
Development of augmented reality media for earth-changing materials: R&D studies in grade V of elementary school

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Abstract

The purpose of this research is to develop digital-based augmented reality learning media to minimize the use of costs in making learning media. This can be seen from the manufacturing process which does not cost anything except internet quota. In addition, this augmented reality media also aims to make it easier for students to understand material concepts that cannot be described through conventional media. The research method carried out in this study is a type of research and development or Research and Development (R&D). The development of this media follows the steps contained in the 4D Model which consists of define, design, develop, and disseminate. The results of the development of augmented reality media show that this media is considered good based on the validity carried out by expert validators. However, this augmented reality media requires further development before it will be tested on students. The reason for the need for this development is because the display of the side-view illustration does not look like 3 dimensions.

Keywords: augmented reality; learning media; technology

INTRODUCTION

Learning is said to be the process of changing a person's behavior that affects personality which is reflected in the improvement of the quality and quantity of behavior (Hakim, 2005). This includes improving habits, knowledge, skills, critical thinking, attitudes, understanding, and various other abilities (Hakim, 2005). This process often involves students who are learners and teachers who act as facilitators. The core of all learning activities is the learning process itself (Rohani, 2019). One of the influences of learning success is the influence of learning aids or media

Learning media is a tool that functions in conveying information to students during learning activities so that it can attract students' attention so that they can foster interest in learning (Arsyad, 2015). Learning media includes all tools that can convey messages and can engage students' thoughts, emotions, attention, and motivation, as well as encourage intentional and structured learning experiences (Yusufhadi, 2011). From the above definition, it can be said that learning media refers to any resource or tool used to communicate messages and information during the teaching and learning process. This learning medium is essential to capture students' attention and can increase their interest in learning, as well as engage their thoughts, emotions, and motivations.

In the student book, in some subjects in elementary school, there are usually no examples of the use of learning media that are in accordance with the material. This is also what encourages teachers to inevitably have to find and even create learning media that is in accordance with the content of the material to be studied. In general, the student books that are commonly used at the elementary school level today still have a significant gap in terms of

media that supports learning. This limitation can be overcome by including more interesting and diverse technology-based learning media, such as augmented reality (AR) media that can support deeper understanding. However, there are still many teachers who tend to use conventional-based media and these media require money in the process of making them. Conventional learning media always operate without depending on certain programs or applications so teachers have to make their own, of course this will take up teachers' teaching time. The creation of conventional learning media also definitely requires money. Basically, the purpose of using learning media is to increase the efficiency and effectiveness of learning. However, if the use of media actually causes waste, then this will cause concern. Therefore, the cost factor should be an important consideration (Pakpahan *et al.*, 2020).

One of the efforts to minimize the use of costs in creating learning media on conventional learning media is to switch and develop technology-based digital learning media, because there are many programs or applications for making learning media that can be accessed easily and at no cost. There is no doubt about the rapid advancement of technology today in the field of education, especially in the creation of learning media. In today's digital era, the importance of digital devices cannot be ignored, especially in the world of education (Widiara, 2018). This also happens to students. Students tend to be more engaged when they see teachers utilizing supportive learning resources, such as technology-based learning media. One of the digital or technology-based learning media that can also save manufacturing costs is AR learning media.

AR media can be an alternative learning medium to integrate digital technology into the learning process. The application of AR media offers a way to develop exciting media innovations. This media functions as a bridge between teachers and students in the learning process, conveying information, fostering relationships, and conveying messages, so that learning becomes more efficient and effective (Aditama *et al.*, 2019). AR media is also expected to be a good step to develop interesting and creative learning activities (Riskiono *et al.*, 2020). Teachers must refresh the learning media they use to move away from dependence on conventional learning media. AR is a technology that combines 2-dimensional or 3-dimensional illustrations into a real environment and projects those virtual illustrations in real time (Eder *et al.*, 2020). This technology emphasizes on the real environment and allows objects previously viewed in two dimensions to be presented as virtual entities incorporated into actual settings in real-time (Gargish *et al.*, 2020).

As is well known, not all illustrations of the material available in the student's book can be seen directly. One of the illustrations of material that requires learning media that can help students' concepts is earth change caused by natural factors in science subjects in grade V of elementary school. In this material, we discuss natural disasters caused by nature itself and cause the earth to undergo changes. These natural disasters include earthquakes, tsunamis, mountain eruptions, floods, hurricanes, and landslides. The existence of this material, of course, makes teachers need real learning media to make it easier for students to explore and understand the material. Commonly used learning media always use conventional learning media that requires manufacturing costs, so AR learning media is suitable for use in this material (Putri & Wiguna, 2020). This AR media can help reduce conceptual misunderstandings that students may have when understanding the actual concept, especially in materials that require clear

depictions such as in materials of earth changes caused by natural factors. This AR learning medium can be used both at home and at school because of its easy-to-use operation. Students only need to scan the QR code through the Assemblr Studio App, where the QR code will be provided by the teacher. After that, there will be views of changes in the earth caused by natural factors such as earthquakes, tsunamis, volcanic eruptions, floods, hurricanes, and landslides.

From the many problems above, this research aims to develop AR learning media that can be used as a choice of digital learning media. This research is expected to be the development of learning media, especially digital-based.

METHODS

The research method chosen in this study is the type of research and development or Research and Development (R&D). The R&D method can be said to be a research method that is deliberately and systematically designed to find, improve, create, or evaluate models, product effectiveness, strategies, methods, strategies, or approaches that are innovative, better, efficient, productive, and meaningful (Putra, 2015). R&D can also be said to be the process used to create and assess the validity of educational products (Borg & Gall, 1984). Based on the opinions of these experts, it can be concluded that R&D is a research method that is focused on creating a specific product.

The model used in this study is the 4D Model. This model was developed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974. The 4D model is a development framework that can be applied to create various kinds of learning media (Arkadiantika *et al.*, 2020). The basis for the selection of this learning model is because the 4D Model is carried out simply. The 4D model consists of Define, Design, Develop, and Disseminate (Haviz, 2013).

Define

This defining stage involves analyzing the identification of problems during the learning process and learning objectives. In accordance with one of the special principles of the Independent Curriculum put forward by Sukmadinata (2001), namely the principle of selecting media and aids, in choosing media and aids, it is important to consider things such as planning activities, reviewing available aids/media, and organizing these aids into learning materials, both in the form of modules and textbooks. However, researchers found that in general, student books that are commonly used at the elementary school level today still have a significant gap in terms of media that supports learning, so teachers must create conventional learning media that always costs money in the process of making it. In addition, not all of the material taught can use conventional media, so this also causes students to still have difficulty in exploring concepts and understanding the material without the help of media.

The research product that will be made is of course adjusted to the learning objectives of the selected material, namely in Chapter 8 Topic A (Earth Changes) in the science subject of class V elementary school, namely through learning media, where students are able to distinguish six causes of the earth changing due to natural factors. This material requires the help of learning media that can support learning activities such as concrete media that can help students understand abstract concepts such as illustrations of the earth changing due to natural

factors. It is hoped that later it will be able to help solve problems related to media that can support learning in accordance with learning objectives and students' books.

Design

The design stage focuses on selecting media and determining the design to be implemented. The researcher decided to develop an AR learning media that could be a solution to the problems that have been described. The Assemblr Studio application was chosen in the creation of AR media because the way to use this application is not too complicated, so teachers are also expected to be able to create this learning media themselves.

Develop

The development stage aims to create a product. At this stage, the researcher asks for validation from expert validators regarding the product being developed. The development stage begins after the product is completed and ready for validation. The data collection instrument is through feedback by expert validators through a rating scale by giving a value from low to high to measure or evaluate something (Ilhami & Rimantho, 2017). The rating scale used is a questionnaire designed to collect validation information.

The data analysis technique used is qualitative descriptive analysis. The qualitative descriptive method is a research approach that aims to gain a deep understanding of the research subject's experience in the form of words or oral expressions that provide a comprehensive view of the subject (Moleong, 2006). The researcher is positioned as a research instrument as well as a data analyst, where the researcher directly reveals his analysis in accordance with the indicators contained in the validation grid.

Disseminate

The disseminate stage aims to disseminate the product more widely. At this stage, the researcher only disseminates the product to educators through a trial during Microteaching. There are five educators who are trying to use this AR media. On another occasion, the researcher will try to develop this AR media to students.

RESULT AND DISCUSSION

In this study, the product developed is an AR-based media focused on earth change caused by natural factors in science subjects in grade V of elementary school. This media is created using the Assemblr Studio application. The development of this media is carried out with steps on the 4D Model. The use of Augmented Reality-based learning media in the learning process is as follows: (1) students download the Assemblr Studio application on the Play Store or App Store through their respective smartphones; (2) after the application is installed, the student registers an account first; (2) if the account registration process is complete, students can log in to the Assemblr Studio application; (3) after logging in, students select the Scan menu in the bottom center; (4) when the Scan menu is opened, a camera display will appear and students need to scan the QR code that has been given by the teacher; (5) after that there will be a view of changes in the earth caused by natural factors such as earthquakes, tsunamis, volcanic eruptions, floods, typhoons, and landslides; (6) select the Vertically menu

located in the upper right corner so that the illustration can be seen clearly, while the Horizontally menu functions to make the illustration look more 3-dimensional; (7) students can minimize or enlarge the illustration by pinching the illustration; (8) In the upper right corner there is also a screenshot menu, students save a screenshot of this illustration; (9) students can find out at a glance the definition of the illustration displayed by displaying the writing at the bottom of the image; (10) The illustration can be seen from the front and back, but for the side of the illustration, the author still needs to develop it to look like 3 dimensions. Here's a screenshot of augmented reality media.



Figure 1. QR Code Display



Figure 2. Scan Menu Display



Figure 3. Illustration of Earthquake

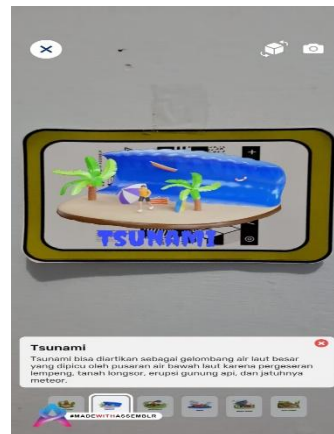


Figure 4. Tsunami Illustration



Figure 5. Illustration of an erupting mountain

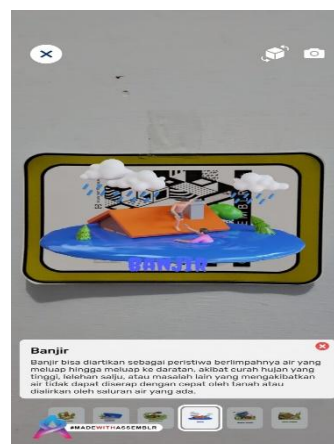


Figure 6. Illustration of Flood



Figure 7. Illustration of Hurricane Typhoon

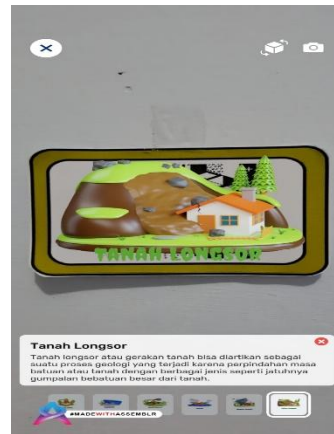


Figure 8. Landslide Illustration

Material Validity Test Results

The validity of the material is obtained from the results of the validation sheet given to expert validators. Validity or validation refers to the accuracy and correctness of the measuring instrument in assessing a product (Putri, 2018). The validity results that have been obtained will be explained in the following table.

Table 1. Material Expert Validity Test Grid

Yes	Aspects Assessed	Indicators	Rating Scale				
			Excellent (5)	Good (4)	Enough (3)	Less (2)	Poor (1)
1.	Content Quality	Suitability of the material with learning objectives		✓			
		Clarity of material on AR media		✓			
2.	Material Accuracy	Accuracy of the material in AR media		✓			
		Image accuracy on AR media		✓			

(Octaviana *et al.*, 2020)

After the researcher gets the results, then the researcher begins to calculate the score obtained. The following is the formula used (Akbar, 2013).

Formula:

$$NA = \frac{\sum n1}{\sum n}$$

Information:

NA = final score of validity

$\sum n1$ = total member value 1

$\sum n$ = number of members

$$NA = 80\% \frac{80\%}{1}$$

Based on the scores obtained, the researcher entered the scores obtained in the table below.

Table 2. Results of the Validity Test of Subject Matter Experts

Validator	Quantity (%)
Material Expert	80
Validator	

Based on the table above, the score obtained from the validity test results of the subject matter expert validity test is 80%. In addition, expert validators also did not suggest improvements in terms of material.

Media Validity Test Results

The validity of the media was obtained from the results of the validation sheet given to expert validators. Validity or validation refers to the accuracy and correctness of the measuring instrument in assessing a product (Putri, 2018). The validity results that have been obtained will be explained in the following table.

Table 3. Media Expert Validity Test Grid

Yes	Aspects Assessed	Indicators	Rating Scale				
			Excellent (5)	Good (4)	Enough (3)	Less (2)	Poor (1)
1.	Application Design	Font selection, placement, and size	✓				
		Image size		✓			
2.	Media Attractiveness	Image illustration		✓			
		Font color selection		✓			

(Octaviana *et al.*, 2020)

After the researcher gets the results, then the researcher begins to calculate the score obtained. The following is the formula used (Akbar, 2013).

Formula:

$$NA = (\sum n1) / (\sum n)$$

Information:

NA = final score of validity

$\sum n1$ = total member value 1

$\sum n$ = number of members

$$NA = (85\%) / 1 = 85\%$$

Based on the scores obtained, the researcher entered the scores obtained in the table below.

Table 4. Media Expert Validity Test Results

Validator	Quantity (%)
Media Expert Validator	85

Based on the table above, the score obtained from the results of the validity test of media experts is 85%. In addition, expert validators suggest improvements in terms of media, i.e. the side-view view is made more 3-dimensional.

Media Practicality Test Results

The practicality of the media is obtained from the results of the validation sheets given to expert validators. Validity or validation refers to the accuracy and correctness of the measuring instrument in assessing a product (Putri, 2018). The validity results that have been obtained will be explained in the following table.

Table 5. Material Expert Practicality Test Grid

Yes	Aspects Assessed	Indicators	Rating Scale				
			Excellent (5)	Good (4)	Enough (3)	Less (2)	Poor (1)
1.	Effective	Learning media can be used to explain the material			✓		
		Learning media can help learning activities		✓			
2.	Efficient	Easy to use learning media	✓				
		Easy to carry learning media	✓				

(Octaviana *et al.*, 2020)

After the researcher gets the results, then the researcher begins to calculate the score obtained. The following is the formula used (Akbar, 2013).

Table 6. Results of the Practical Test of Material Experts

Validator	Quantity (%)
Material Expert Validator	85

Formula:

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

Information:

P = value of practicality aspect

F = turnover score

N = maximum score

$$P = \frac{17}{20} \times 100\% = 85\%$$

Based on the table above, the score obtained from the results of the validity test of media experts is 85%. In addition, experts also do not suggest improvements. Based on the results that have been obtained from the validation of experts. Furthermore, the results will be discussed based on the criteria in the table below.

Table 7. Level of Validity and Practicality

Criterion	Value Scale	Percentage (%)
Excellent	5	$85 < \text{average} \leq 100$
Good	4	$65 < \text{average} \leq 85$
Enough	3	$50 < \text{average} \leq 65$
Less	2	$35 < \text{average} \leq 50$
Bad	1	$20 < \text{average} \leq 35$

(Oktaviana *et al.*, 2020)

Validity of Augmented Reality-based Materials

The validation of AR material in this study was assessed based on the assessment of one expert validator. Based on the assessment of this expert validator, it produces a Good category which indicates that there is no need for further improvement. Based on expert validators, the validity of the material which includes the quality of the content and the accuracy of the material has been well displayed through AR media.

The quality of the content displayed through AR media is in accordance with the learning objectives. The learning objectives for this material are focused on CHAPTER 8 Topic A (Earth Changes) in the science subject of grade V elementary school, namely, through learning media, students are able to distinguish six causes of the earth changing due to natural factors. The learning media presents six causes of the Earth changing due to natural factors such as earthquakes, tsunamis, volcanic eruptions, floods, hurricanes, and landslides. In addition, the content or material displayed is also not excessive but still effective and easy to understand. Where the material conveyed through text is located at the bottom of the illustration which presents the meaning of each illustration so that students are able to distinguish between one cause definition and another. Another thing that encourages the accuracy of the material lies in the similarity between the appearance of the illustrations produced and the reading materials in the student book on page 218 by Amalia Fitri Ghaniem *et al.* Where on the page is also told examples of natural events that can become natural disasters such as earthquakes, tsunamis, mountain eruptions, floods, hurricanes, and landslides.

Validity of Augmented Reality-based Media

The validation of Augmented Reality media in this study was assessed based on the assessment of one expert validator. Based on the assessment of these expert validators, the category of Excellent is produced. However, expert validators suggest that the side-view view look more 3-dimensional. Based on expert validators, the validity of media that includes application design and media attractiveness has been shown very well through AR media.

Application design on AR media does not bore students so that it can support learning activities. This AR media also displays media illustrations that attract attention. In media illustration, the placement of elements and sizes plays an important role in determining the attractiveness of this medium.

Practicality of Augmented Reality-based Media

The practicality of AR media in this study was assessed based on the assessment of one expert validator. Based on the assessment of this expert validator, it produces the Very Good category, which indicates that there is no need for further improvement. Based on expert

validators, the practicality of media that includes the level of effectiveness and efficiency of use has been shown very well through AR media.

The effectiveness of this media is seen when AR media is used by expert validators and educators through trials in Microteaching. Users of this media feel helped by the existence of AR media, while the efficiency of this media can be seen during the trial of users of this media consisting of expert validators and educators who are considered quite easy to use and carry everywhere. The following are comments from educators who have conducted trials on AR media.

Table 8. Educators' Comments

No.	Respondents	Commentary
1.	Educator 1	How to use this media is quite easy, just direct the Scan menu contained in the Assemblr Studio Application to the QR code and the 3-dimensional illustration will automatically appear.
2.	Educator 2	The display on the media is quite interesting and the material presented is also not too long.
3.	Educator 3	This media is good and looks like 3 dimensions, but on the display seen from the right and left sides, it does not look like 3 dimensions.
4.	Educator 4	I just got to know AR media and I think this media is quite interesting

In addition, expert validators also provide their comments and suggestions overall on the development of this media. Here are the comments and suggestions from expert validators in order for the development of this medium.

Table 9. Expert Validator Comments and Suggestions

No.	Respondents	Comments and Suggestions
1.	Expert Validators	The learning media and materials displayed are good, but when viewed from the side, it doesn't look like a 3-dimensional display. Hopefully it can continue to be refined and developed again.

From the results of the research obtained, AR media can be one of the efforts to minimize the use of costs in making learning media. This can be seen from the manufacturing process which does not cost anything except internet quota. Technology-based digital learning media provides many learning media creation programs that can be accessed easily and at no cost.

In addition, AR media also helps students to understand material concepts that cannot be described through conventional. This AR media can help reduce conceptual misunderstandings that students may have when understanding the actual concept, especially in materials that require clear depictions such as in materials of earth changes caused by natural factors.

This AR media can be used both at home and at school because of its easy-to-use operation so that AR media can be a medium that is considered practical because it is easy to use. Basically, the purpose of using learning media is to increase the efficiency and effectiveness of learning.

CONCLUSION

In this study, researchers have disseminated a wider range of products to educators. Researchers have also conducted trials with expert validators. Based on the results and discussions that have been presented, this AR media is considered Good by expert validators who have tested this media. However, this AR media requires further development before it will be tested to students. The reason for the need for this development is because the display of illustrations that when viewed from the side does not look like 3 dimensions.

In the creation of this AR media, a 4D Model is used consisting of Define, Design, Develop, and Disseminate. At the Define stage, we discussed one of the principles and objectives of learning the chosen material, namely the principle of selecting media and tools. In the Design stage, we discuss the selection of media and the determination of the design to be implemented. At this stage, the product must also be completed. In the Develop stage, it discusses the validity test of the product that has been made which is carried out by validators who are experts in materials and media. At the Disseminate stage, we discussed the plan of researchers who disseminate products to educators through trials during Microteaching. There are five educators who are trying to use this AR media.

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