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Development of *Smart Apps Creator* Interactive Learning Media with Augmented Reality (AR) Containing Water Cycle Material for Grade V Elementary School

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Abstract

The water cycle topic in IPAS learning is often perceived as abstract and difficult to understand by elementary school students. To address this issue, this study aims to develop, validate, and evaluate the effectiveness of an interactive learning media based on *Smart Apps Creator* with Augmented Reality (AR) to improve the learning outcomes of fifth-grade students. The research method used is Research and Development (R&D) with a simplified Borg & Gall model, consisting of nine stages, from problem identification to large-scale testing. Expert validation showed that the media was highly feasible, with average scores of 92.5% from media experts and 94% from subject matter experts. Normality tests confirmed that the data were normally distributed, while the Paired T-Test indicated significant differences between pretest and posttest results ($p = 0.019$ for the small group and $p = 0.000$ for the large group). The N-Gain scores were 0.6281 (small group) and 0.5812 (large group), both falling into the moderately effective category. These results indicate that the *Smart Apps Creator*-based media with AR is feasible and effective in enhancing students' understanding of the water cycle concept and improving their academic performance in fifth-grade science classes.

Keywords: interactive educational media; augmented reality; *smart apps creator*; water cycle

INTRODUCTION

Education plays an important role in creating quality and competitive human resources. Based on Law Number 20 of 2003, education is a conscious and planned effort to create a learning atmosphere that can develop the potential of students optimally. Quality education is expected to be able to produce individuals who have skills, knowledge, and attitudes that are in accordance with the demands of the times. In the era of rapid globalization, the challenges in the world of education will be increasingly complex, so various innovations in learning are needed to improve the quality of education (Indah Junia & I Wayan Sujana, 2023). The use of technology in learning media is an important innovation in improving the quality of the teaching and learning process.to be more interesting, interactive, and effective in improving student understanding (Azizah et al., 2020). One of the innovations that is developing in the world of education is the use of technology the use of digital learning media that can facilitate the delivery of material visually and contextually (Fadhli M, 2015).

Based on the results of observations conducted at Parikesit State Elementary School 1, several problems were found in the teaching process that could hinder the achievement of student learning outcomes. The teaching process in grade V is still dominated by the lecture method, which causes low student interaction in understanding the material. This kind of learning is included in the conventional approach which tends to be one-way and less

involving students in the material exploration process. For example, when explaining the water cycle material, the teacher only delivers the explanation through the blackboard without the help of visual media or props, so that students have difficulty understanding the abstract process (Ghani, 2022). One of the materials that has difficulty in understanding is the water cycle. The results of the pre-study showed that as many as 70% of students have not achieved the Learning Objective Achievement Criteria (KKTP) in the subject of science, especially in the water cycle material. This difficulty is caused by the limited media that can visualize the water cycle process concretely (Gusti et al., 2023). This condition shows the need for innovation in delivering materials so that students better understand the learning concept and improve their learning outcomes (Handayani & Zainil 2023).

As a solution to these problems, this study developed an interactive learning media based on *Smart Apps Creator* which contains Augmented Reality (AR) technology (Ilma et al., 2022). This media aims to help students understand the concept of the water cycle in a more realistic and interactive way (Jaiz et al., 2022). Augmented Reality allows students to see three-dimensional visualizations that are more interesting and easier to understand compared to conventional learning (Ginting & Tambunan, 2023). In addition, this technology can increase students' learning motivation by providing a more immersive and interactive learning experience. By using *Smart Apps Creator* as a learning medium, it will be more flexible and easily accessible to teachers and students (Junita & Bahri, 2024). It is hoped that this solution can have a positive impact in increasing students' understanding of the concept of the water cycle and making the learning process more interesting and effective.

Several previous studies have shown that technology-based learning media are effective in increasing student engagement and learning outcomes (Mufidah & Sulaikho, 2022). However, there is still limited research that specifically integrates Augmented Reality (AR) technology into *Smart Apps Creator* for learning water cycle material at the elementary school level. Therefore, this study presents a novelty by developing interactive media based on *Smart Apps Creator* equipped with AR content, to provide more concrete and interesting visualizations in understanding the concept of the water cycle. Research conducted by Oktaviani Desi (2022) shows that *Smart Apps Creator*-based learning media integrated with a scientific approach has an average validation rate of 93.8%, indicating a high feasibility of the media. These results are in line with the findings in this study, which show that the media developed also received a high level of validation from experts. Furthermore, Sari & Erita (2024) found that *Smart Apps Creator* has a very high level of practicality, with teacher practicality results of 100%. This is consistent with the results of the practicality in this study, where teachers stated that the media developed was easy to use and very helpful in the learning process. Meanwhile, research by Dewi et al. (2024) stated that the use of Augmented Reality (AR)-based media can significantly improve student learning outcomes. These findings are also reinforced by the results of this study, where students showed a significant increase in learning outcomes after using AR-based media to understand the water cycle material (Muhaimin & Zumrotun, 2023). This comparison shows that the integration of *Smart Apps Creator* and AR has strong potential to optimize student learning outcomes effectively (Ririn et al., 2024). The use of AR technology allows students to interact directly with learning materials, so that abstract concepts can be visualized more realistically and easily understood (Susiloningsih et al., 2015). Based on previous studies, technology-based learning media has proven effective in increasing student engagement and

understanding (Uno, 2024). However, most previous studies only use *Smart Apps Creator* or Augmented Reality (AR) technology separately, without combining the two in an integrated manner in one complete learning media. This is a research gap that has not been explored in depth.

This research aims to develop interactive learning media based on *Smart Apps Creator* integrated with AR technology for water cycle material for grade V elementary school. The novelty of this research lies in the combination of three-dimensional visualization of AR with the interactive interface of *Smart Apps Creator*, which allows students to not only see objects concretely, but also interact directly with learning content through digital devices. This media is also equipped with evaluation features and water cycle simulations that help improve students' conceptual understanding in more depth. With this approach, this research not only contributes to providing innovative media, but also provides a practical learning model that can be implemented by teachers in the digital era. It is hoped that this media can be a real solution in delivering abstract material such as the water cycle in a more interesting, concrete, and effective way.

METHODS

This study uses a research and development approach. According to Dewi et al. (2024) this approach aims to produce interactive learning media based on *Smart Apps Creator* which contains Augmented Reality (AR) technology, as well as to test its feasibility and effectiveness in improving student learning outcomes in the water cycle material for grade V of elementary school. The media development process refers to the adapted Borg & Gall model, starting from identifying potential and problems through initial observations of teaching and learning activities, especially on materials that are difficult for students to understand. Furthermore, initial data collection is carried out in the form of literature studies and needs reviews for appropriate learning media. The next stage is the design of media products that are designed based on the results of the needs analysis, then validated by material and media experts to assess the feasibility of the content, appearance, and technical use. After validation, a limited trial is carried out to determine the practicality of the media in learning (Sari & Harjono, 2021). The final stage is the effectiveness test by comparing student learning outcomes before and after using the media, which is analyzed to assess the impact of media use on understanding the concept of the water cycle. All of these stages are carried out systematically to produce learning media that are feasible, practical, and effective for use in elementary schools.

Research Subject

The subjects of this study were 38 fifth grade students of Parikesit State Elementary School 1, Wonosobo Regency, with Purposive Sampling. Teachers and expert validators (materials and media) were also involved as data sources for needs analysis and product validation.

Research Instruments

The research employed several key instruments to gather comprehensive data. Observation and interviews were utilized to identify the potential and needs of learning media. A questionnaire served to validate the suitability of the media by experts and student and teacher

responses. To measure the effectiveness of learning media, a test instrument was administered, comparing result through a pretest and a posttest. Finally, documentation was crucial throughout the process to record the research process as supporting evidence.

Research Procedures

The research began with potential and problem identification, which involved observation and interviews with teachers and students. These initial steps revealed a significant issue that show students' low understanding of science and technology materials, especially the water cycle, due to conventional learning methods. Following this, data collection was conducted using interviews, needs questionnaires, and direct observation of learning activities. The next stage was product design, resulting in an interactive learning media based on *Smart Apps Creator* that incorporates Augmented Reality (AR), according to student needs and science learning materials. To ensure the product's suitability, design validation was carried out by material experts, media experts, and teachers who provided assessments through validation questionnaires. Based on their input, design revision was performed to improve product quality. Subsequently, a product trial was conducted with small groups to gauge practicality and identify product weaknesses, leading to a second round of refinement called product revision. Finally, a comprehensive usage trial was performed on all fifth-grade students to thoroughly evaluate the overall effectiveness of the developed learning media.

Research Data Analysis

Media Validation: Validation data is calculated using the percentage of media eligibility based on the score from the validator with the following formula and validated according to the criteria in Table 1.

$$\textbf{Eligibility Percentage } (\%) = \frac{\textbf{Obtaining Score}}{\textbf{Max Score}}$$

Table 1. Data Validation Criteria

Percentage	Criteria
76% - 100%	Very Worth It
51% - 75%	Worthy
26% - 50%	Quite Decent
0% - 25%	Less Worthy

Source: Budiastuti & Bandur (2018)

Media Effectiveness: Pretest and posttest data were analyzed using T-Test to determine the significance of the increase in learning outcomes. The average value increase index (N-gain) was used to measure the normalized increase in student learning outcomes in Table 2.

$$\textbf{N} - \textbf{Gain} = \frac{\textbf{Posttest Score} - \textbf{Pretest Score}}{\textbf{Ideal Score} - \textbf{Pretest Score}}$$

Table 2. Criteria of Average Increase

N-Gain Score	Criteria
N-Gain ≥ 0,70	Effective
0,30 < *N-Gain* < 0,70	Quite Effective
N-Gain ≤ 0,30	Less Effective

Source: Budiastuti & Bandur (2018)

Place and Time of Research

The research was conducted at Parikesit State Elementary School 1, Wonosobo Regency, during the odd semester of the 2024/2025 Academic Year.

RESULT AND DISCUSSION

Result

This study aims to develop interactive learning media based on *Smart Apps Creator* that integrates Augmented Reality (AR) technology in the water cycle material for grade V elementary school through the stages of developing a simplified Borg & Gall model. The development process is carried out starting from identifying needs and curriculum analysis, designing interactive media, validation by media and material experts, to small-scale and large-scale trials. The final product is an AR-based interactive learning application that displays a three-dimensional visualization of the water cycle process, accompanied by interactive quizzes and user-friendly navigation. Development documentation includes interface design, AR feature integration, and input from teachers and students during the revision process. The effectiveness of the media was tested through a pretest and posttest which were analyzed using statistical tests, showing a significant increase in learning outcomes after using the media.

The validity and reliability of the research instrument were tested to ensure the accuracy and consistency of the measuring instrument in collecting data. Furthermore, a normality test was conducted to determine whether the pretest and posttest data were normally distributed, so that they could be used in parametric statistical analysis. The N-Gain test was used as a tool to measure the increase in student learning outcomes after using the media, while the Paired T-Test was applied to determine the significance of the difference in learning outcomes before and after using the learning media.

The results of this study will be presented in several parts, including analysis of teacher and student needs, media validation results, trial results, and analysis of the effectiveness of learning media.

Instrument Validity and Reliability Test

The research instruments used in data collection consisted of expert validation assessment forms, student response questionnaires, and pretest and posttest questions. Validity testing was carried out using Pearson Product Moment correlation analysis, where the results of the instrument validity test showed that out of 50 questions tested, 46 questions were declared valid with validity scores ranging from 0.012 to 0.756, while 4 questions (questions 39, 40, 42, and 50) were declared invalid. that all instrument items have a correlation value above the r-table of 0.334 with a significance value of 0.005. This shows that the instrument used is valid to measure the research variables.

Reliability testing was also conducted using the Cronbach's Alpha formula, with a result of 0.807, which means that the data in this study is said to be reliable. This result indicates that the instrument has a good level of consistency for use in research.

Table 3. Reliability Test Result

Cronbach's Alpha	*N of items*
0,807	21

Data Normality Test

Normality test was conducted to ensure that the pretest and posttest data were normally distributed before further statistical analysis was conducted. The test used the Shapiro-Wilk method, with the pretest results showing a value of 0.140 for the Large Group and 0.932 for the Small Group. While the posttest results showed a significance value of 0.052 for the Large Group and 0.211 for the Small Group. Based on the testing criteria, the data is declared normal if the significance value is greater than 0.05. Thus, it can be concluded that the pretest and posttest data for both small and large classes are normally distributed.

Table 4. Normality Test Results

Group	*Kolmogorov-Smirnov*			*Shapiro-Wilk*		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
Pretest Large Group	0,163	32	0,031	0,950	32	0,140
Posttest Large Group	0,144	32	0,089	0,934	32	0,052
Pretest Small Group	0,135	6	0,200	0,976	6	0,932
Posttest Small Group	0,236	6	0,200	0,866	6	0,211

Paired T-Test

To find out the significant difference between the pretest and posttest results, a Paired T-Test was conducted. The test results showed a t-count value of -12.971 for large classes and -3.410 for small classes, with a significance of 0.000 and 0.019. Thus, it can be concluded that there is a significant difference between student learning outcomes before and after using the *Smart Apps Creator* interactive learning media containing AR.

Table 5. Results of the Large Group Paired T-Test.

	Mean	Std. Dev	Std. Error Mean	95% *Confidence Interval of the Difference*		t	Df	Sig (2-tailed)
				Lower	Upper			
Pretest-Posttest Large Group	-29,903	13,041	2,305	-34,605	-25,201	-12,971	31	0,000

Table 6. Results of the Small Group Paired T-Test.

	Mean	Std. Dev	Std. Error Mean	95% *Confidence Interval of the Difference*		t	Df	Sig (2-tailed)
				Lower	Upper			
Pretest-Posttest Small Group	-29,350	21,085	8,608	-51,477	-7,223	-3,410	5	0,019

N-Gain Test

The analysis of student learning outcomes improvement was calculated using the N-Gain

index, which compares pretest and posttest scores. Based on the analysis results, the N-Gain value was 0.5812 (58.12%) for large classes and 0.6281 (62.81%), which is included in the category of quite effective learning outcomes improvement. These results indicate that the AR-based *Smart Apps Creator* interactive learning media has succeeded in improving students' understanding of the water cycle material.

Table 7. Results of the Large Group N-Gain Test

	N Statistic	*Min Statistic*	*Max Statistic*	*Mean*		*Std. Deviation Statistic*	*Variance Statistic*
				Statistic	*Std. Error*		
N-Gain	32	-0,25	0,85	0,5812	0,03879	0,21944	0,048
N-Gain Percent	32	-25,13	84,52	58,1219	3,87916	21,94385	481,533
Valid N (listwise)	32						

Table 8. Small Group N-Gain Test Results

	N Statistic	*Min Statistic*	*Max Statistic*	*Mean*		*Std. Deviation Statistic*	*Variance Statistic*
				Statistic	*Std. Error*		
N-Gain	6	0,25	0,81	0,6281	0,07962	0,19504	0,038
N-Gain Percent	6	25,13	81,23	62,8061	7,96245	19,50394	380,404
Valid N (listwise)	6						

Analysis of Student and Teacher Responses

Based on the results of the student and teacher response questionnaire, the learning media received positive responses in terms of readability, ease of use, and visual appeal. As many as 90% of students stated that this media helped them understand the concept of the water cycle better, while teachers gave a satisfaction score of 100%.

Product Trial Results

The development of interactive learning media *Smart Apps Creator* containing AR was tested in two stages, namely small-scale trials and large-scale trials. In the small-scale trial involving 6 students, a positive response of 90% was obtained, while in the large-scale trial with 32 students, the response results showed that this media was very feasible with a percentage score of 91%.

Discussion

The results of the study indicate that the development of interactive learning media *Smart Apps Creator* containing Augmented Reality (AR) on the water cycle material for grade V ELEMENTARY SCHOOL has had a positive impact on student learning outcomes. This media was developed based on a needs analysis which showed that previous learning methods were still conventional with limited visual media, so that students had difficulty in understanding the concept of the water cycle. The findings of this study were confirmed through various statistical tests that referred to a significant increase in learning outcomes after the use of interactive learning media.

Development of Interactive Learning Media Smart Apps Creator with AR Content

The development of interactive learning media based on *Smart Apps Creator* containing Augmented Reality (AR) was carried out through three main stages, namely identification of potential and problems, data collection, and product design. Identification of potential and problems was carried out through observation and interviews with teachers at Parikesit State Elementary School 1. The results showed that science learning, especially water cycle material, was still dominated by lecture methods with minimal use of interactive learning media. As a result, as many as 70% of students had difficulty understanding the concept of the water cycle and had not reached the KKM.

The data collection stage was carried out by reviewing the needs of more interactive and technology-based learning media. Data were collected through literature studies and analysis of teacher and student needs for innovative learning media. The results of the analysis show that the use of Augmented Reality (AR) technology can improve students' understanding of abstract concepts, such as the water cycle, because it allows for more realistic visualization of the process (Dewi et al., 2024).

The effectiveness of this media is supported by several main factors. First, the use of AR provides a more immersive learning experience compared to conventional media. With AR, students can observe three-dimensional visualizations of the water cycle concept directly, thereby increasing their understanding of the processes that occur. Second, this media is designed to be more interesting and interactive through animated simulations and game-based practice questions, which can increase students' learning motivation. Third, the integration of AR technology in learning allows students to learn independently according to their own speed and learning style, thus providing a more flexible learning experience.

Figure 1. Material Factors Affecting the Water Cycle

At the product design stage as in Figure 1, learning media was developed using *Smart Apps Creator*, which allows the integration of animation and AR technology in learning. This media is designed to be easy to use by teachers and students, with the main features being interactive simulations of the water cycle concept, practice questions, and materials in text and audio form. This initial product was then tested for success through expert validation before being tested on students.

Eligibility of AR-Containing Smart Apps Creator Interactive Learning Media

The feasibility of a learning media is highly dependent on its validity and practicality in supporting the learning process. *Smart Apps Creator*-based learning media has a high level of validity, with an overall value of 91% for material and media validation (Yallah R &

Huda, 2022). The feasibility of learning media is tested through design validation by media experts and material experts. In Table 9, the validation results show that this media received a score of 91% from student responses and 100% from material experts, which is categorized as very suitable for use in learning. This is in line with research (Elviana & Julianto, 2022), which found that *Smart Apps Creator*-based media has a validity level of 87.7% for media and 86.7%. Thus, the use of *Smart Apps Creator*-based learning media that integrates Augmented Reality (AR) can be categorized as a medium that is very suitable for use because it has been proven to meet high validity standards and can increase learning effectiveness. Several aspects that are assessed include the suitability of the content, readability, clarity of instructions, and the effectiveness of the AR display and features in helping to understand the concept of the water cycle.

The effectiveness of this media is due to several main factors. First, the use of Augmented Reality (AR) technology in learning media allows students to observe the concept of the water cycle visually and interactively, thereby increasing their understanding of the processes of evaporation, condensation, and precipitation. With more realistic visualizations, students can more easily understand abstract material compared to conventional methods.

Second, this media is designed to be attractive and easy with a user-friendly interface. The interactive display and animation integration help to increase students' interest and motivation to learn. Third, the practice questions feature provided in this media allows students to test their understanding independently, thus providing a more flexible and effective learning experience.

Table 9. Results of Student Response Questionnaire Analysis of Large-Scale Trial

Percentage	91%
Criteria	Very feasible

After design validation, design revisions were made based on suggestions from the validator. Improvements made included adjusting the interface to be more user-friendly and adding interactive animations that more clearly display the evaporation, condensation, and precipitation processes. After revision, the media was ready to be tested on a limited and large scale to test its effectiveness on student learning outcomes.

Effectiveness of Smart Apps Creator Interactive Learning Media Containing AR on Student Learning Outcomes

The results of previous studies have shown that *Smart Apps Creator*-based learning media has high effectiveness in improving student learning outcomes. The use of interactive media based on *Smart Apps Creator* can increase the level of student learning completion by up to 100%, with an increase in the N-Gain value of 0.81, which is categorized as a high increase (Mahdiratana & Istianah, 2022). In addition, research by Elviana and Julianto (2022) shows that *Smart Apps Creator*-based media has a high level of effectiveness with an N-Gain result of 0.73, which indicates an increase in student understanding in a significant category. This increase occurs because AR-based media can present alternative learning concepts that are more interesting and interactive, so that students can understand the material more easily. Thus, the results of statistical tests in this study are in line with previous studies which prove that AR-based interactive learning media can significantly

improve student understanding and learning outcomes.

The effectiveness of learning media was tested through three stages, namely product trials, product revisions, and large-scale usage trials. In the product trial stage, the media was applied on a small scale involving a number of fifth grade students. The results of the pretest and posttest were analyzed using the normality test and the T test to determine the effectiveness of the media. The normality test showed that the data was normally distributed, while the T test showed a significant difference between the pretest and posttest results with a significance value of 0.019. This indicates that the media has a positive impact on student understanding.

The effectiveness of the learning media was tested through small and large-scale trial stages. In the initial stage, the media was applied to a number of fifth-grade students to measure its impact on student understanding. The results of the pretest and posttest analysis using the normality test showed that the data was normally distributed, while the Paired T-Test showed a significant difference with a significance value of 0.019. Based on these results, revisions were made to the visual appearance and adjustments to the practice questions based on input from students and teachers, in order to increase the attractiveness and suitability of the content to the students' cognitive level.

After the improvements, the media was re-tested on a large scale. Statistical tests showed a significant increase in student learning outcomes, with a significance value of 0.000 and an N-Gain score of 0.6281 for small classes and 0.5812 for large classes, both of which were in the fairly effective category. These results strengthen the effectiveness of the media in supporting learning, in line with previous research findings that showed an increase in student understanding through AR-based media and *Smart Apps Creator*.

The success of this media is inseparable from the application of Augmented Reality technology which is able to create a more immersive learning experience, allowing students to explore the material visually and contextually. The interactive and intuitive display also increases learning motivation and encourages flexible independent learning. Based on further trials, no additional suggestions for improvement were found from teachers or students, so the media is considered ready to be used widely in supporting more modern and effective learning.

CONCLUSION

Conclusion

Based on the research results, it can be concluded that interactive learning media based on *Smart Apps Creator* with Augmented Reality (AR) technology on the water cycle material for grade V of elementary school has been successfully developed and declared very feasible to be used as a student learning method, with validation results of 91% from student responses and 100% from material experts. This media has also proven effective in improving student learning outcomes, as shown by the results of the T-test, where there is a significant difference in results between the pretest and posttest with a significance value of 0.019 in small classes and 0.000 in large classes. In addition, based on the results of the N-Gain test, this media is included in the fairly effective category, with a score of 0.6281 for small classes and 0.5812 for large classes. The use of this media received positive responses

from students and teachers because of the interactive features and AR visualizations that can help understand the abstract concept of the water cycle. Thus, this learning media can be used as an innovative learning tool and in accordance with the needs of digital-based learning.

Recommendations

Based on the research results, it is suggested that the use of interactive learning media based on Augmented Reality (AR) be expanded to other materials in the science subject to help students understand other abstract concepts more broadly. Further research is also needed by involving a wider range of student respondents to test the effectiveness of this media in various school environments that have different characteristics. In addition, media development should be equipped with adaptive evaluation features that can adjust the level of difficulty of questions according to student abilities. In order for the use of this media to run optimally, training is needed for teachers in the use of technology-based learning platforms.

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