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Development of Android-based Solar System Interactive Learning Application Using Augmented Reality with Unity and Blender

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Abstract: This research aims to develop Augmented Reality (AR) based applications to support interactive solar system learning. In the era of rapid technological development, learning can be enhanced through 3D illustrations that are more interesting and immersive for students. AR is one of the technologies that can be applied in the development of educational applications, allowing visualization of the solar system in three-dimensional form. The methodology used in this research is Multimedia Development Life Cycle (MDLC). This AR development was developed using Blender and Unity Game Engine software. Blender is used to create 3D models of solar system objects such as planets, sun, and satellites. Meanwhile, Unity Game Engine is used to integrate the object model into Android-based applications and add interactive elements based on Augmented Reality. The result of this research is an AR-based interactive application that serves as an innovative learning media. The results showed that: (1) AR-based Android applications can be used flexibly anytime and anywhere, and are equipped with animations, 3D, and 2D images to enhance the learning experience; (2) The developed product has been validated and declared suitable for testing. With this application, it is hoped that students can find it easier and more enjoyable to learn about the solar system through interactive 3D visualization.

Keywords: Android Application, Augmented Reality, Blender, Interactive Learning, Solar System, Unity.

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A. INTRODUCTION

Teaching aids have an important role in supporting the effectiveness of learning in the world of education, (Unaenah et al., 2023). Teaching aids help students relate abstract concepts to concrete representations, making them easier to understand. This is especially beneficial for students who have visual and kinesthetic learning styles (Panggabean et al., 2021). The learning process becomes more active, meaningful, and able to increase students' learning motivation with the presence of teaching aids (Haudi, 2021). One of the materials in Natural Science learning classified as abstract and complex is the Solar System material (Sholeh et al., 2023). This material includes various scientific concepts about celestial bodies, including planets, satellites, orbits, and the movements of celestial bodies that are not easily observed directly (Yusuf et al., 2021). This often causes students to have difficulty understanding the material and even causes misconceptions about the basic concepts taught (R. B. A. Pratama & Mubarok, 2022). Therefore, learning media is needed that can help visualize the material in a real and interesting way.

Along with the development of technology, Augmented Reality (AR) comes as an innovative solution in the field of education (Widodo & Utomo, 2021). AR is a technology that allows the incorporation of virtual elements (2D and 3D) into the real world interactively and in real-time through digital devices such as smartphones (Kanti et al., 2022). Learning becomes more interactive by utilizing AR, thus providing a more vivid and enjoyable learning experience for students. In the context of Solar System learning, Augmented Reality (AR) allows visualization of celestial bodies in three-dimensional (3D) form equipped with interactive animations and explanations, thereby increasing students understanding of the material (Aditya et al., 2024). The development of this application will be directed specifically at the material of the planets in the Solar System, namely the eight planets that surround the Sun: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. This focus was chosen because the planets are the core of the Solar System system and are the basic concept that students must understand (Rosa et al., 2019). Limiting the scope to only the planets allows the application to present a more detailed and in-depth visualization of the shape, size, and physical characteristics of each planet.

The visualization of the planets will be developed in the form of 3D objects created using Blender software, which is open-source software that has high capabilities in three-dimensional modeling and animation. The 3D objects that have been created will be integrated into the Android-based AR application so that they can be accessed through students mobile devices (Zebua et al., 2020). The AR application development process uses Unity 3D as a game engine that supports the integration of 3D objects with real-time AR functionality. Unity 3D was chosen because it has cross-platform capabilities and high compatibility with Android-based mobile devices (Syahputra et al., 2024). In addition, Unity 3D also supports integration with the Vuforia SDK, which enables the creation of marker-based and interactive AR applications. The combination of Unity and Vuforia makes it easy to manage 3D objects and structuring the flow of user interaction with the displayed material (Wijaya, 2022).

The utilization of 3D models in AR is very important because it can improve students' spatial perception and strengthen their understanding of geometric and visual concepts, such as the relative size and position of planets in the Solar System (Gumilang & Qoiriah, 2023). In addition, research conducted by Santi et al (2022) regarding the development of Augmented Reality-based interactive modules using Assemblr on Solar System materials grade VII SMP/MTS proved that the use of AR-based interactive modules on Solar System materials can significantly increase student interest and engagement, with positive responses reaching 91% in small-scale tests and 93% in large-scale tests.

The purpose of this article is to develop an Android-based learning application that integrates Augmented Reality (AR) technology and 3D models from Blender as innovative media in the teaching and learning process. This application is specifically focused on the material of the planets in the Solar System as a strategic step to deepen students' understanding of the core parts of the Solar System. In addition, this article also aims to answer the challenges of learning abstract concepts in the digital era and encourage the creation of interactive, fun, and sustainable learning through the effective use of technology in the world of education.

B. METHOD

This research uses the Multimedia Development Life Cycle (MDLC) development method. The MDLC method is often applied in the manufacture of multimedia products. The use of this methodology is very important so that the product development process is carried out systematically, so that the final result can be achieved more effectively (Rahmatika et al., 2023). The MDLC consists of six stages as shown in Figure 1, namely: concept planning, design, material collection, assembly, testing, and distribution.

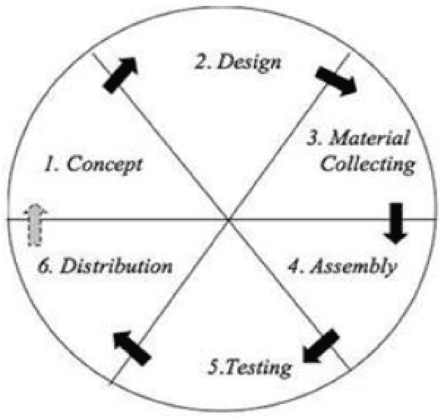

Figure 1. Six Stages of The MDLC Method

This research method consists of six stages:

1. Concept

This stage aims to set the goals of the application and determine the main target users. This application is designed to support the process of learning about the solar system in a more interactive way through the use of Augmented Reality technology. Key features include three-dimensional visualization of solar system objects, as well as informative material presentation with sound features to make it more engaging and easy to understand.

2. Design

At the design stage, the main focus is on creating a three-dimensional object model that will be used in the application. Blender's software is used in this process to design and refine 3D models of the elements of the solar system. These models will later serve as core visual assets in the display of Augmented Reality-based applications.

3. Material Collecting

Learning materials are collected from a variety of sources, such as modules, books, and two-dimensional drawings. There are a total of 10 celestial bodies, namely the Sun, Moon, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

4. Assembly

At this stage, the design that has been prepared is implemented to build the application. The creation of the three-dimensional model is carried out using the Blender software as an initial stage. Furthermore, the Vuforia SDK is used to support the integration of marker-based Augmented Reality features. After that, all components including 3D models and learning materials are combined and developed into an interactive application using Unity as the main platform. This process results in an app in APK format that is ready for users to use.

5. Testing

Testing is done after the app is finished assembling, to ensure all features are running as intended. The test was carried out technically using the black-box testing method. Black box testing is a test that is carried out only by observing the results of execution through test data and checking the functionality of the software, besides that the application also gets feedback from validators to assess its effectiveness and functionality.

6. Distribution

Applications that have been developed and tested are then distributed through digital platforms such as Google Drive or other application distribution platforms for users to access and use.

C. RESULTS AND DISCUSSION

1. Concept

The concept of this development is to design an Android-based learning application that integrates Augmented Reality (AR) technology with 3D models from Blender. This application is designed as an innovative media that is able to enrich the teaching and learning process in science subjects, especially on the material of planets in the Solar System. The focus of development is limited to visualizing the ten major planets in the Solar System to help students understand abstract concepts in a more realistic and fun way. The use of AR aims to answer learning challenges in the digital era and encourage the creation of innovative and sustainable learning processes.

2. Design

One of the results of the design stage is the application creation flow diagram shown in Figure 2. Figure 3 shows a navigation diagram that illustrates the flow of movement between menus in the learning application.

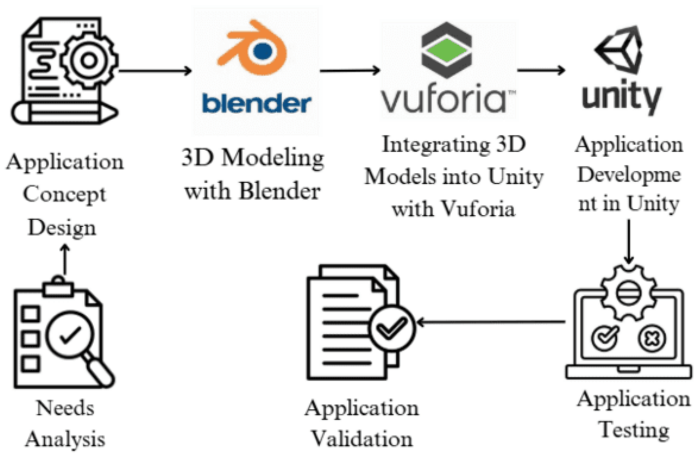

Figure 2. Flowchart of Application Development

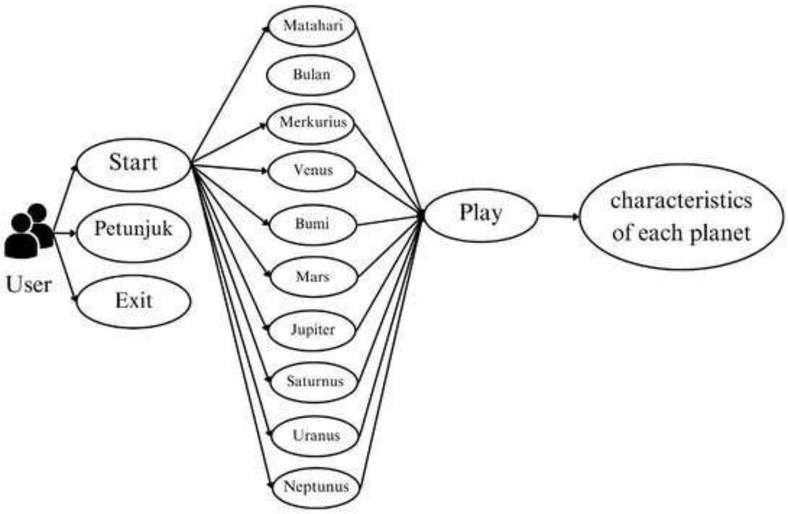

Figure 3. Navigation Diagram of the Application

3. Assembly

The assembly stage of interactive media includes several stages:

a. Stages of Creating Solar System Objects Using a Blender

The initial stage of media development begins with the process of creating three-dimensional (3D) models of solar system objects using Blender software as shown in Figure 4 Then the texture of the planets and satellites is downloaded from online sources and a 3D sphere-shaped object (UV Sphere) is formed for each celestial body as shown in Figure 5 Image textures are applied through material features and editor nodes to produce realistic surface visualizations. Furthermore, lighting and cameras are set up to support the visualization of objects in three-dimensional space, and projects are saved to be integrated into augmented reality systems.

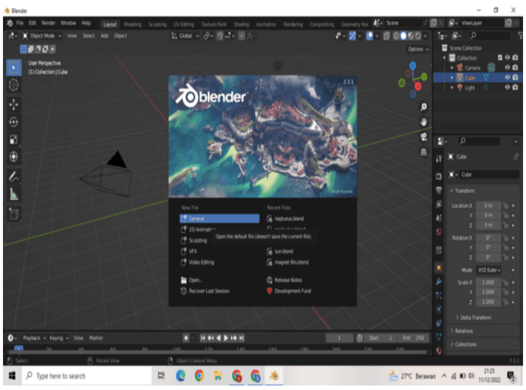

Figure 4. The initial process of creating a 3D model of the Solar System using Blender.

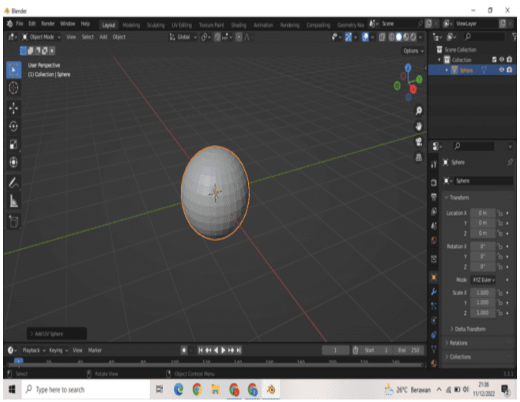

Figure 5. Application of texture to the planetary objects using the material feature and node editor in Blender

b. Stages of Uploading Marker Images Using Vuforia Developer

At this stage, the Vuforia site is accessed to create a database of markers that are used as augmented reality object markers. Markers in the form of two-dimensional images are uploaded into the Target Manager system, then processed to generate a database with Unity. Creating a database starts by clicking add database, then entering a folder

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name, and creating a database. Click the database folder that has been created, then select add target until a menu appears like Figure 6**.** Then select the card to be uploaded, then click add to upload the selected card. In Figure 7 the database is downloaded in a special format (Unity Editor) so that it can be imported directly into the Unity project. This stage connects the physical marker with the digital object that has been created in Blender.

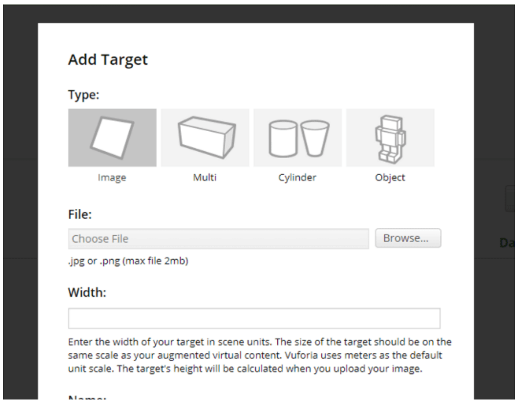

Figure 6. Add Target menu in Vuforia

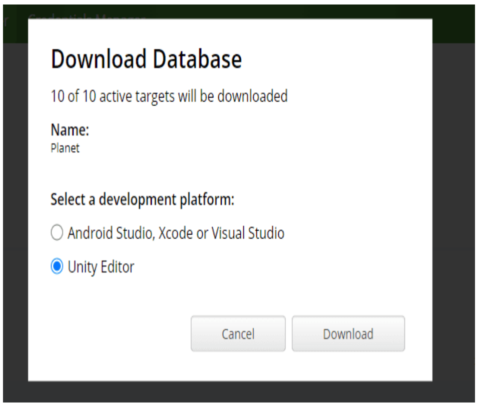

Figure 7. The process of downloading the marker database in Unity Editor format from Vuforia.

c. Stages of Integration of 3D Objects and Markers in Unity 3D

The integration was done by developing a Unity 3D-based project in Figure 8 using the Vuforia package as an augmented reality support plugin. After importing the marker database and the 3D model, the AR Camera component is added in place of the main camera. Next, AR Camera is added from the Vuforia Engine menu and the license key is inserted into the Vuforia Configuration. Then the *Target Image* is added, the 3D object and its texture are imported, and then the position of the object is set above the marker like Figure 9. The Target Image is set to From Database. The Solar System object model is then connected with the corresponding marker, so that when the marker is recognized by the device's camera, the 3D object appears automatically on the screen.

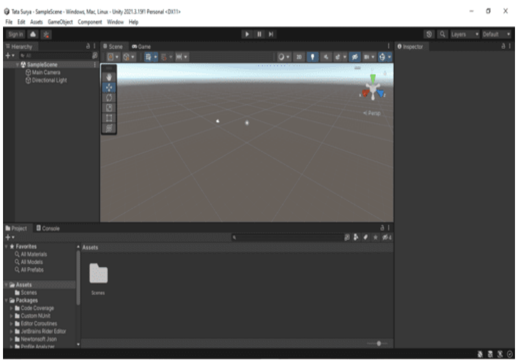

Figure 8. Unity3D project preview

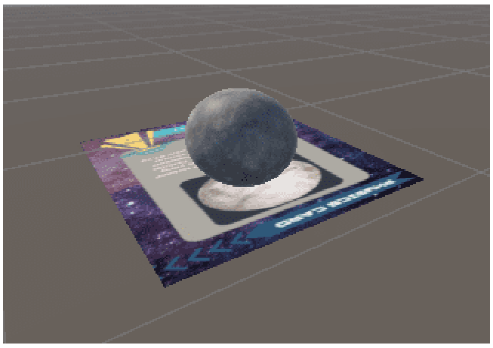

Figure 9. Placement of 3D objects on top of markers using the Image Target feature in Unity

d. Stages of Planning the Augmented Reality Main Menu
The user interface in the form of the main menu is designed using the two-dimensional (2D) display mode in Unity. This interface includes visual elements such as backgrounds, navigation buttons, and icons designed to support user interactivity. All components are organized in a single Canvas and adjusted to the screen resolution of the target device. This menu serves as a control center that directs users to specific scenes, such as object information, galleries, or augmented reality displays.

e. Stages of Setting Navigation Between Scenes Using Hyperlinks
Navigation between scenes is controlled by utilizing simple C# language-based programming in Unity. Each button on the interface is assigned a scene switching function through a special script that is directly linked to the button object. All scenes that have been created are added to the Build Settings so that they can be called by the system at runtime.

f. Stages of Adding Interactive Audio Features
Additional features in the form of narrative audio are added to enhance the appeal and educational functionality of the app. The audio is inserted into the GameObject via the Audio Source component, then controlled via the play button connected to the sound player script. The audio file contains a brief explanation of each planet or Solar System object, which can be played individually based on user interaction.
The author has successfully designed and installed this application on Android devices. This section presents the results of documentation in the form of screenshots and an explanation of the appearance of the Solar System Interactive learning application of solar system objects using augmented reality technology.

Figure 10. Initial view of the app

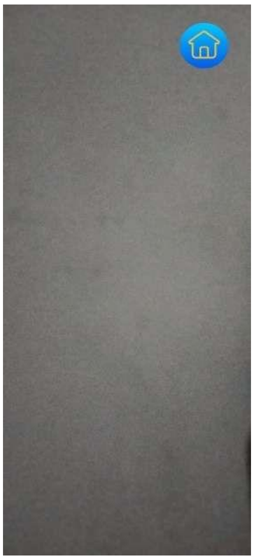

Figure 11. AR camera page

Figure 12. The 3D object appears after the camera detects the card

Figure 13. Instructions page

Figure 10 shows the app's initial view that presents three main buttons. The three buttons direct the user to the AR camera page (Start), media usage instructions, and exit button. Figure 11 shows the AR camera page. The AR camera page is a key feature in the app that allows users to display 3D objects when the camera is pointed at the prepared card. Once a planetary object appears, the app will display a play button that you can press to play an explanation about the planet. In addition, there is a button with a picture of a house that functions to return to the main page (home). Figure 12 shows the app's success in rendering 3D objects through the AR camera page after the card was successfully detected by the system. The 3D object, along with other virtual elements such as the information button (Play), is displayed interactively on a real surface. The 3D objects that can be displayed in this feature include the sun and all the planets in the solar system, namely Mercury, Venus, Earth, Mars, Jupiter, Saturn, and Uranus. Each object is accompanied by an informative explanation that can be accessed through the Play button, so that users can obtain information about the characteristics of each of these objects. Figure 13 shows the user manual page that appears after the user presses the instruction button on the main menu. This page explains the functions of each button contained in interactive media, including the Start button to access the AR camera page, the Instructions button to return to this page, and the Exit button to exit the application. In addition, this page also presents information about how to use an AR camera, namely by pointing the device's camera to a marker that has been prepared until an illustration of a 3D object appears on the screen.

4. Testing

The test in this study uses the black-box testing. Black box testing is a test that is performed only observing the execution results through test data and checking the functionality of the software (Syarifah & Abd Latif, 2024). Black box testing is a testing method that focuses on the functionality of the software by testing various input conditions without knowing the internal structure of the program (S. D. Pratama et al., 2023). So *black box testing* is a method of testing software that evaluates its functionality based on the results of various inputs, without looking at the internal structure of the program. Table 1 Present results Black Box.

Table 1. Black Box Results

Responses	Action	Result
Press the "Start" button	Display camera page	Succeed
Pressing the "Instructions" button	Display the app's user instructions page	Succeed
Pressing the "Exit" button	Exit the app	Succeed
Press the "Home" button	Showing the main page	Succeed
Point the camera at the Sun card	The Sun 3D object and the "Play" button appear	Succeed
	Press the "Play" button and an audio appears with a brief explanation of the Sun	
Point the camera at the Saturn card	Saturn 3D objects and the "Play" button appear	Succeed
	Pressing the "Play" button then an audio appears with a brief explanation of Saturn	
Point the camera at the Mars card	Mars 3D objects and the "Play" button appear	Succeed
	Pressing the "Play" button will bring up an audio with a brief explanation of Mars	

Point the camera at the Venus card	The Venus 3D object and the "Play" button appear Pressing the "Play" button then an audio appears with a brief explanation of Venus	Succeed
Point the camera at the Moon card	Moon 3D object and "Play" button appear Pressing the "Play" button will bring up an audio with a brief explanation of the Moon	Succeed
Point the camera at the Neptune card	Neptune 3D object and "Play" button appear Pressing the "Play" button will bring up an audio with a brief explanation of Neptune	Succeed
Point the camera at the Mercury card	Mercury 3D object and "Play" button appear Pressing the "Play" button will then appear an audio with a brief explanation of Mercury	Succeed
Point the camera at the Jupiter card	Jupiter 3D objects and the "Play" button appear Pressing the "Play" button will bring up an audio with a brief explanation of Jupiter	Succeed
Point the camera at the card Uranus	Uranus 3D object and "Play" button appear Pressing the "Play" button then an audio appears with a brief explanation of Uranus	Succeed
Point the camera at the Earth card	The 3D Earth object and the "Play" button appear Pressing the "Play" button will bring up audio with a brief explanation of the Earth	Succeed

5. Validation/Distribution

The result of the distribution stage is in the form of APK files from the developed application. The file is then uploaded to cloud storage for users to access. In this study, Google Drive was used as a cloud storage medium. The distribution process of this application.

D. CONCLUSIONS AND SUGGESTIONS

Based on the results of development and testing, an android-based solar system interactive learning development application using augmented reality with unity and blender has been proven to function optimally and be well accepted by users. This application provides an interactive and engaging learning experience, and has the potential to be an effective alternative to conventional learning media. The development process follows the MDLC stages and black-box testing shows that each feature performs according to its function. The results of field trials show that this application not only makes it easier to understand the concept of the solar system, but also increases students' interest in learning.

REFERENCES

Aditya, B., Hidayat, S., Ikhsan, A., & Wulandari, B. (2024). *Development of a Solar System Learning Application Using Markerless Augmented Reality Based on Android*. *11*(2), 49–54. https://doi.org/10.31294/inf.v11i2.19084

Gumilang, B. G., & Qoiriah, A. (2023). Android app for markerless augmented reality-based arachnophobia therapy. *Journal of Informatics and Computer Science (JINACS), 04*, 322–333. https://doi.org/10.26740/jinacs.v4n03.p322-333

Haudi, H. (2021). *Learning strategies*. Insan Cendekia Mandiri.

Kanti, L., Rahayu, S. F., Apriana, E., & Susanti, E. (2022). Analysis of the Development of Augmented Reality-Based Learning Media with the POE2WE Model on Gas Kinetic Theory Material: Literature Review. *Journal of Education and Physical Sciences*, *2*(1), 75. https://doi.org/10.52434/jpif.v2i1.1731

Panggabean, S., Widyastuti, A., Damayanti, W. K., Nurtanto, M., Subakti, H., Kholifah, N., Chamidah, D., Sianipar, L. K., Purba, D. P. Y. A. F. J., & Cecep, H. (2021). *Learning Concepts and Strategies* (R. W. & J. Simarmata (ed.); 1st ed., Issue August). Our Writing Foundation.

Pratama, R. B. A., & Mubarok, A. (2022). Application of Augmented Reality Technology in Solar System Subjects with Marker Based Tracking Method. *Information Systems E-Commerce...*, *3*(2), 253–260. http://eprosiding.ars.ac.id/index.php/psi/article/view/690

Pratama, S. D., Lasimin, L., & Dadaprawira, M. N. (2023). Black Box Testing on the Edu Digital Application is based on a website using the Equivalence and Boundary Value methods. *J-SISKO TECH (Journal of Information Systems Technology and TGD Computer Systems)*, *6*(2), 560.

Rahmatika, A., Manurung, A. A., & Ramadhani, F. (2023). Development of Augmented Reality-Based Learning Media to Increase Early Childhood Empathy with the MDLC (Multimedia Development Life Cycle) Method. *Sudo Journal of Informatics Engineering*, *2*(3), 122–130.

Rosa, A. C., Sunardi, H., & Setiawan, H. (2019). Augmented Reality Engineering of Planets in the Solar System as a Learning Media for Students of SMP Negeri 57 Palembang. *Global Informatics Scientific Journal*, *10*(1). https://doi.org/10.36982/jiig.v10i1.728

Santi, L. N., Nuriman, N., & Mahmudi, K. (2022). Development of Augmented Reality (AR)-based textbooks using Assemblr Apps in theme 9 "Exploring Outer Space" grade VI elementary school. *Elementary School: A Study of Educational Theory and Practice*, *31*(2), 78. https://doi.org/10.17977/um009v31i22022p078

Sholeh, M., Fatkhiyah, E., & Aprianto, H. (2023). Developing an Augmented Reality Application as Instruction Media to Help in Learning the Solar System. *International Journal of Advances in Data and Information Systems*, *4*(2), 20–28. https://doi.org/10.25008/ijadis.v4i2.1264

Syahputra, F., Naufal, T., Haqnizo, E., & Ramadhi, W. (2024). *The Use of Augmented Reality Technology in Unity-Based Simple Space Building Applications and Vuforia Engine*. *2*(4).

Syarifah, S., & Abd Latif, K. (2024). Web-based e-learning design at Smk Sidratul Munthaha Yapis Wamena Papua using the Blackbox method. *Rabit: Journal of Information Technology and Systems, Univrab*, *9*(2), 343–354. https://doi.org/10.36341/rabit.v9i2.4701

Unaenah, E., Aulia, N., & Rahma, S. N. (2023). Factors Causing the Lack of Effectiveness of the Use of Teaching Aids in Learning to Measure Units of Time in Grade V Students. *Masaliq*, *3*(6), 1007–1018. https://doi.org/10.58578/masaliq.v3i6.1567

Widodo, A., & Utomo, A. B. (2021). Augmented Reality-Based Animal Taxonomy Learning Media with Multi-Target Features. *Edu Computing Journal*, *8*(1), 1–8. https://doi.org/10.15294/edukomputika.v8i1.40611

Wijaya, I. M. P. P. (2022). Android-based animal recognition augmented reality app uses the Vuforia library. *Journal of Information Systems and Informatics (Simika), 5*(2), 173–181.

Yusuf, A., Suardana, I. N., & Selamet, K. (2021). Development of Flashcard Learning Media for Junior High School Science Solar System Materials. *Indonesian Journal of Science Education and Learning (JPPSI), 4*(1), 69–80. https://doi.org/10.23887/jppsi.v4i1.33181

Zebua, T., Nadeak, B., & Sinaga, S. B. (2020). Basic Introduction of 3D Blender Applications in 3D Animation Creation. *Journal of ABDIMAS Budi Darma*, *1*(1), 18–21.