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DEVELOPMENT OF AUGMENTED REALITY LEARNING MEDIA IN GEOGRAPHY LEARNING WATER CYCLE MATERIAL AT SMA NEGERI 4 BANDA ACEH

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ABSTRACT

This study aims to develop augmented reality learning media on geography learning of water cycle material at SMAN 4 Banda Aceh. This research uses a 4D (four-D) research design, including defining, designing, developing, and disseminating. The sampling technique used was simple random sampling. The subjects of this study were two media and material experts and 28 students of class X7 SMAN 4 Banda Aceh. The research objective is the feasibility of media and materials and student responses and understanding. Data collection instruments used media and material feasibility test sheets, student response questionnaires, and test sheets. Analysis of feasibility data and student responses using the percentage formula while analysing data on student understanding of the material using the value-gain. Analysis of media feasibility test obtained 89% with very feasible criteria. The feasibility of the material was obtained at 98%, according to very feasible criteria. Student response to the media obtained 97.3% with very good criteria. Student understanding increases after using augmented reality learning media on water cycle material. Based on the results of media and material feasibility tests, responses and understanding of students, it can be concluded that augmented reality learning media in learning geography of water cycle material is very feasible to use as one of the learning media for students at SMAN 4 Banda Aceh.

Keywords: *Development, Learning Media, Augmented Reality*

INTRODUCTION

Technological developments have impacted progress in all areas of life, including politics, economics, culture, art, and even education. Nowadays, technological progress is impossible to prevent because it always coexists with scientific progress.

The ability of teachers to integrate technology in learning, adjusted to the learning materials discussed by teachers

with students in class, and learning methods that adapt to the different characteristics of students is an essential skill for teachers to master. Teachers are a critical component in the success of education (Damanik Rabukit, 2019).

Meanwhile, according to Banowati (2017), a teacher is anyone who has the power and carries out teaching duties to students. Teachers must be able to design intelligent and innovative learning. The TpaCK-based learning system provides this ability. Explains that TPaCK is a framework in a specific learning and teaching context that combines technological knowledge with content and pedagogical expertise.

Geography teachers often find fostering students' enthusiasm and interest in learning materials challenging in schools. This happens because teachers only use the lecture method, using textbooks in learning. It is also not uncommon for teachers to have difficulties applying technology in learning.

So, a geography teacher must apply creativity and innovation in the classroom. Creating interesting media is something that can be done. Students will find it easier to understand the material if the learning media are interesting and clear.

In addition, several other things can be applied, such as preparing the right resources, choosing appropriate strategies in class, utilising various learning models, and utilising adequate facilities to create an engaging classroom atmosphere.

Learning media generally aims to help teachers communicate ideas or lesson content to students so that the content is more approachable, interesting and enjoyable for them (Lestari 2013). According to Habibiyah et al (2023), in their research, they said that an alternative that can overcome learning problems is learning media that combines visual features.

The purpose of using learning media in the classroom is also to give students access to fundamental concepts. Learning media such as augmented reality will allow students to see what they are learning in real time.

Good educational media can increase active involvement, avoid boredom, and improve students' psychological development. Using relevant learning resources, students can now see the

objects they are studying in real terms, material that was previously abstract.

In addition, several other things can be applied to create a pleasant learning atmosphere, such as preparing appropriate learning resources, choosing appropriate strategies in class, utilizing various learning models, and utilizing adequate facilities to create an engaging learning atmosphere.

SMA Negeri 4 Banda Aceh is one of the leading schools, has adequate facilities, and is in Aceh City. Based on the results of initial observations, learning activities at SMA Negeri 4 Banda Aceh are carried out face-to-face, using lecture methods and independent curriculum textbooks. The main reason for the lack of use of interactive learning media by geography teachers at SMA Negeri 4 Banda Aceh is the limited expertise of teachers in designing new learning media. Then, based on the results of a preliminary study in the student book for grade X IPS in the even semester, chapter 6 of the Independent curriculum, there is hydrosphere material with a sub-chapter on the water cycle. The study of the hydrosphere layer covers all aspects of water and the phenomena that occur in it. Based on the interview results, geography subject teachers have not used learning media when teaching water cycle material. However, teachers only use books and present materials in the form of reading texts and pictures. As a result, students will be less involved and more passive in class because textbooks often display still images and are also less real for students. Geography learning in schools is expected to be a bridge for students to understand the phenomena that occur in everyday life.

The solution to the problem above is that researchers want to develop augmented reality (AR) media. The development of AR media can later be used as interactive media to assist teaching and learning activities. Augmented reality (AR) is a current technique representing the natural world in virtual form with contextual information assisted by computer technology (Chen & Liu, 2020). Furthermore, according to Ismail et al. (2021), AR is an effort to combine the real world with the virtual world created through computers so that the boundaries between the two become very thin. Because of its potential to enhance learning and teaching, AR has attracted attention in education (Annetta & Shapiro, 2019).

Augmented reality (AR) combines the real world with the virtual world in two-dimensional or three-dimensional form and is simultaneously projected in a real environment (Mustaqim & Kurniawan, 2017).

Furthermore, according to Ananda (2015). AR can help people understand and interact with the real environment. The displayed items' information helps users perform actions in the real world.

The research results on AR learning media conducted by Prasetyo (2022) show that the water cycle science material of AR learning media for grade V SD is classified as very practical according to the validity results based on data analysis conducted.

In other research conducted by Muzakki et al. (2023), the study's results showed success both in the application of the application system and its application to the learning process. The teacher's reaction test score was 90.58, with a very good category.

Meanwhile, the post-test results of students' understanding, 86.41, are included in the good category. Other research conducted by Atut & Patonah (2023) shows that class V water cycle material AR-based flipbook media SDN Bugangan 01 is rated “Very Good." Thus, AR-based flipbook media for grade V water cycle material SDN Bugangan 01 meets the requirements for use by educators in the classroom.

What makes this study different from previous studies is the location of the study and the discussion contained following the geography material in class X, and adjusting to the problems that occur in the Aceh community, such as adding animations of the hydrological cycle that occurs in land planted with oil palms, in land with lots of vegetation and critical land without vegetation. In the end, the author added a quiz. Given that the school studied has the potential to develop augmented reality media.

The availability of infrastructure and facilities supports the development of AR media, such as Wi-Fi networks, and students can also bring cellphones to school. So far, educators have not implemented AR interactive learning media, allowing researchers to develop the media.

Based on the problems that have been stated above, the researcher is interested in conducting a study entitled Development Of Augmented Reality Learning Media On Geography Learning

Materials On The Water Cycle At State Senior High School 4 Banda Aceh, with the hope that the AR media used in the learning process can help students visualize abstract concepts on the water cycle material so that it can improve students' understanding after using the AR media that has been developed.

MATERIALS AND METHODS

Research and development (R&D) is the focus of this research. An AR product on water cycle material is the result of this research. The 4D development model (four-D model), which was first described by Thiagarajan in 1974 and has four stages, namely define, design, develop, and dissemination, is a teaching media development design methodology used in this study.

Convenience is one of the factors for choosing this model, and it is also considered appropriate for creating AR educational resources about the water cycle. **Table 1** below shows the flow of the 4D model:

Table 1. Details of Product Development Stages

No	Step	Collecting Technique Data	Data Type
1	Define	Initial Analysis	Qualitative
		Student Analysis	Qualitative
		Concept/Material Analysis	Qualitative
		Learning Objectives Analysis	Qualitative
2	Design	Material Design	Qualitative
		Validation Instrument	Qualitative
		Media Design	Qualitative
3	Develop	Product Development	Qualitative
		Initial Eligibility Test	Quantitative
		Final Eligibility Test	Quantitative
4	Dessimination	Pre-Test and Post-test	Quantitative

The 4D development stages are described as follows:

1. Define

   In this phase, researchers investigate problems, deficiencies, or circumstances that are the primary source of product development activities. Determine the teaching media to be developed, namely AR on water cycle material. Initial analysis, student analysis, concept/material analysis, and analysis of learning objectives are all included in this defined stage. The following steps must be followed:

   a. Initial analysis

      Finding the problem is the first step in the analysis process,

which outlines specifically the main problem that is the reason for media development.

b. Learner analysis

This analysis examines the problems that learners who use this information to guide future product development face.

c. Concept/material analysis

The material analysis process first determines the material that will be contained in a product, then collects the material from various online and print sources.

d. Learning objectives analysis

This analysis is conducted to ascertain the learning achievement goals, limit the development, and tell the researcher what needs will be met in the final product. He also acts as a guide to keep the research on track and not deviate from the original purpose of making the product.

2. *Design*

The design stage includes the development of AR teaching media on the water cycle. Media creation, instrument preparation, and material structure design are part of the design step.

3. *Develop*

The expert assessment step is known as the development stage. The development stage's purpose is to create teaching media and the revision process from experts. Product development, material and media expert validation, and product improvement are all included in this stage.

4. Dessimination

This is the last stage of product development, where the findings of the completed development study are shared. This stage aims to evaluate how well the product being developed works.

At this stage, teaching media in augmented reality on water cycle material is distributed to students. Questionnaires are also distributed after the product distribution process to get a response to the products made.

The location of this research is SMA Negeri 4 Banda Aceh, which is located on Jalan T. Panglima Nyak Makam No. 19, Kota Baru, Kuta Alam District, Banda Aceh City. At the same time, the subjects of this research are media experts and material experts who are

lecturers and teachers in geography education, as well as students of class X7 SMA Negeri 4 Banda Aceh.

The sample collection technique in this study is simple random sampling. According to (Golzar & Noor, 2022), "Simple random sampling has a homogeneous population where research members are randomly selected to participate in the research". A simple random sampling technique is an easy technique.

The implementation of random sampling is because the members of this research population are considered homogeneous. After all, the sample taken is class X students of SMA Negeri 4 Banda Aceh. This sampling method is done by writing the names of class X, consisting of eight classes, on a piece of paper, then putting them into a glass to be taken randomly.

Furthermore, the researcher used several data collection techniques to obtain data for this study, including interviews, validation sheets, questionnaires, and tests. The research data were processed using descriptive statistical analysis. The data analysed in this study were the results of expert team validation, student responses and student test results on augmented reality learning media on the water cycle material.

An examined expert feasibility test sheet using a Likert scale with four categories and a 1-4 scale, with the lowest score of 1 and the highest score of 4, was the data collection method used in this study. In addition, a questionnaire was also used to collect the final results with five categories of student responses using a Likert scale with a score range of 1 to 5, where 1 represents the lowest score and 5 represents the highest score.

The results of the data are then used to see the feasibility level of AR learning media on water cycle material that has been developed. The resulting data is quantitative. The data is then converted into qualitative data in the form of intervals using the formula. Other data is also obtained from the students' pre-test and post-test answer sheets.

To determine students' level of understanding, the normalised average gain score (N-gain) data is calculated using the formula. Data analysis of the results of the expert team's validation sheet uses the following scoring provisions: Score 1 with category not suitable for use, score 2 with category worth using with significant revisions,

score 3 with category worth using with minor revisions, score 4 with category suitable for use without revisions. Meanwhile, the analysis of student response questionnaire data uses the following scoring provisions: Score 1 with category very bad, score 2 with category not good, score 3 with category pretty good, score 4 with category good, score 5 with category very good.

Next, to calculate the percentage of eligibility, the validator team uses the following formula:

$$P = \frac{F}{N}\ x\ 100 \qquad (1)$$

Information:

P = Percentage
F = Total score from validators
N = Maximum score
100 = Constants

Meanwhile, the assessment criteria used for the learning media developed are: score 0-20 % with category unworthy, score 21 % - 40 % with category not worthy, score 41 % - 60 % with category quite decent, 61 %- 80 % with category worthy, score 80 % - 100 % with category very worthy.

Furthermore, for the analysis of data on the level of student understanding, the calculation of the normalised average gain score (N-gain) data developed by Hake (1999) was used with the following formula:

$$\langle g \rangle = \frac{Spost - Spre}{Sm\text{-}ideal - Spre} \qquad (2)$$

Information:

‹g› = Gain Average Score
Spost = Average score of students' final test
Spre = Average score of students' initial test
Sm-ideal = Ideal maximum score

Then, after the average N-Gain value is obtained, learning outcomes are categorised based on the following criteria: Mark ‹g› ≥ 0,7 with criteria Tall, 0,3 ≤ ‹g› < 0,7 with criteria Medium, ‹g› < 0,3 with criteria Low.

RESULTS AND DISCUSSION

According to Ismayani (2020), augmented reality (AR) is a technology that combines computer-generated, two-dimensional or three-dimensional objects into the real environment around the user in real time.

Media developed based on AR on water cycle material will help teachers create more active learning. The learning media

is everything used in the classroom to stimulate students' thoughts, feelings, interests, and attention (Muhayat et al., 2017). This is so that the educational communication interaction process between teachers and students can take place well and successfully.

This AR learning media can display explanations, images, and barcodes with animations that can be viewed in AR on a laptop or smartphone. Mahartika, et al (2023), in their book AR-based learning media, explain that "utilising AR in the classroom will open the door to a generation of students who are engaged, motivated, and ready to face future educational and professional challenges". So it can be said that AR learning media is affordable, and very useful for teachers and students in their educational efforts.

After being validated by media and subject matter experts, the learning media have undergone additional revisions and testing on the development product at school. The development model in this research is the 4D model (define, design, development, and dissimilation) with the following stages of activity:

a. Define

The first step before starting development is called the define stage. Here are the stages:

1. Initial analysis

   The initial analysis was carried out using the observation method, namely observing the learning process in the classroom. This analysis found that learning at SMA Negeri 4 Banda Aceh was carried out face-to-face, as in general. During the learning process, the teacher leads the learning in the classroom; the researcher observes the teacher's teaching strategy and student involvement during the class. As usual, the learning activity begins with a greeting, followed by the teacher checking attendance.

   Next, the teacher discusses a little material from the last meeting to determine the extent of students' memory, then continues with an appraisal of the material to be learned. The teacher divides the students into several groups, each presenting their work to the other students. After all groups had finished, the teacher explained the material and answered some

students' questions. Here, the teacher uses textbooks in learning.

At this stage, the researcher also interviewed geography teachers at SMAN 4 Banda Aceh and obtained results that teachers had never used AR learning media; teachers only used printed media such as pictures and PowerPoint. This is because teachers have not been able to develop other interactive learning media. The use of textbooks can cause students to misunderstand when learning independently. This happens because the discussion in the textbook is still too difficult to understand (Afifah N & Isnawati, 2023).

AR-based learning media was chosen to help students learn independently at home and can enable students to access the learning resources provided whenever they want. The display of 3D objects in AR learning media is also able to display processes in the water cycle realistically.

As explained by Aprilia (2023) in her research, the advantage of AR learning media is that it can display 3D objects and their animations that seem to exist in a real environment.

2. Learner analysis

   By observing the ongoing learning process and by interviewing students. The indicators used in this analysis are understanding and learning motivation (Habibiyah et al., 2023). Not all students were active during the learning process because only certain students dominated the group division method.

   AR-based learning media was developed based on the initial and student analysis. Media that contains important concepts from a learning material can make it easier for students to master, understand and remember the material being studied. This is based on research by Mahartika (2023), which explains that AR can help students understand concepts better.

3. Concept/material analysis

   This material analysis is carried out to be a reference in determining learning indicators

and objectives. This analysis is carried out based on learning outcomes. The process of identifying content to be included in the media is known as material analysis.

Based on the analysis of the water cycle material in the package book used in the learning process, the water cycle material is discussed in general. However, the infiltration stage is not explicitly discussed by analysing the water cycle material used in the learning process. Material analysis aims to ascertain the content of the lessons that need to be created.

The media materials to be created are rich in explanation and contain three-dimensional items that add to the attractiveness of the media. Feedback was also given on the materials produced by the media. The questions in the worksheets can help remember the material they have learned.

4. Analyse learning objectives

   To provide information to researchers about the studies that will be presented in the media and to limit the scope of media development, this analysis was conducted to identify learning achievement indicators based on material analysis. Learning objectives are specified by developing learning objectives based on learning achievements and learning objective flows in the independent curriculum, which are then described into indicators and learning objectives.

   At this stage, the final objectives of the learning media developed are formulated as follows: (1) explaining the water cycle and the processes that occur in it, (2) explaining the infiltration process and its types.

b. Design

   The design stage is the process of designing validation instruments and product development. In his research, Mampouw et al. (2022) stated that this stage aims to find solutions to the problems to be developed.

   Design is done after analysing the material and learning objectives. The material is a fundamental component of learning media, and data is collected. The next step is to design the product to be developed.

Product design is done by designing objects on the media, namely the stages of the water cycle and infiltration. The initial design is done in the Canva application to determine what elements will be contained in the object. The validation instrument was designed by looking at several previous research references, which the author then modified by adjusting the media to be developed.

c. Development

The process of creating a product occurs throughout the development phase. Product development, media and material expert feasibility testing, and product refinement are all included in this phase. Based on the objectives of this study, the goal is to develop AR learning media in geography learning of water cycle material.

AR is an application that combines the real world with the virtual world in two-dimensional or three-dimensional form, which is projected in a real environment at the same time (Mustaqim & Kurniawan, 2017).

The media produced is categorised as technology-based learning media. Technology is an effective and efficient tool that can be used to develop learning media (Wijaya et al., 2020). The following are the results of making augmented reality learning media about the water cycle for geography learning at SMA Negeri 4 Banda Aceh.

1. Development results

a) Cover and menu display.

The initial part consists of a cover and menu display, where the menu consists of several sections, including the pre-test, material, student profile, supervisor profile, post-test, and exit menu.

b) Material section

This section is the core part, which includes the entire study of the water cycle material. The material selection is determined through the define stage, namely, the material in the media based on learning achievement indicators.

In addition to achieving learning objectives. This is also an effort to limit the reach of the media creation process. Attractive images and an

appropriate and understated colour scheme are included in this core/content section. The goal is to grab the attention of students.

c) Literature

This section contains a bibliography or literature review used to quote material on the media. According to (Ridwan et al., 2021), the literature review is a summary from a reading source related to the research topic.

d) Student profile section

This section contains a brief profile of students who conduct development and research on augmented reality learning media in learning geography of water cycle material.

e) Supervisor section

This section contains a brief profile of the supervisors I and II who have helped the author complete this development and research.

f) Pre-test and post-test section

The following is a look at the pre-test and post-test menus. The display is made the same, but there is an explanation in the filling to distinguish the pre-test and post-test that is done. Then, before the test, there is also an instruction menu that will help students take the test. The questions section is included so that teachers can assess students' success in receiving the information conveyed (Abdiah & Hanim, 2023).

Furthermore, a feasibility test is carried out on the developed media to determine whether or not the product is suitable for use (Fatimah et al., 2020). Validation is carried out with the help of material and media experts. Validity tests are carried out to obtain data used to revise the learning media that have been produced (Rachmawati et al., 2024). The following are the results of the validation of media experts and material experts: Media expert I total score 57, average score 3.8, percentage 95 % with criteria very feasible. Media expert II total score 50, average score 3.3,

percentage 83, with feasible criteria.

Validation from both media experts was carried out based on five aspects: aspects of usability, aspects of text quality, aspects of colour quality, aspects of design quality, and aspects of the effect on learning.

The percentage of results from validator I (media expert) is 95%, which is based on very feasible criteria. The percentage of validator II (media expert) obtained was as much as 83%, according to very feasible criteria. So that the results of validation on AR learning media in learning geography of water cycle material by both media expert validators obtained an overall percentage score of 89% with very feasible criteria.

The results of this study follow research conducted with the title "Feasibility of AR Learning Media on Science Material Water Cycle Class V Elementary School," and the results of its validity qualify as very feasible.

Based on the complete media development process that has been completed, the results show that 100% of material experts meet the validation criteria very suitably, 86% of media experts meet the same criteria, and 80% of linguists meet the appropriate criteria. Validation from both material experts consists of 4 aspects, namely aspects of content feasibility, aspects of presentation feasibility, aspects of language feasibility, and aspects of contextual feasibility.

The percentage results from validator I (material expert) are 100% with very feasible criteria. The percentage of validator II (material expert) obtained as much as 97% with very feasible criteria, so that the results of validation on AR learning media in learning geography of water cycle material by both validators of material experts obtained an overall percentage score of

98% with very feasible criteria.

The results of this study are based on research conducted by Atut & Patonah (2023) with the title "Development of AR-Based Flipbook Media on Class V Water Cycle Material at SDN Bugangan 01," showing that AR-based flipbook media can be used to improve learning about the fifth-grade water cycle.

The findings of this study are in line with their findings. SDN Bugangan 01 is included in the "Very Good" classification. Therefore, the creation of AR-based flipbook materials for the water cycle for grade V SDN Bagungan 01 is eligible for use in teaching capacity by educators. In the development and feasibility testing process, advantages and disadvantages were found in the media, and then further improvements were made. The water cycle and infiltration process in the AR media that has been developed can explain the water cycle material with an attractive appearance and allows students to learn independently at home.

This is following the opinion of Gagne and Briggs (Efendi et al., 2023), who stated that media in the learning process is a tool used to convey the content of learning materials that can trigger students' interest in participating in the learning process. With these two results, augmented AR media in learning geography of water cycle material is categorised as very feasible to be tested on class X7 SMA Negeri 4 Banda Aceh students.

d. Dessimination

Dissemination is the final phase of the 4D development model after testing to ensure that the teaching media is suitable for use in the classroom. According to (Rahman et al., 2023), this stage is carried out to implement the system created in the development stage.

The dissemination stage includes providing students access to AR learning media about the water cycle.

In the dissemination stage, students learn to use the learning media that have been developed. During the learning process, students are also given pre-test and post-test questions already in the media.

The results of students' responses to augmented reality learning media on water cycle material are presented in the form of graphs that can be seen in **Figure 2** as follows:

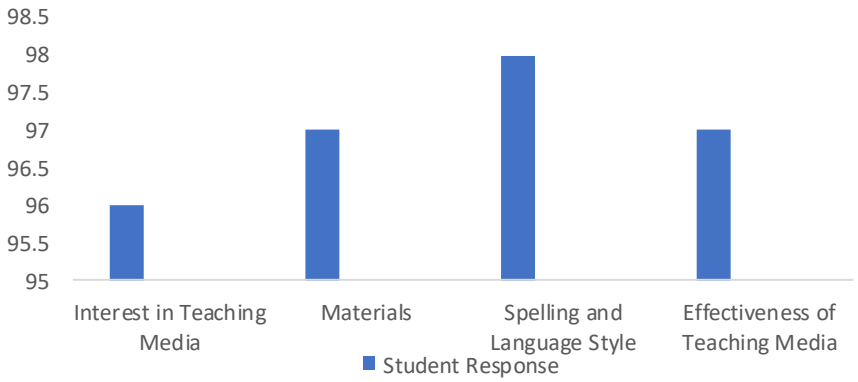

Figure 2. Graph of Learner Response Results

The student response questionnaire aims to determine whether the technology is fun, effective, and so on (Rahman et al., 2023). Learner responses were based on four aspects: teaching media interest, material aspects, spelling and language style aspects, and teaching media effectiveness.

All aspects obtained very feasible criteria. During the learning process, the researcher also indirectly conducted observations, which found that students paid good attention to explaining the media and materials. This can be seen from several students who actively ask questions. In addition, during the learning process, no students experienced any obstacles in using the media.

This is following the criteria for selecting learning media according to Jalinus (2016), including: (1) learning objectives; (2) suitability to the material; (3) student characteristics; (4) student learning styles; (5) environment; and (6) availability of supporting facilities.

Furthermore, during the trial of the AR learning media, students were also given pre-test and post-test sheets, which aimed to measure students' understanding of the water cycle

material. According to (Magdalena et al., 2021), the pre-test determines the extent to which students have understood the content or material to be taught.

While the post-test determines the depth of students' understanding of the material taught, the tests given to students are relevant to the material taught. This study's pre-test and post-test sheets consisted of 10 multiple-choice questions covering the water cycle and infiltration material. Furthermore, the results of the pre-test and post-test from the students are shown in **Figure 3**:

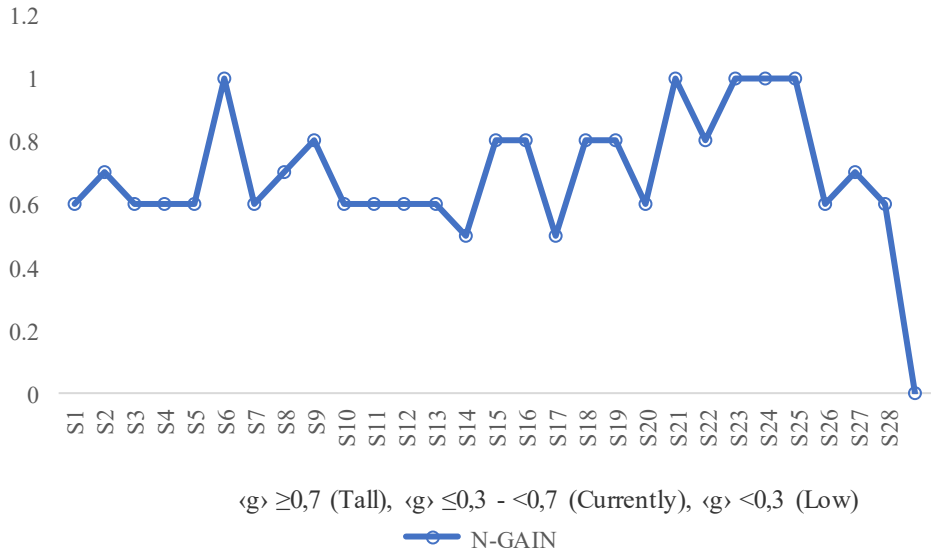

Figure 3. Value-Gain Criteria

Based on **Figure 3** above, 14 students get moderate gain values ranging from 0.5 to 0.6, and 14 get high gain values ranging from 0.7 to 1. In other words, 50% of students get a medium gain value and 50% get a high gain value (**Figure 4**).

The factor that causes there to be still students who get moderate gain scores is the learning conditions, where, during the learning process, there are several students who are late to class, so they are left behind in understanding the material.

This follows what (Closs et al., 2022) said: the learning environment is closely related and impacts students' learning experiences. Then, looking at the students' responses to the media, it can be concluded that the condition of the media is not a factor in students getting moderate gain scores because, during the learning process, there are no obstacles

for students in using the media that has been developed.

Based on this, it can be concluded that the pre-test and post-test results show that class X7 students of SMA Negeri 4 Banda Aceh experienced an increase in understanding after learning AR learning media on the water cycle material. The results obtained in this study contradict the research of (Azis et al., 2023) on the subject of hydrosphere dynamics. The level of students' conceptual understanding in general is also low.

In hydrosphere learning material, many students do not understand the concept. According to (Desfandi et al., 2020), students' lack of understanding of material related to the dynamics of the hydrosphere is caused by several factors, one of which is that students experience misconceptions about a concept taught by the teacher when learning in class.

Students are said to understand the subject matter well when they can construct the meaning of the learning message and then convey it using their own words and sentences (Gadeng et al., 2019).

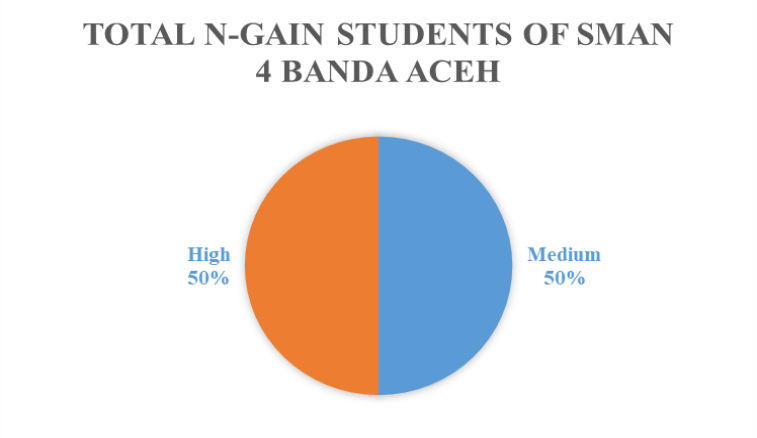

Figure 4. Total N-Gain Students of SMAN 4 Banda Aceh

This study's findings align with (Muzakki et al., 2023) with the title "Development of AR Book Applications on Water Cycle Material at MI Mathalibul Huda Mlonggo." The results of this study indicate the effectiveness of the application of learning outcomes, as evidenced by the results of the teacher response test of 90,58, with a very good category.

While the results of the student understanding post-test of 86,41 are included in the good category. Based on the research results obtained, the

validation results from the two experts, namely media experts and material experts, were obtained with very appropriate criteria, indicating that the media used has good quality and supports the teaching and learning process.

This is what can ultimately contribute to improving students' understanding and learning values. Furthermore, the responses of students who obtained positive results showed that students felt more interested in participating in learning.

This happens when students are happy with the media used, and the relevant and easy-to-understand material makes them involved and enthusiastic in learning activities, thus providing opportunities to improve student understanding.

This is in line with the opinion of Daniyati et al. (2023), who said that learning media plays an important role in improving the quality of teaching, because it can make it easier for teachers to explain lesson materials and make it easier for students to understand lesson materials.

Finally, closed with the opinion of (Gadeng et al., 2022) SMA/MA geography subject teachers must be creative, technologically literate and innovative in designing learning by utilising the environment around students as a learning resource on all learning materials.

CONCLUSIONS

The conclusion that can be drawn from the research that has been conducted at SMA Negeri 4 Banda Aceh is that this development research uses the R&D model using a 4D research design (four-D model) which includes four stages, namely definition, design, development, and distribution, the feasibility of the media obtained: 89% meets the criteria of very feasible, the results of media feasibility by material experts are 98% meet the criteria of very feasible.

Furthermore, the student response obtained a total percentage of 97.3% with very good criteria, and the results of the student understanding test before and after the understanding test showed that class X7 students of SMA Negeri 4 Banda Aceh experienced an increase in understanding after using AR learning media on the water cycle material that had been developed.

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