

Development of augmented reality-based interactive space media for 5th grade elementary school students

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Abstract: *This research is motivated by the lack of interactive learning media in schools. The purpose of this study is to determine the feasibility of interactive spatial media based on Augmented Reality (AR) using the Assemblr EDU application for 5th grade elementary school students. This development research applies the ADDIE model with data collection through observation, interviews, documents, and questionnaires. The research subjects involved 14 students one of the elementary schools in Malang City. The study focused on the feasibility aspect based on expert validation. The results showed that media experts gave a feasibility percentage of 98% with the category "Very Feasible", while material experts gave a feasibility percentage of 75% with the category "Feasible". These results indicate that AR-based interactive media is feasible for use in learning in elementary schools, meets feasibility standards, and has the potential to support an interesting and effective learning experience for students.*

Keywords : AR; Assemblr EDU; Building Space.

Introduction

In this era of the 4.0 revolution, science and technology are developing very rapidly. This is equivalent to the opinion of (Raditya & Widhiyani, 2018) who stated that rapidly developing information technology will bring changes in all aspects of life. The development of educational science and technology (IPTEK) is used to improve the quality of education. For example, according to (Heni Widia Ayu. Wahyuningtyas, 2019), every year education in Indonesia experiences further development in line with the challenges faced that can improve individual competencies. According to (Yayuk & Sugiyono, 2019), to produce superior human resources, it is necessary to improve the quality of education. And in the 4.0 era, technology is no longer something new in society. The development of information technology in this digital era has had a tremendous impact on various aspects of life, one of which is the field of education. The rapid development of technology and communication is certainly unavoidable, electronic teaching materials must also be developed to provide more varied learning opportunities for students (Triwahyuningtyas & Suastika, 2022). In the world of education, technology is commonly used as a learning medium. Learning media that can be used by utilizing technology or multimedia in the learning process is interactive learning media. Interactive learning multimedia is one means of creating more effective learning in delivering learning messages (Firdian & Maulana, 2018). The use of interactive learning media is designed to facilitate the learning process. One interactive learning media that teachers can use in an interactive and effective learning process is the use of Augmented Reality media or often called (AR). Augmented Reality is a technological development that can combine a three-dimensional object and then project the virtual object in real time. Displaying 3D objects as if they were in a real environment is the attraction of Augmented Reality (Iksan & Djuniadi, 2017). Augmented Reality is the interaction of the virtual physical world environment, either directly or indirectly, which is added by adding a virtual computer (Adami

& Budihartanti, 2016). Many studies have been found in the literature, which of course point to the use of Augmented Reality to increase student motivation by improving the visualization of learning materials to make them easier to understand (Kaur et al., 2020).

Interactive learning media based on Augmented Reality can be created in various applications, but here the author develops interactive learning media based on Augmented Reality using the Assemblr EDU application. Assemblr EDU is a platform that utilizes 3D displays and AR to make learning sessions more interesting and interactive (Dewi et al., 2022). Assemblr EDU is an AR application created for educational purposes. With the help of 3D and AR technology, this application has several menu options and templates for creating learning media, which can be in the form of images, videos and 3D animations, or you can design your own material as creatively as possible which will certainly make the media display more interesting and enjoyable. The Assemblr application that presents Augmented Reality can be implemented in learning activities via smartphones, thus providing an interesting learning impression for students and improving student learning outcomes. This is in line with research conducted by (Idham Minaldi, 2019) which shows that the use of interactive learning media based on Augmented Reality through the Assemblr application can improve students' creative thinking skills. According to Assemblr CEO, Hasbi Asyadiq in (Arrum & Fuada, 2021), this application is an Augmented Reality platform to make it easier for users to design 3D content visualized in AR form simply and quickly.

Based on the results of observations and interviews with fifth-grade elementary school teachers in Malang, it was found that approximately 65% of students experienced difficulty understanding mathematics material, particularly the topic of spatial construction presented in textbooks. In addition, around 70% of students reported feeling bored when using learning media such as PowerPoint (PPT) and concrete objects, as these media were perceived as ordinary and less engaging. In fact, what teachers expect from students when learning mathematics is in accordance with the opinion Wahyuningtyas & Shinta, (2017) that it is hoped that by learning mathematics, students will have a disciplined attitude, tenacity, curiosity and self-confidence. However, until now, many students still think that mathematics is difficult because it is abstract, full of numbers and formulas. Mathematics material that contains abstract words or ideas will be easy for students to understand if they are previously given concrete examples from the surrounding environment. However, in this modern era, media is needed that is not only concrete, but in digital form, namely interactive learning media. And usually teachers use interactive learning media in thematic subjects, for mathematics subjects teachers have never used interactive learning media. In fact, if mathematics uses concepts presented in concrete form, it will be easily understood by students. Mathematical concepts presented in concrete form are easier to understand (Suastika & Rahmawati, 2019). Therefore, a media is needed that can display spatial objects using Augmented Reality technology with the help of the Assemblr EDU application. The reason researchers chose this interactive learning media is because this media can display geometric objects clearly in 3D or AR so that objects can be seen from various angles and explained from each angle. So it can bring the material to life and make it easier for students to understand spatial material quickly.

Previous studies have also utilized Augmented Reality (AR) with the Assemblr EDU application in developing interactive learning media. For instance, Rachmawati et al. (2020)

developed MAR (Mathematics Augmented Reality) Exploration worksheets for elementary school building material topics with character-strengthening elements. Their findings indicated that the media met the criteria of validity, practicality, and effectiveness. Similarly, Octaviani et al. (2022) designed AR-based learning media assisted by Assemblr EDU for the topic of reactant and catalyst concentrations in chemical reactions, which was found to be valid, effective, and practical.

Unlike these studies, the present research focuses specifically on interactive space-building media for 5th grade elementary school mathematics using the Assemblr EDU application, emphasizing not only the three-dimensional visualization of geometric shapes but also the integration of interactive elements tailored to primary school learners. This study applies the ADDIE model but reports in detail the analysis, design, and development stages, highlighting feasibility evaluation through both media and material expert validation. Such a focus addresses the gap in prior research, which has not extensively explored AR-based media for geometry concepts at the upper elementary level in a highly interactive format.

Method

The method used in this study is the ADDIE model. According to Tegeh & Kirna (2013), the ADDIE model provides an opportunity to evaluate development activities at each stage, this has a positive impact on the quality of the development product. The ADDIE development model consists of five stages of development, namely: Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2016). This research was conducted at one of the elementary school in Malang City. The subjects of this study were 14 fifth-grade students. The following are the steps of the ADDIE research method:

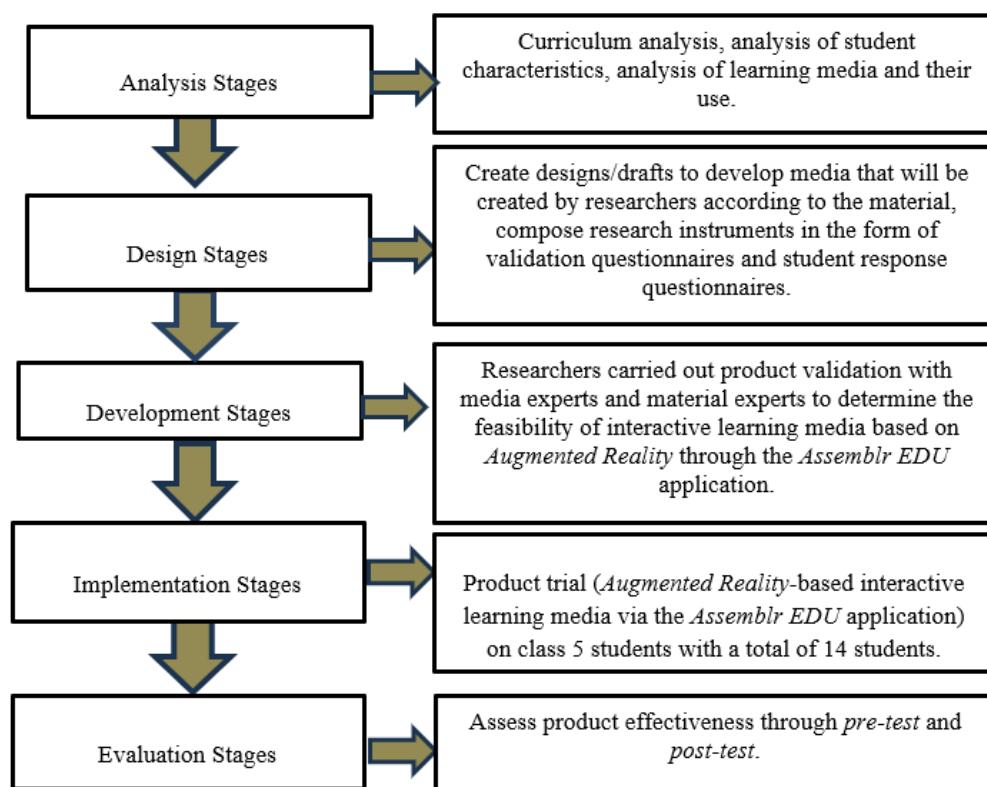


Chart 1. ADDIE Research Stage Chart (Sugiyono, 2020)

This article only describes the feasibility or expert validation stage. Data collection used a questionnaire. Data processing used quantitative and qualitative methods. Qualitative data were obtained from interviews and statements from the data processing results. Quantitative data were obtained from processing the questionnaire.

Results and Discussion

At this development stage, the researchers began creating interactive Augmented Reality-based learning media through the Assemblr EDU application, which presents mathematics material related to building materials for fifth-grade elementary school students. The model used in this study is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The development stages carried out by the researchers are in accordance with the ADDIE model:

First, the analysis was conducted by researchers using field observations and interviews at the research site. The analysis included reviewing the curriculum used, which was the 2013 Curriculum (K13). In this study, the focus was on one Mathematics subject, namely the topic of spatial figures as the material for developing interactive learning media. An analysis of basic competencies was also carried out, and competencies relevant to spatial figures were found in semester 2. The analysis of student characteristics revealed that students had a high level of curiosity but lacked understanding of the material presented by the teacher due to the limited availability of interactive learning media and learning resources. The analysis of learning media and its use showed that students struggled to visualize spatial objects in detail and tended to feel bored when using only concrete media. In mathematics learning, teachers mainly used lecture methods with a strong emphasis on theory, delivering material with the help of the blackboard and mathematics books. Interactive media such as PPT were rarely used when teaching mathematics, as they were considered less effective for conveying the material.

Second, the product design to be developed by the researcher is tailored to the students' needs based on the analysis conducted by the researcher. This activity of designing interactive learning media based on Augmented Reality requires the Assemblr EDU application which can be downloaded on the Playstore. This interactive learning media based on Augmented Reality is designed to be as attractive as possible with objects or animations in 3D and videos that can also be applied in the form of Augmented Reality (AR) so that students are more engaged in learning and easily understand spatial material. This is also relevant to the design of the research media being conducted by Lino Padang et al., (2022) which uses the Assemblr EDU application containing material on the organizational system of living things. Therefore, the Assemblr EDU application is needed to describe in more detail in 3D or AR on learning materials that are difficult to detect by human senses.

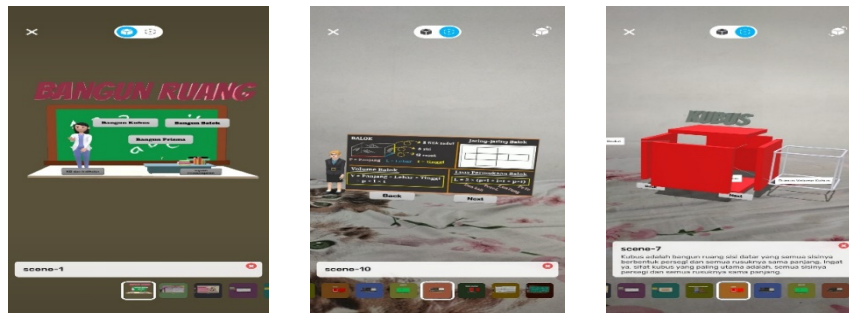


Figure 1. Interactive Media Display of Building Space Based on Augmented Reality through Assemblr EDU App

Third, Development. At this development stage, researchers naturally make improvements or updates. This differs from previous studies, such as that conducted by Amelia et al., (2022), which developed an Augmented Reality technology-assisted module with puzzles on spatial structure material. Researchers created learning media that could help elementary school students understand the basic characteristics of spatial shapes using 3D object displays that were made as engaging as possible. Furthermore, research conducted by Subagyo et al., (2015) developed an Augmented Reality application to introduce more innovative mathematical spatial formulas. This application was designed as well as possible, with objects for introducing spatial formulas rendered in 3D images.

The development of media carried out in this study shares both similarities and differences with previous research. Both this research and prior studies utilize Augmented Reality (AR)-based technology and focus on mathematics in the topic of spatial figures. However, the novelty of this study lies in the development of AR-based learning media using the Assemblr EDU application, which offers engaging 2D and 3D objects that facilitate the design of interactive learning media. At this stage, the product was developed according to the initial design plan. Subsequently, the media underwent validation by two experts—media experts and material experts—who assessed its feasibility by completing evaluation questionnaires. In addition to providing numerical ratings, the validators also offered constructive suggestions and criticisms aimed at improving the quality of the product. Based on these inputs, the researcher made revisions before conducting the media's practicality test.

Table 1. Validation Assessment by Media Experts

NO.	Rated aspect	Eligibility Level	Category
1.	Sustainability for Learning Purposes	94%	Very Worthy
2.	Feedback and adaptation	100%	Very Worthy
3.	Motivation	100%	Very Worthy
4.	Design	94%	Very Worthy
5.	Compliance with standards	100%	Very Worthy
6.	Accessibility	100%	Very Worthy
7.	Presentation	100%	Very Worthy
Average		98%	Very Worthy

(Processed by researchers 2023)

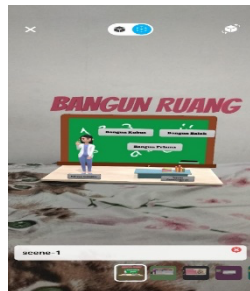
Based on table 1, it can be concluded that the assessment from media experts obtained a result of 98% so that the interactive learning media based on Augmented Reality through the Assemblr EDU application is categorized as "Very Appropriate" or "Very Valid"

Table 2. Validation Assessment by Material Experts

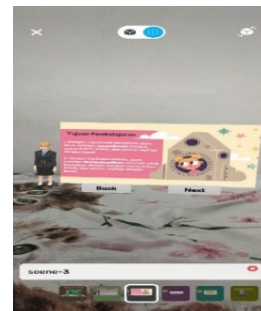
NO.	Rated aspect	Eligibility Level	Category
1.	Determining media that is appropriate to the competencies to be achieved	75%	Worthy
2.	Completeness of materials	75%	Worthy
3.	Collapse of matter	75%	Worthy
4.	Presentation of language and materials	75%	Worthy
Average		75%	75%

(Processed by researchers 2023)

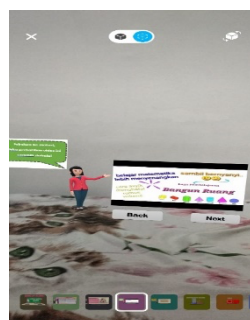
Based on Table 2, the assessment from the material experts yielded a score of 75%. This percentage indicates that the interactive learning media based on Augmented Reality through the Assemblr EDU application falls into the "Worthy" category, meaning it meets the required feasibility standards for use in the learning process. The results or products of developing interactive learning media based on Augmented Reality through the Assemblr EDU Application are as follows:

Table 3. Interactive Learning Media Development Products Based on Augmented Reality through the Assemblr EDU Application

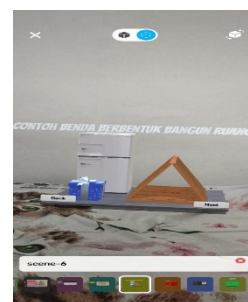
The cover page has a Geometry material menu button.



There are pages of KD, Indicators, and learning objectives.



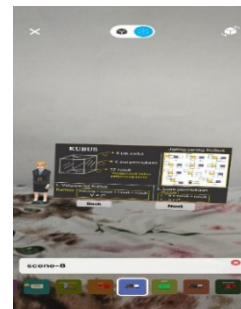
There are pages of video songs about various spatial structures.



There are sample pages of objects in the form of various types of spaces.



There are pages of geometric shapes, such as cubes, cuboids, and triangular prisms, while each geometric shape has its own characteristics. Within each building is a building framework.



There is a material board for each room structure to make it easier for students to understand space building materials.

Based on research conducted by researchers who produced a product in the form of interactive learning media based on Augmented Reality through the Assemblr EDU application to support the achievement of learning activities that focus on one topic, namely mathematics, spatial building material.

Researchers used the ADDIE model in conducting research on the development of interactive learning media based on Augmented Reality through the Assemblr EDU application. However, in this article the researchers only explain three stages, namely analysis, design and media development. So it only shows the results of media validation or suitability by media experts and material experts and then after being declared valid by media experts and material experts, the media can be directly tested on users (teachers and students). In the validation assessment by media experts there are seven aspects that must be assessed and the results of the assessment show that there are five aspects that show a feasibility level of 100% or the "Very Feasible" category and two aspects that show a feasibility level of 94% or the "Very Feasible" category. Meanwhile, in the validation assessment by material experts there are four aspects that must be assessed and the results of the assessment show that there are four aspects that show a feasibility level of 75% or the "Feasible" category.

From the validation test by two experts conducted through a questionnaire, the following results were obtained, namely the results of the media experts obtained a percentage of 98% with the category "Very Feasible", and the results of the material validation obtained a percentage of 75% with the category "Feasible". From the results of these two validations, the interactive learning media based on Augmented Reality through the Assemblr EDU application can be declared valid and suitable for use by teachers and students to be implemented in schools as an interactive learning media in supporting the learning process on building materials material for 5th grade elementary school students to achieve learning objectives. The feasibility of this research media is relevant to previous research conducted by Fatimatuzzahro et al., (2021) which produced Fun Mathematics Comic Learning Media (MASIK) Based on Augmented Reality on the Volume of Spatial Buildings Material, through the validation results by the validator with the category "Very Good" and through three questionnaires given to students with the category "Very Good". In addition, this research is also relevant to previous research from (Fakhrudin & Kuswidyanarko, 2020) which produced Elementary School Science Learning Media Based on Augmented Reality as an Effort to Optimize Student Learning Outcomes, through validation results by several

experts, namely material experts, media experts, learning experts and language experts obtained the categories "Valid" and "Feasible".

Conclusion

Based on the results of the research on the development of interactive space-building media based on Augmented Reality through the Assemblr EDU application for 5th grade elementary school students using the ADDIE method, this study focused on three stages analysis, design, and development to evaluate the product's feasibility. The validation results from media experts categorized the media as "Very Feasible" (98%), while material experts categorized it as "Feasible" (75%). These findings indicate that the developed media is valid and suitable for implementation in elementary school learning, particularly for space-building material, and has the potential to enhance learning engagement and effectiveness.

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