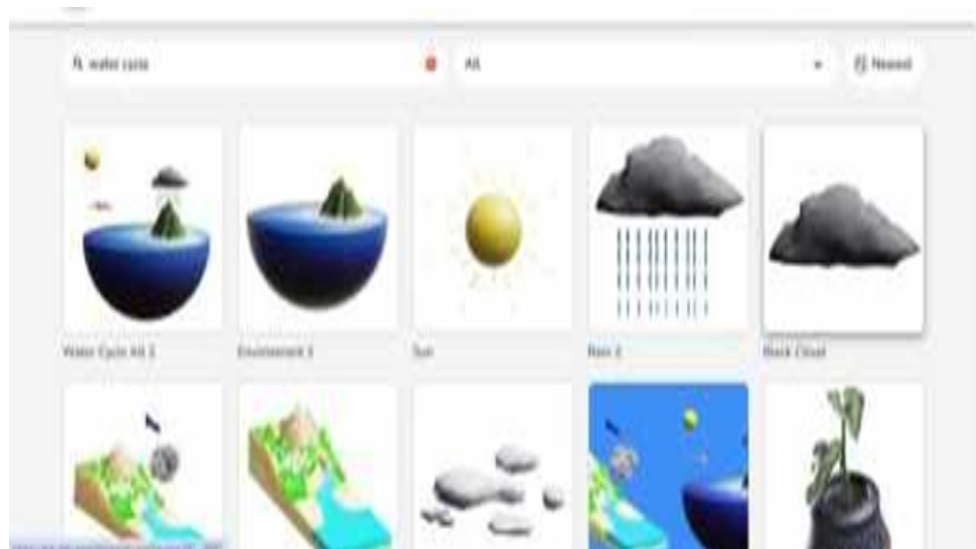


Figure 2. 3D Image Design in Assembler Edu

Media design begins with a product concept, including the features used and video design related to collaborative digital reality (AR)-based media. The initial steps taken by researchers at this stage included developing the learning media concept and gaining a deeper understanding of the features within the assembler.edu application. The next steps included identifying the features to be integrated into the augmented reality (AR) learning media focused on the water cycle, as well as designing the videos to be included in this educational resource. The third stage involved developing learning videos that would accompany the interactive learning media utilizing augmented reality (AR) to explain and enhance the educational experience for students. The fourth stage involved developing the interactive learning media utilizing augmented reality (AR), beginning with the implementation of the designed framework and incorporating videos.

In the third stage of development, researchers carefully evaluated the visual representation and placement of each important component in the learning media, including land, oceans, mountains, plants, clouds, sun, and rain. The arrangement and visualization of these elements were designed to be aesthetically appealing to students while simultaneously illustrating each stage of the water cycle. The developed media aims to facilitate students' understanding of the water cycle through informative and educational visual displays, thereby increasing comprehension and engagement. The media design developed by the researchers can be accessed through barcode scanning. Next, fellow researchers conducted observations to assess the effectiveness and presentation of the media during the learning process. The next stage involves the creation of augmented reality-based media and research tools, which will be the media was evaluated by supervisors and co-researchers who teach fifth-grade students. The media was evaluated based on its design, communication skills, assessment materials, and language. Researchers received evaluations, criticisms, and recommendations for further media development from validators. The validators' assessment of the 'DIOS_AR' media indicated that both the validators and users considered the media highly suitable for use. The findings of the data assessment are presented below:

Table 3. Summary of Validator Questionnaire Values

Validator	Total score	Average Eligibility	Percentage
Supervisor of Regional Coordinator Waru	23	4,6	92%
Grade 5.1 Teacher at SD Al Falah Darussalam 2	22	4,4	88%
Grade 5.2 Teacher at SD Al Falah Darussalam 2	23	4,6	92 %
Grade 5.3 Teacher at SD Al Falah Darussalam 2	24	4,8	96%
Average Criteria	23	4,6	92%
		Very worthy	

In the fourth stage of dissemination, after the 'DIOS_AR' media was used in water cycle learning in grade 5 of SD Al Falah Darussalam 2 which involved student exploration, Paper Toy assembly and the use of this media to deepen the stages of the water cycle. Students who tried using the 'DIOS_AR' media were 24 students in grade 5.4.



Figure 3. Implementation of 'DIOS_AR' Media in Learning

At this stage, initial and final trials were conducted to assess the effectiveness of augmented reality-based media in improving students' understanding of the water cycle science concept. Figure 3 shows the results of the initial and final trials.

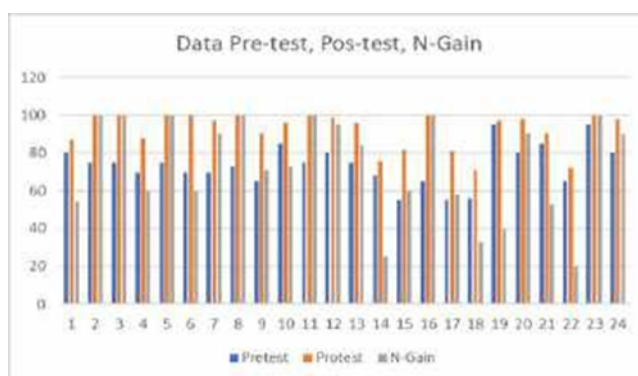


Figure 4. Data Pre-test, Pos-test, N-Gain

Based on Figure 3, the pre-test and post-test results (blue and orange bars) show an increase in students' understanding of science concepts in the water cycle using augmented reality. The data represent the pre-test average, post-test average, and N-Gain average.

Table 4. Average Results of Pretest, Posttest and N-Gain

No	Pretest	Posttest	N-Gain
1	73,63	92,42	73,17

The findings of table 4 show that the average pretest was 73.63, the average posttest was 92.42, and the N-Gain was 73.17. The average N-Gain value of 73.17 based on the table is included in the 'high increase' which means students experienced an increase in conceptual understanding (Hake, 1998) of the water cycle material.

2. Discussion

From the media development stage using 4D, researchers found several notes that need to be considered in the future use of AR technology. Media analysis showed that students were less interested in using traditional learning media. Traditional media resulted in less than optimal student engagement and understanding of the water cycle. Students had difficulty understanding abstract science topics, and augmented reality facilitated their visualization of these concepts (Purwanti et al., 2024). Furthermore, curriculum analysis yielded suitable resources for AR-based media, exemplified by 'DIOS_AR'. Previous research (Masrurroh et al., 2023) supports this research, which revealed that augmented reality (AR) media can make science learning fun and participatory, which can help students understand difficult science concepts. According to Jurnal et al. (2022), the use of AR Assembly Edu makes information easier to understand, which makes students more interested in learning science. Research findings indicate that three-dimensional (3D) media using AR can improve student understanding by up to 96.97%. Consequently, the implementation of AR can offer substantial additional benefits within an educational framework. To obtain this data, the researchers examined the conditions of the school where the research was conducted to determine the needs of teachers and children in elementary schools. At this stage, unstructured interviews were conducted with fifth-grade teachers at Al Falah Darussalam 2 Elementary School in Sidoarjo, East Java. The interviews were conducted by asking several questions regarding the curriculum, educational materials used, and pedagogical methods implemented at the institution. The subsequent investigation focused on fifth-grade students at Al Falah Darussalam 2 Elementary School in Sidoarjo, East Java, who were participants in the trial. One of the challenges in teaching and learning is the lack of ways to learn scientific concepts in the water cycle. Currently available media only provide photos of the stages of the water cycle, making it difficult for students to understand scientific concepts. Concept analysis is a method for finding, describing, and organizing important concepts that have been presented. Establishing learning objectives is the goal of content analysis. Concept analysis became the learning objective when creating "DIOS AR" media about the water cycle.

When designing the media, researchers used the Assemblr Edu application to create augmented reality. They also used Canva software to create a diorama depicting the stages of the water cycle (evaporation, condensation, precipitation, and infiltration) and explored ways to incorporate AR into the

diorama. At this stage, researchers also began creating tests and quizzes, as well as validation questionnaires for supervisors and other fifth-grade teachers. The design phase of Research and Development (RnD) is highly valued and important because establishing the structure and methods for creating innovations or new products (Samsudin et al., 2021). The first product development project is tested to ensure its functionality. There are several steps in the development process: a) creating augmented reality-based media and research tools to be reviewed by supervisors and fifth-grade teachers; b) asking supervisors and fifth-grade teachers to evaluate the 'DIOS_AR' media in terms of content, materials, and language, and providing feedback and suggestions on how to improve the 'DIOS_AR' media. And c) modifying the media approved by supervisors and fifth-grade teachers based on their input, ideas, and criticism. This evaluation ensures that the educational media meets scientific criteria and effectively communicates lesson content in a way that is engaging for students (Samsudin et al., 2021).

When the "DIOS_AR" media has been created and deemed valid or suitable for use, it is distributed. This dissemination stage is carried out by distributing the product at Al Falah Darussalam 2 Elementary School in Sidoarjo, East Java. The purpose of this stage is to ensure that the product can be used in the classroom and can be improved in further research. Based on the results of the pretest and posttest and the average N-Gain value, it shows that the 'DIOS_AR' media is effective in improving students' understanding of science concepts in the water cycle material. Data were collected through questionnaires, and the average value (mean) of the results of the pre-test and post-test devices was obtained with an N-Gain score of 0.7317 (where a g value above 0.7 is classified as a high increase). This finding indicates that the developed learning media makes a high contribution to improving students' understanding of concepts. These results also align with the study entitled "Validity and Practicality of AR (Augmented Reality)-Based Diorama Media Assisted by Assembler Edu on the Water Cycle" by Rahmat et al., 2024, which stated that the AR-based diorama media developed was valid and practical. These results align with several studies that state that AR-based interactive multimedia provides a more engaging and directly relevant learning experience for students, leading to greater engagement and enthusiasm for exploring digital concepts (Fajari et al., 2023).

Furthermore, responses from teachers and students to this media were positive, both in terms of appearance, ease of use, and its benefits in the learning process. Considering the analyzed quantitative and qualitative data, the researchers concluded that the developed media met the standards of feasibility and effectiveness. Therefore, no final revisions were necessary at this stage, and the media was deemed ready for optimal use in the learning process in accordance with the stated objectives.

CONCLUSION

Observations by colleagues and students indicate that the DIOS AR (Water Cycle Diorama) media is highly suitable and can be used in learning. Meanwhile, observations and interviews with colleagues indicate that the DIOS AR media is highly suitable and can be used without revision in science learning on the water cycle in fifth grade. The feasibility of the DIOS AR media was obtained through questionnaires

from various parties, namely: fellow teachers, the principal, and junior high school science teachers. These values indicate a high level of feasibility, thus the media is considered suitable for use in the learning process. Based on product trials related to improving student conceptual understanding, results obtained from 24 students with an N-Gain value of 0.3808, which is included in the moderate category. The media can be used without revision because it meets the criteria for effectiveness in improving student conceptual understanding.

Prospects for developing the results of this research include expanding other learning materials and adapting them to various curricula. In the future, this AR application can be developed for other subjects and expand the scope of its technology with more advanced features such as combining it with artificial intelligence and coding.

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