



# Interactive Learning Media Based on Augmented Reality to Improve Elementary School Grade V Students' Understanding of the Water Cycle Concept

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## ABSTRAK

Pemahaman dan pengetahuan siswa tentang konsep siklus air masih tergolong rendah, karena media pembelajaran yang digunakan kurang kreatif dan sebagian besar masih berupa media konvensional. Penelitian ini bertujuan untuk mengembangkan media pembelajaran interaktif berbasis Augmented Reality untuk meningkatkan pemahaman siswa terhadap konsep siklus air pada materi IPA kelas V SD. Penelitian ini menggunakan model pengembangan ADDIE. Terdapat dua jenis data yang digunakan pada penelitian ini, yakni data kualitatif dan data kuantitatif. Pengujian untuk mengukur efektivitas produk dilakukan dengan menggunakan desain one group pretest posttest dengan sampel 15 orang siswa. Pada penelitian ini menggunakan metode pengumpulan data dalam bentuk kuesioner kelayakan, kepraktisan, dan tes keefektifan media pembelajaran interaktif berbasis Augmented Reality terhadap peningkatan pemahaman siswa pada konsep materi siklus air di SD. Penelitian ini menggunakan 4 instrumen: (1) uji validitas oleh ahli materi, (2) uji validitas oleh ahli media, (3) uji kepraktisan oleh siswa, dan (4) uji efektivitas melalui lembar observasi sebelum dan sesudah penggunaan media. Uji efektivitas dilakukan dengan uji-t berkorelasi. Hasil penelitian menunjukkan bahwa, media pembelajaran interaktif berbasis Augmented Reality untuk materi IPA kelas V SD pada konsep siklus air dinyatakan valid, praktis, dan efektif dalam meningkatkan pemahaman siswa terhadap konsep tersebut. Dengan demikian, inovasi media pembelajaran interaktif berbasis Augmented Reality layak digunakan secara berkelanjutan.

## ABSTRACT

Students' understanding of the water cycle concept remains low due to the reliance on less creative, mostly conventional learning media. This study aims to develop interactive learning media based on Augmented Reality to improve students' understanding of the concept of the water cycle in science material for grade V of elementary school. This study uses the ADDIE development model. There are two types of data used in this study, namely qualitative data and quantitative data. Product effectiveness testing was conducted using a one-group pretest-posttest design with a sample of 15 students. This study used a questionnaire to assess the feasibility, practicality, and effectiveness of Augmented Reality-based interactive learning media for enhancing elementary students' understanding of the water cycle. This study used 4 instruments: (1) validity test by material experts, (2) validity test by media experts, (3) practicality test by students, and (4) effectiveness test through observation sheets before and after using the media. The effectiveness test was carried out with a correlated t-test. The results of the study indicate that interactive learning media based on Augmented Reality for science material for grade V SD on the concept of the water cycle is declared valid, practical, and effective in improving students' understanding of the concept. Thus, the innovation of interactive learning media based on Augmented Reality is worthy of being used sustainably.

## 1. INTRODUCTION

Education is an important need for humans (Ardykusuma & Mahadewi, 2020; Handayani & Wiyasa, 2020). In education, there is a Natural Science (IPA) subject that studies natural phenomena and scientific concepts. Science or IPA learning has characteristics that are close to the environment, therefore it is very

important to direct students to be able to interact with their surroundings (Nawati et al., 2023; Hariri & Yayuk, 2018; Ardaya, 2016). Science is closely related to various events around humans, one of which is the water cycle. Students may have difficulty understanding the water cycle material, because the water cycle process cannot be observed directly. Therefore, learning media is needed to improve students' understanding of the water cycle. Lack of student understanding has an impact on their learning outcomes, so researchers designed interactive learning media based on Augmented Reality to improve understanding of the concept of the water cycle. This ability to understand is very fundamental, because with understanding, procedural knowledge can be achieved (Al-Siyam & Sundayana, 2014). Augmented Reality can create interaction between the real world and the virtual world, all information can be added so that the information is displayed in real time as if the information is interactive and real (Abdulghani & Sat, 2020; Saurina, 2016). This application is often applied in a game (Afifah et al., 2019; Mustaqim, 2017). In this way, Augmented Reality media can be utilized as one of the learning media that can combine the real and virtual worlds, where the learning process will certainly be more practical and easier to understand by schools. Students can still do practical work by seeing objects like the original, but in virtual form (Sofyan & Dewantari, 2023; Riskiono et al., 2020).

Conceptual understanding is a person's ability to understand or comprehend something after it is known and remembered. A student is said to understand something if he can provide an explanation or give a more detailed description of it using his own words (Susanti & Ruqoyyah, 2021; Utami et al., 2017). In science learning, children need to understand concepts and develop their curiosity through logical explanations. An understanding of the water cycle must be gained through direct observation before students are introduced to abstract information. Learning media is a tool that can be used by teachers to convey information to students related to learning so that it is easy to understand (Fadilah et al., 2023; Zahwa & Syafi'i, 2022). Learning media is very much needed in the learning process in elementary schools, this is because students who are still at the elementary school level of education has the characteristic of liking real or concrete objects. Learning media is useful for making teaching materials more concrete and interesting, so that students can easily understand the material (Zain & Pratiwi, 2021; Nurrita, 2018). Previous research states that learning media makes it easier for students to understand the material (Isnaeni & Hildayah, 2020). Fun, interesting and practical learning is called edutainment, which is a learning process that is designed in such a way that educational and entertainment content can be combined harmoniously to create fun learning (Yunailis et al., 2019; Sianturi, 2014).

The use of learning media in the teaching and learning process can arouse new desires and interests, arouse motivation and stimulate learning activities, and even have psychological influences on students (Isa & Rustini, 2023). Media are all physical tools that can present messages and stimulate students to learn (Wangge, 2020; Suhendar & Mustofa, 2014). Learning media is a tool used by educators to ensure that learning activities take place effectively (Silmi & Hamid, 2023; Hasan et al., 2021). But in reality, the application of creative and innovative learning media in elementary schools is still lacking. The lack of interesting learning media to support learning is the basis for students' low literacy skills.

Based on the problems found in SD Negeri 2 Pucaksari in science learning in Grade V, many students still do not understand the concept of the water cycle. This is due to the limited learning media in schools, which makes it difficult for students to understand the material. The learning media in the school is still lacking, which has an impact on students' understanding of the concept of the water cycle. Teachers tend to use conventional methods, such as lectures, so that learning becomes less interesting and relies more on books as a learning resource. During the teaching and learning process, students who sit at the back often talk about things outside the material, causing them to be less focused. This situation causes a low understanding of the water cycle material and makes students tend to be silent when asked, so that the class becomes passive.

Another problem that occurs is the low learning outcomes of students in science lessons, which is reflected in the values obtained in semester II. As many as 45% of students get scores below 70, which indicates that they do not meet the Minimum Completion Criteria (KKM). This problem is related to the results of the researcher's interview with the homeroom teacher of Class V of SD Negeri 2 Pucaksari, where students have difficulty in understanding the concept of the water cycle in science material. The media used are still less varied and tend to be conventional, and the delivery of the material is less interesting, so that student understanding is still low.

Based on the recapitulation data of science learning outcomes of Grade V students of SD Negeri 2 Pucaksari, it can be seen that most students do not understand the material on the water cycle, with a percentage reaching 70% which is considered very low. Efforts that can be made to improve students' understanding of the water cycle material are by developing appropriate and interactive learning media that can facilitate students' understanding of the water cycle. One of the media that will be developed to facilitate students to understand the water cycle is interactive media based on Augmented Reality. The

development of interactive media based on Augmented Reality aims to facilitate students in understanding the water cycle material.

Based on the problems found by researchers when conducting interviews and observations at SD Negeri 2 Pucaksari, where 5th grade students still have difficulty in understanding the water cycle material where the students' KKM scores are not met. Therefore, researchers developed interactive learning media based on Augmented Reality to improve students' understanding of the water cycle material. In developing interactive media based on Augmented Reality to improve students' understanding of the water cycle material, researchers used the ADDIE research model. Several previous studies have shown that AR-based learning media is effective in improving students' conceptual understanding (Zulfa et al., 2023; Nugraha et al., 2021). Previous research also shows that AR-based learning media is included in the very good category and is suitable for use in learning (Sudarmayana et al., 2021; Fakhruddin & Kuswidyanarko, 2020; Mukti, 2019; Aripin & Suryaningsih, 2019). Previous research also revealed that AR-based learning media can make learning more interactive (Pratiwi & Riyanto, 2022; Nugraha et al., 2021).

The novelty of this research is that this research was conducted at the Elementary School level with science content that focuses on theme 8, namely the water cycle and emphasizes increasing students' understanding of the water cycle material. This research uses books as its media which contain 2D images and the book contains a QR Code that can display 3D images. This research also uses a QR Code which will later display images and explanations of the material presented. In this media, students can see how the water cycle process occurs and students can also see directly through 3D images that visually simulate the water cycle. In addition, students can also listen to explanations one by one of the water cycle processes. Therefore, students' understanding of the concept of the water cycle will increase more than before. This Augmented Reality media can be used as one of the learning media that can combine the real and virtual worlds where the learning process will certainly be more practical and easier to understand for students in elementary school. Knowing that conventional media is less effective, the urgency of this research is to improve students' understanding of the water cycle by utilizing more innovative learning media. This research aims to Developing interactive learning media based on Augmented Reality to improve students' understanding of the concept of the water cycle in science material for grade V of elementary school. In this media, students can see how the water cycle process occurs and students can also see directly through 3D images that visually simulate the occurrence of the water cycle. This learning media innovation is expected to help teachers in facilitating the learning process in elementary schools, as well as improving students' understanding of the water cycle as expected.

## 2. METHOD

This research is a research on the development of interactive media based on Augmented Reality with the ADDIE development model. The ADDIE model stands for Analysis, Design, Development, Implementation, and Evaluation. This research was conducted in one of the elementary schools in Seririt District, Buleleng Regency, precisely in SD Negeri 2 Pucaksari. This location was chosen because the diversity of learning media is still limited, resulting in students' understanding of the water cycle material remaining low. In addition, students in this school often feel bored during the learning process, caused by the use of less interesting media, especially in Grade V of Elementary School. This research was conducted over a period of 3 months.

This research procedure refers to the ADDIE model, namely: (1) analysis stage, (2) planning stage (design), (3) development stage (development), (4) implementation stage (implementation) and (5) evaluation stage (evaluation). The subject of this development research is interactive media based on Augmented Reality. Meanwhile, the object of this research is the validity, practicality, and effectiveness of interactive media based on Augmented Reality which is aimed at 15 students in Grade V of elementary school. There are two types of data in this study, namely qualitative data and quantitative data. Qualitative data is obtained from the results of the questionnaire used in the validation of media experts and material experts in the form of input that will be used as reference material for revision. Furthermore, quantitative data is obtained from the results of expert and practitioner validation.

This study uses a data collection method in the form of a questionnaire to measure the feasibility, practicality, and effectiveness of interactive learning media based on Augmented Reality in improving students' understanding of the concept of the water cycle in elementary schools. This development research uses a questionnaire as a research method. This development research uses a rating scale instrument with a scale of 1-5. Validity test requirements must be met so that the instrument created is suitable for use. The grid of the Augmented Reality media validation sheet instrument to be tested by media experts, material experts, practitioner responses, and student responses can be presented in Table 1, Table 2, Table 3, and Table 4.

**Table 1. The Media Expert Review Instrument Grid**

No	Aspect	Indicator	Item Number	Number of Items
1	Text	Conformity of text type and size.	1	1
		Clarity of text at each stage of the water cycle material.	2	1
		Text color matching with 3D Augmented Reality media colors.	3	1
2	Picture	Clarity of 3D images in Augmented Reality media.	4	1
		The attractiveness of the image.	5	1
		The accuracy of the images supports the explanation of the material.	6	1
		Suitability of Augmented Reality media image placement.	7	1
		The suitability of 2D images in books with 3D Augmented Reality media.	8	1
		Clarity of the QR Code in the book that will bring up 3D Augmented Reality media.	9	1
3	Book	2D image quality in 3D Augmented Reality media books.	10	1
		Clarity of 2D images in 3D Augmented Reality media books.	11	1
		Compliance of 2D images with materials learning.	12	1
		Ease of opening 3D Augmented Reality media through 2D books.	13	1
4	Instructions for use	The appeal of the 2D book used.	14	1
		The conformity of the instructions for use with the method of using Augmented Reality 3D is easy to understand.	15	1
5	Layout	Harmony of text layout in 2D and 3D images.	16	1
		Image proportion conformity with text in the book and 3D Augmented Reality.	17	1
		Appearance compatibility images at each stage of the water cycle.	18	1
6	Media Operations	Ease of use of interactive media based on Augmented Reality.	19	1
		Interactive media based on Augmented Reality can be used repeatedly.	20	1
<b>Amount</b>				<b>20</b>

**Table 2. The Grid of Material Expert Review Instrument**

No.	Aspect	Indicator	Number of Items	No. Question
1.	Relevance (Suitability)	Suitability of the material presented in the learning media.	1	1
		Suitability of the learning material concept with the media used.	1	2
		The suitability of each part of the media to the material presented.	4	4,5,6,7
		Suitability of the learning material concept with the media used.	1	3
		The accuracy of the time allocation given with the weight of the learning material.	1	8
2.	Consistency (Constancy)	Consistency of material with the subject matter.	1	9
		Consistency between the main topic and the sub-topics.	1	10
3.	Sufficiency (Sufficiency)	The learning materials are arranged systematically.	1	11
		Clarity of discussion of each material.	1	13
		Suitability of learning materials to student characteristics.	2	12,14
		The overall content of the learning media can motivate students to improve their understanding of the concept of the water cycle.	1	15
<b>Number of Questions</b>				<b>15</b>

**Table 3. The Grid of Student Response Practicality Instruments**

No.	Aspect	Indicator	Number of Items	Item No.
1.	Instructional Media	Ease of Use Attraction Accuracy of Learning Media	4	1,2,3,4

No.	Aspect	Indicator	Number of Items	Item No.
2.	Material	Accuracy of Content Language Discussion Text	9	5,6,7,8,9,10,11,12, 13
3.	Benefit	Interest Motivation to learn	3	14,15,16
<b>Number of Questions</b>				<b>16</b>

Source : [Rahayu et al., \(2022\)](#) with modification

**Table 4.** The Question Instrument Grid

No	Science Concept Understanding Ability Indicators	Type of Questions	Amount Item	Question Indicator	Cognitive Domain	Item Number
1.	Interpreting	Objective	2	Interpreting the benefits of the water cycle.	C2	1.3
			1	Determine the elements that play a role in the water cycle.	C2	2
			2	Determine the process of the water cycle stages.	C2	5.10
			2	Interpreting water sources and conserving water in the water cycle.	C2	4,7,9
			2	Determine the names that occur in the water cycle.	C2	6.8
<b>Amount</b>						<b>10</b>

This study used 4 instruments, namely: (1) media validity test instrument by material experts, (2) media validity test instrument by learning media experts, (3) media practicality test instrument by students, and (4) effectiveness test in the form of observation sheets that will be used before and after using the developed media. In this study, qualitative data analysis was carried out using descriptive techniques. After obtaining the validity value for interactive learning media based on Augmented Reality, the next step was to carry out an effectiveness test. The implementation of this effectiveness test in this study was carried out using the correlated t-test method which was analyzed through the SPSS application.

### 3. RESULT AND DISCUSSION

#### Result

Descriptive analysis of the effectiveness test data in this study was conducted with the help of IBM SPSS 22 for Windows software. The results of the descriptive data analysis can be presented in [Table 5](#).

**Table 5.** The Descriptive analysis of effectiveness test data

No	Statistics	Pretest	Posttest
1	Mean	50.67	82.67
2	Median	50	80
3	Variance	106.67	78.09
4	Standard Deviation	10.33	8.84
5	Minimum Value	30	70
6	Maximum Value	70	100

The prerequisite tests conducted in this study include the normality test of data distribution and the homogeneity test of variance. The prerequisite test of this analysis was conducted with the help of IBM SPSS 22 for Windows software. The complete analysis results can be presented in [Table 6](#). Based on the results of the normality test analysis with the help of IBM SPSS 22 for Windows software, it can be seen that the significance value in the Shapiro Wilk column of the pretest data is 0.293 and the posttest data is 0.063. Based on these results, it can be seen that the Sig. value is > 0.05 for all data groups. Thus, it can be concluded that both data groups are normally distributed. The results of the homogeneity test can be presented in [Table 7](#).

**Table 6. The Normality Test Results**

		Tests of Normality					
Group		Kolmogorov-Smirnova			Shapiro Wilk		
		Statistics	df	Sig.	Statistics	df	Sig.
Student	Pre Test	0.208	15	0.081	0.932	15	0.293
Understanding	Post Test	0.219	15	0.052	0.888	15	0.063

**Table 7. The Homogeneity Test Results**

		Test of Homogeneity of Variance					
		Levene Statistics			df1	df2	Sig.
Student	Based on Mean	0.028	1	28	0.869		
Understanding	Based on Median	0.076	1	28	0.785		
	Based on Median and with adjusted df	0.076	1	27.532	0.785		
	Based on trimmed mean	0.041	1	28	0.841		

Based on the results of the homogeneity test of the variance of the effectiveness data analyzed using the assistance of IBM SPSS 22 for Windows, a significance value of 0.869 was obtained in the Based on Mean column. Based on these results, it can be seen that the Sig. value > 0.05. It can be concluded that the variance of the data is homogeneous. Because both prerequisite tests for data analysis are met, further testing can be carried out. Hypothesis testing in this study was carried out using the Paired Sample T-Test or Correlated Sample T-Test. Hypothesis testing was carried out with the assistance of IBM SPSS 22 for Windows software. The results of the hypothesis test can be presented in [Table 8](#).

**Table 8. The Hypothesis Test Results**

		Paired Samples Test								
		Paired Differences						t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		Lower	Upper			
				Lower	Upper					
Pair 1	Pre Test - Post Test	-32.00000	14.73577	3.80476	-40.16040	-23.83960	-8.411	14	0.000	

Based on the results of the Paired Sample t-test analysis of correlated samples, the significance value obtained in the Sig. (2-tailed) colog is 0.000. Based on these results, it can be seen that the Sig. value <0.05. Therefore, it can be concluded that H<sub>0</sub> is rejected and H<sub>1</sub> is accepted. In other words, there is a significant difference in students' understanding of the concept of the water cycle before and after being taught using interactive learning media based on augmented reality. Thus, the use of this media is effective in improving students' understanding of the concept of the water cycle.

**Discussion**

The results of this development research show that 1) interactive learning media based on augmented reality in the science content of grade V Elementary School obtained a validity index from material experts of 4.4 with a very valid predicate and media experts of 4.3 with a very valid predicate; 2) obtained an assessment from the student's practicality test through a student response value of 4.5 which was stated as very practical; and 3) obtained a significance result (2-tailed) of 0.000. Based on these results, it can be seen that the Sig. value <0.05. Therefore, it can be concluded that H<sub>0</sub> is rejected and H<sub>1</sub> is accepted. In other words, there is a significant difference in students' understanding of the concept of the water cycle before and after being taught using interactive learning media based on augmented reality.

Interactive learning media based on augmented reality This applies the ADDIE model. The creation of this media utilizes several software as 3D media that is created and hardware in the form of a book containing a barcode scan to access media from the software. The software used is Assembler Studio to create 3D media in interactive learning media, Canva is used to create covers, and is also used to create book contents that will be printed. This interactive learning media based on augmented reality has an influence on student understanding. This is in line with previous research which states that AR-based learning media can make students understand learning materials better ([Indriani & Abidin, 2022](#); [Aripin & Suryaningsih, 2019](#); [Prayoga, 2018](#); [Wahyudi et al., 2017](#)).

Student understanding is a determining factor in the effectiveness of the media applied in the learning process. To determine the increase in students' understanding of the concept of the water cycle, the results of the student pre-test are used as a reference for comparison in finding the effectiveness of the media. The results of the pre-test on increasing the understanding of grade V students of SD Negeri 2 Pucaksari are still relatively low. After being given learning treatment by implementing interactive learning media based on augmented reality, there was an increase in student understanding as measured by giving a post-test.

The results of this study indicate that AR-based interactive media effectively improves students' understanding of the concept of the water cycle before and after learning. Thus, the use of interactive learning media based on augmented reality is effective in improving students' understanding. The results of this study are in line with previous studies which state that, AR-based learning media is effectively used to improve students' conceptual understanding (Zulfa et al., 2023; Nugraha et al., 2021).

Based on the research results, interactive learning media based on augmented reality has several advantages and disadvantages. The advantages of this media lie in its concrete form and accessibility through barcode scanning. This allows students to see an interesting and easy-to-understand 3D display, thus increasing their interest and attention. This media can be used in class together. This media is also made in the form of a book, so that the small and easy-to-store media size adds to the advantages of the media with a storage space that does not take up much space. This interactive media based on augmented reality also has a disadvantage, namely that the material can only be accessed with electronic assistance in the form of a cellphone and internet that supports it.

This interactive learning media innovation based on augmented reality can improve students' understanding of the water cycle concept material. This AR media can be used for various student learning styles. In the future, teachers are expected to be able to design learning devices that are in accordance with this interactive media based on augmented reality. Teachers can also apply creative learning media, especially in science learning for grade V elementary schools, as well as develop visual or concrete learning media independently or in groups. In addition, schools need to provide facilities and infrastructure that support the use of augmented reality-based learning technology so that it can be utilized optimally. Some of these things are expected to minimize various problems in the learning process.

This research has implications for the creation of interactive learning media based on augmented reality to improve students' understanding of the water cycle concept. The limitations of this study are the scope of the material, levels, and subjects developed in the media. The material developed in interactive learning media based on augmented reality is the concept of the water cycle, science subjects for fifth grade elementary school students. This media was developed according to the characteristics of students at SD Negeri 2 Pucaksari, so this media is only dedicated to fifth grade students at SD Negeri 2 Pucaksari. The number of subjects involved in the application of this media is 1 class consisting of 15 students. Therefore, further research can expand the scope of the material, levels, and subjects. Further research can also involve a larger number of subjects in order to obtain more optimal research results.

#### 4. CONCLUSION

Based on the results and discussion, it can be concluded that innovation Interactive learning media based on Augmented Reality to improve students' understanding of the concept of the water cycle in science material for grade V of elementary school is declared valid, practical, and effective in improving students' understanding of the concept of the water cycle, so it is suitable for continuous use in learning activities.

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