

# DEVELOPMENT OF ANDROID-BASED AUGMENTED REALITY LEARNING MEDIA ON THE INTRODUCTION OF GEOMETRY MATERIAL FOR KINDERGARTEN STUDENTS

Taufik Rachman <sup>1</sup>, Hilal Istafaina Awab <sup>2</sup>

Informatics Engineering Department, Sekolah Tinggi Teknologi STIKMA Internasional Malang  
*ktopik@gmail.com*

## ABSTRACT

This research aims to develop an application that can help kindergarten students in understanding space buildings in the introduction of Geometry subject. Research and development of the application used Research and Development (R&D) method that aim to produce certain products and test the effectiveness of these products. The product was developed using the ADDIE Process model method. The ADDIE software development model has five stages: analysis, design, development, implementation, and evaluation. This geometry learning media application using Unity 3D was tested through the Black Box Testing method and questionnaire testing. This learning application can help teachers in teaching the material of geometry through media applications to contribute a more interactive learning process.

**Keyword :** *Geometry, Research and Development, ADDIE, Blackbox, Unity 3D*

## 1. INTRODUCTION

Current technological advances in the world of education require maximum efforts to be able to produce quality students to face science and technology. One of the uses of smartphone technology in the field of education is as a learning medium. Learning media in general is a tool for teaching and learning process. Anything that can be used to stimulate thoughts, feelings, attention and learning abilities or skills so that it can encourage the learning process.

The implementation of teaching and learning activities carried out in the classroom is often found problems, including teachers who consider students as objects that can only receive learning from the teacher, as well as the amount of subject matter that students need to learn. In addition, teachers are less accustomed to using diverse learning media.

Therefore, learning media will be made in the form of Android-based augmented reality applications so that students can learn more easily. The choice of Augmented Reality technology is because users will be presented directly with an attractive display. This learning media has already been done by Andi nurul mutia et al (2019), he made a learning media application with Android-based Augmented Reality technology. To run the application using an android smartphone. They make the application of course aims to facilitate the teachers and also the students of TK /RA in the process of introducing the wake space.

## 2. LITERATURE REVIEW

### 2.1. Kindergarten Learning

Kindergarten education is known as the type of education that parents usually take so that their children will be better prepared for elementary school. In the area of kindergarten education,

children are given a variety of basic lessons that are often taught with interactive materials.

During kindergarten education, children are usually not able to digest more difficult lessons because they still need to have fun. Therefore, kindergarten teachers also use various playful methods to help students understand the material being taught.

The purpose of kindergarten education itself is very noble because it is directly related to the growth and development of children from an early age. According to Anderson (1993), kindergarten is designed in such a way that it can provide very adequate learning facilities later on and cover various aspects of development at the same time.

Some people think that kindergarten is the same as a playgroup, but in fact, kindergarten education is not the same as a learning/playgroup. This is because the 2003 National Education System Law states that playgroups are a non-formal version of kindergarten education.

In fact, the formal education of children through kindergarten is still "liberated" in the sense that the curriculum is still not too strict. Bredecamp (1997) states that the curriculum of kindergarten education is very much adapted to the character of children who still like to have fun. The kindergarten curriculum is constantly evolving from year to year, because basically the aspects of education and play, which are a means of children's cognitive development, need to be balanced. Meanwhile, according to deVries (2002), play is a means of developing children's mindset.

Kindergarten lessons can be in the form of basic science, activities that can stimulate children's motor skills, and lessons that stimulate students' language skills. In addition, a variety of activities

that can develop the social and emotional side of the child are also needed.

## 2.2. Learning

Learning is a combination of human elements, facilities, equipment and processes that work together to achieve the learning objectives themselves. The term learning can be interpreted from various perspectives from a behavioral perspective, learning is the process of changing student behavior by optimizing the environment as a source of learning motivation learning is a systematic activity and has components, each of which is not separate, but must work regularly, interdependently, complementary and continuous. Learning can be defined as learning with important aspects of how students can actively learn the topics presented so that they can be well controlled.

Learning is a fundamental function of the entire educational process, because the success or failure of education depends on how the process takes place Learning takes place after learning ends. Whereas teaching is essentially an activity carried out by teachers disseminating information to students at school. Teaching and learning is basically a regulatory process carried out by the teacher.

## 2.3. Learning Media

Understanding Learning Media requires different types of media to motivate students to learn. Learning media is one of the methods or tools used in teaching and learning activities. It should stimulate the learning model, support the success of the teaching and learning process, and enable the effective achievement of the objectives of teaching and learning activities. There are different learning environments. And in this modern age, the role of technology has taken over in many aspects, including the world of education. One of the challenges of learning media is to get students interested in the topics presented. In fact, learning is often neglected for various reasons. This doesn't have to happen if every facilitator has the knowledge and skills to research media.

Before getting to know the different types of learning environments, it is important to understand the importance of proper learning for students. The word media comes from the Latin word *medius*, which means mediator, intermediary, or facilitator. More specifically, the concept of media in the teaching and learning process tends to be interpreted as graphic, photographic, or electronic tools for capturing, processing, and reorganizing visual or verbal information. In general, media is a tool to communicate and convey educational messages. Learning media are all the functions, tools and media used in the learning process. What are learning media according to Latuheru? An online learning environment helps to increase students'

interest in the learning material presented. It also helps students to understand the material better. Therefore, it is important to use learning media during training and learning to motivate students to learn.

We use the term media as a point of contact for the transmission of information from a source to a receiver. This definition can be emphasized in terms of the learning environment as a mediator. Mass media helps to connect information from one party to another. In education, the word media is also referred to as the learning environment. Learning media can be used to receive and transmit messages and information in the education and learning process to attract students' attention and interest in learning.

According to Heinich and friends (1983) in Arysad (2013:3), the learning environment clearly states that in it there are tools that are physically used to convey material content. From these two definitions, according to media experts, it is a means of presenting learning material in such a way that the learning process is not boring and attracts the attention of children. Gagne and Briggs (1975) in Arysad (2013:4)

Three main elements are the most important features in the recognition of learning media are:

1. Sound (audio), also divided into broadcast media (telecommunications) and mass media records (registration).
2. Visuals, divided into three, namely images, lines and symbols, which are a continuum of forms that can be seen by the sense of sight.
3. The movement of the above opinions can be concluded that the characteristics of a good learning environment are learning from the media as a better learning aid, which can be in the form of sound, images, recordings, films / videos, lines, symbols, which can be converted into summary objects of events that are then repeated as an overview.

## 2.4. Android as Teaching Media

Android is very supportive of learning with various features that have been provided. All available features are very useful to help students understand learning materials, so that teachers do not need to explain repeatedly, students can more easily understand learning materials through media. In addition, students tend to prefer learning through media rather than just listening to teachers' explanations, students will find it more difficult to understand what is conveyed (Fansury, 2017).

In order to maximize the teaching and learning process, teachers need to be able to choose the type of media or features to be used in learning. To be able to use Android applications as learning media, teachers need to know at least 6 things so that the use of Android as a learning media can be maximized and can really support the learning process.

In addition, teachers must also be able to overcome the negative effects of using Android as a learning medium, for example, by supervising the student's use of the application on Android so that the goal does not deviate in an undesirable direction. In this way, the learning objectives can be achieved and the learning process is not disturbed. A teacher should also make combinations in their teaching models to stay creative.

## 2.5. Geometry

Geometry are mathematical shapes that have content or volume. This shape has a volume bounded by several sides. The number and type of sides that bound the shape determine the name and shape of the shape. Different types of simple geometry include blocks, cubes, tubes, spheres, and cones (Listy, 2017).

Geometry can also be interpreted as part of the geometric plane. A spatial figure is a three-dimensional building with space or volume and side boundaries. The shape of the space can be divided into two types, namely the shape of the curved side and the shape of the flat side. Examples of curved side shapes are cones, spheres, and cylinders, while flat side shapes are cubes, blocks, pyramids, and prisms.

Geometry shapes used in this media are:

- a. Cone, Cone is a three-dimensional space that has a circular base and a curved side as a ceiling that has a slice of the circle. The cone is similar to a tube in that both have a circular base. But it has a difference from the ceiling side. The surface of the cone is the upright side of the cone.
- b. Tube, Tubular space is a three-dimensional space that has a cover and a circular base of the same size, and the upright side plane encloses the "body" with a rectangle. Examples of tubular objects are milk cans, barrels, etc.
- c. Cube, The cube is a three-dimensional space bounded by 6 (six) equal sides, 12 (twelve) equal-length ribs, and 8 (eight) vertices. The cube has a square shape and has another word that is a regular six-plane. Examples of cubes are equal-sized cardboard boxes, dice, etc.
- d. Beams, A beam is a three-dimensional solid that is bounded by 2 (two) squares and 4 (four) rectangles that are perpendicular to each other. Unlike the cube, whose sides are congruent rectangles, blocks have sides that are the same size. Examples of blocks in our lives are pencil boxes, cabinets, refrigerators, etc.
- e. Pyramid, Pyramid is a three-dimensional space bounded by a rectangular base and has a top point. There are many types of pyramids, such as triangular pyramids, rectangular pyramids, pentagons, and others. A pyramid with a square base is called a pyramid, while a pyramid with a circular base is called a cone. An example of a

pyramid object is the square base pyramid in Egypt.

- f. Prism. A prism is a three-dimensional space bounded by a base and a top in the shape of a square (various) of the same size (congruent). Examples of everyday objects that we encounter in the form of prisms are the roof of a house, camping tents, and others.
- g. Spherical space is a three-dimensional space that has curved side boundaries. The sphere has no ribs or vertices because it is round. But the sphere has a curved side plane as a volume or space divider. An example of an object we usually encounter is the ball we use to play soccer.

## 2.6. Android



Figure 1. Android Logo

Android is an open-source Linux-based operating system licensed under the APACHE 2.0 license and designed for touchscreen mobile devices such as smartphones and tablets. Android was originally developed by Android, Inc. with financial support from Google, which acquired the company in 2005. The operating system was officially released in 2007 with the formation of the Open Handset Alliance, a hardware, software, and telecommunications organization dedicated to promoting open standards for mobile devices. The first Android phone was released in October 2008.

Android is an open-source operating system, and Google releases its code under the Apache license. The open-source code and the Android license allow device manufacturers, operators, and developers to freely modify and distribute the software. In addition, Android has a large number of software developers (applications) that extend the functionality of the device, usually written in a specialized version of the Java programming language. As of October 2013, more than one million apps are available for Android, and approximately 50 billion apps have been downloaded from Android's main app store, Google Play. According to a survey conducted in April and May 2013, Android is the most popular platform for developers, used by 71% of mobile app developers. At Google I/O 2014, Google announced that there are more than 1 billion monthly active Android users, up from 583 million in June 2013.

Android Oreo, codenamed Android O during development, is the eighth version of the Android mobile operating system. It was first released as a

premium developer preview on March 21, 2017. A second developer preview was released on May 17, 2017, and is considered a beta version. The third developer preview was released on June 8, 2017 and completed the API. The fourth developer preview was released on July 24, 2017 and included final system functionality and the latest bug fixes and optimizations. It was released to the public on August 21, 2017. Google unveiled a statue of the dessert-style upgrade in Manhattan's 14th Street Park, near the original Nabisco factory where the first Oreo was made.

## 2.7. Blender



Figure 2. Blender Logo

Blender is open-source 3D computer graphics software. This software is used to create animated films, visual effects, 3D printed models, 3D interactive applications, and video games. Blender has several features such as 3D modeling, texturing, bitmap image editing, solidification, liquid and smoke simulation, particle simulation, animation, video editing, digital sculpting and rendering.

Since 1988, Ton Roosendaal has funded an animation company called NeoGeo. NeoGeo quickly became the largest animation company in the Netherlands and one of the leading animation companies in Europe. In addition to his art direction, Ton Roosendaal was also responsible for internal software. In 1995, software appeared which was then called Blender. A closer look reveals that Blender has potential for use by artists beyond NeoGeo. In 1998, Ton founded a company called Not a Number (NaN) to further develop and market Blender. NaN's goal is to develop lightweight cross-platform 3D animation software that is free and accessible to the community or general public.

## 2.8. Unity



Figure 3. Unity Logo

Unity 3D is software that is used to create various applications such as presentations, websites and can be used to create AR.

Unity 3D can create 3-dimensional objects in video games or for other interactive contexts such as

architectural visualization or real-time 3D animation.

## 2.9. Photoshop



Figure 4. Photoshop Logo

Adobe Photoshop, or commonly known as Photoshop, is an image editing program from Adobe Systems specifically designed for editing photos/images and creating effects. Widely used by digital photographers and advertising agencies, this software is recognized as the market leader in image/photo editing software and, along with Adobe Acrobat, the best product ever created by Adobe Systems. The eighth version of this application is called Photoshop CS (Creative Suite), the ninth version is called Adobe Photoshop CS2, the tenth version is called Adobe Photoshop CS3, the eleventh version is called Adobe Photoshop CS4, the twelfth version is called Adobe Photoshop CS5 and the thirteenth version is CS6 and the latest version is Adobe Photoshop CC (Creative Cloud). Photoshop is available for Windows, Mac OS X and Mac OS; Version 9 and above can also be used on other operating systems such as Linux.

## 2.10. Vuforia SDK



Figure 5. Vuforia SDK Logo

Vuforia itself is an SDK developed by Qualcomm to help developers create applications or games using augmented reality technology. Of course, applications and games created with this technology look more interactive and lively.

Developers can create 3-dimensional virtual objects that can interact with application users, whether in the form of games, learning applications, videos, fairy tale applications, and many more. Vuforia SDK makes it easier and faster for developers to create applications using augmented reality technology because the libraries and core functions are provided by Qualcomm, so developers can easily imagine and develop interesting applications using this SDK. This SDK itself has several interesting features such as object scanning,

text scanning, frame mark detection, virtual buttons, intelligent object surface detection, cloud-based scanning, image object detection, cylindrical object detection, and predefined target object detection.

Vuforia SDK itself supports application development for iOS and Android-based devices. In addition, the Vuforia SDK supports the Unity game engine, which facilitates development. Now more than 15,000 applications in the world have used the Vuforia SDK to integrate Augmented Reality feature capabilities. In addition, 150,000 application or game developers have registered to use the Vuforia SDK.

### 2.11. Augmented Reality

AR (augmented reality) is a technology that combines two-dimensional and/or three-dimensional virtual objects into a real environment and then projects these virtual objects in real time. Augmented reality can be applied to all senses, including hearing, touch, and smell. Apart from being used in fields such as health, military, manufacturing industry and education. This AR technology can insert certain information into the virtual world and display it in the real world with the help of equipment such as webcams, computers, Android phones, or special glasses.

Augmented Reality is an effort to combine the real world with a virtual world created via computer so that the boundary between the two is very thin. (Mukhlis, 2012).

Augmented Reality (AR) is a variation of Virtual Environment (VE) or better known as Virtual Reality (VR), while virtual reality means a situation where the user is completely in a virtual environment. When in that environment the user himself cannot see the real world around him. In contrast to AR, which can still see the real world and virtual objects are only displayed in the real environment. Therefore, AR is only an addition to reality and not a replacement for it (Pamodji, 2012).

The methods developed in Augmented Reality are currently divided into two methods, namely Marker Based Tracking and Markless Augmented Reality.

- a. Augmented Reality (Marker Based Tracking) markers are usually square black and white illustrations with thick black borders and a white background. The computer will recognize the position and orientation of the marker and create a 3D virtual world, namely points (0,0,0) and three axes, namely X, Y, and Z.
- b. Markerless Augmented Reality One of the Augmented Reality methods that is currently being developed is the "Markerless Augmented Reality" method, with this method users no longer need to use a marker to display digital elements, with the tools provided by Qualcomm for developing Augmented Reality based on mobile devices, making it easier for developers

to create markerless applications (Qualcomm, 2012).

### 3. RESEARCH METHOD

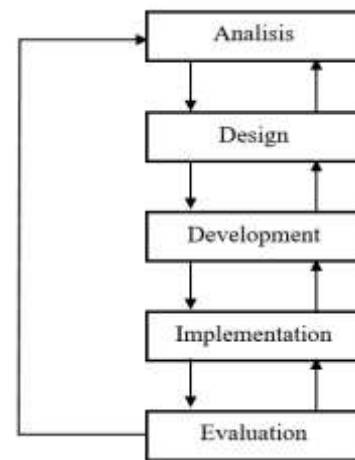


Figure 6. ADDIE Method

This research is a type of research and development which aims to produce products and test product feasibility.

The development model used is the ADDIE development model according to Lee and Owens. The ADDIE development model in this research is the ADDIE development model proposed by Lee and Owens (2004). The ADDIE development model proposed by Lee and Owens is a development model for developing multimedia. Lee and Owens' development model consists of five stages, namely: (1) Assessment and analysis; (2) design (design); (3) Development (development); (4) Implementation and; (5) Evaluation.

This research uses the ADDIE development model. ADDIE development procedures include:

- a. Analysis  
At this stage an initial analysis will be carried out, starting from tool and material requirements, designing the concept and designing the design.
- b. Design  
The design stage is the stage of designing the product to be made. The design stage starts from making a research schedule plan, making a material structure that is designed in such a way that it is easy to understand, and making specifications for the media to be made.
- c. Development  
The development stage was carried out to obtain a product in the form of learning media, validating the product by material experts and media experts. The product developed is an Android-based learning media application. Researchers at this development stage create products using Unity 3D software.
- d. Implementation  
The implementation stage aims to apply the product that has been developed to users. The

application of the product to previous users of the product has been validated from the material aspect and media aspect first.

e. Evaluation

The evaluation stage aims to measure the level of conformity of the product with what is required. Evaluation is carried out after testing the user and then asking the user for feedback. The feedback is carried out with instruments. The instrument used is a questionnaire. The results of the evaluation are used as material or reference for making improvements.

## 4. RESULT AND DISCUSSION

### 4.1 Main Menu Scene Display

The Main Menu scene is the initial display of this Augmented Reality application. Here there are several buttons that lead to several scenes including Main, Info, Credit and the Exit button.



Figure 7. Main Menu Scene Display

### 4.2 Main scene display

In this scene, the user is required to point the smartphone camera at the marker provided. Then a 3D detail of the spatial structure will appear which is directed according to the data from the marker.



Figure 8. Main scene display

### 4.3 Info Display

This scene shows the function of the buttons and how to use the application.



Figure 9. Info scene display

### 4.4 Credit scene display

This scene displays the name of the application creator.



Figure 10. Credit scene display

### 4.5 Testing

Based on the design and work results that have been achieved, the implementation process continues. Implementation is also a process of creating and implementing a complete application, both in terms of functionality and the expected processes.

Testing this application uses black box testing techniques, where at this stage we will ask from the user's side what functionality and features have been provided.

Table 1. Distance Test Result

No.	Distance	Information
1	6 cm	Detected
2	8 cm	Detected
3	10 cm	Detected
4	20 cm	Detected
5	30 cm	Detected



Table 2. Camera Angles Test Result

No.	Sudut	Information
1	30°	Detected
2	40°	Detected
3	50°	Detected
4	90°	Detected
5	130°	Undetected

Table 3. Marker Test Result

No.	Marker	Information
1	Cube	Detected
2	Beam	Detected
3	Pyramid	Detected
4	Tube	Detected
5	Cone	Detected

#### 4.6 Cube Component Test



Figure 11. Cube Components Test

#### 4.7 Beam Component Test



Figure 12. Beam Component Test

#### 4.8 Pyramid Component Test



Figure 13. Pyramid Component Test

#### 4.9 Tube Component Test



Figure 14. Tube Component Test

#### 4.10 Cone Component Test



Figure 15. Cone Component Test

#### 5. CONCLUSION AND SUGGESTION

The conclusion that can be drawn from the realization of an Android-based augmented reality learning media application with material for introducing spatial structure for kindergarten students is the realization of an Android-based augmented reality learning media application with material for introducing spatial structure for kindergarten students. From the results of feedback evaluation, it was concluded that many users were interested and felt that this Android-based learning media was very useful. In this era, most people already have smartphones with the widely used Android operating system.

#### REFERENCES

- [1] Andi Nurul Mutia, Apriyanto, Ahmad Ali Hakam Dani (2019) Rancangan Bangun Media Pembelajaran Bangun Ruang Augmented Reality Berbasis Android Pada Smp Negeri 8 Palopo.
- [2] Gramedia <https://www.gramedia.com/best-seller/pelajaran-anak-tk/>
- [3] Iwan Setya Nugraha1), Kodrat Iman Satoto2), Kurniawan Teguh Martono2),” Pemanfaatan Augmented Reality Untuk Pembelajaran Pengenalan Alat Musik Piano (Fakultas Teknik, Universitas Diponegoro)
- [4] Ida Bagus Made Mahendral (2016).” Implementasi Augmented Reality (Ar) Menggunakan Unity 3d Dan Vuforia Sdk (Universitas Udayana)”
- [5] Indrawan Al Ikhsan1\*), Nanang Supriadi2, & Wawan Gunawan3 (2022).” Media Pembelajaran Berbasis Augmented Reality: Materi Bangun Ruang Sisi Datar (Universitas Islam Negeri Raden Intan Lampung)
- [6] Kemendikbud.go.id <http://solmet.kemdikbud.go.id/?p=2895> Dikutip 18 juli 2023
- [7] <https://www.rikaariyani.com/2022/09/Langkahlangkahpenelitian%20R%20%20D.html> Dikutip 18 Juli 2023
- [8] Lee, William W & Owens, Diana L. 2004. Multimedia-Based Instructional Design. San Fransisco: Pfeiffer.
- [9] Melisa Primatika Putri (2014).” Perancangan Media Pembelajaran Matematika Volume Bangun Ruang Kelas VI SD Menggunakan Teknologi Augmented Reality Dan Animasi 3D Pada Android (Universitas Kristen Satya Wacana Salatiga)
- [10] Model pengembangan ADDIE <https://ranahresearch.com/model-penelitian-pengembangan-addie/>
- [11] Novan Ari Nugroho1, Ahmad Ramadhani2 (2015).” Aplikasi Pengenalan Bangun Ruang Berbasis Augmented Reality Menggunakan Android (Politeknik Negeri Tanah Laut)
- [12] Pengertian pendidikan menurut para ahli
- [13] <https://www.ejurnal.com/2013/11/pengertianpendidikanmenurutparaahli.html> Dikutip 21 juli 2023
- [14] Perkembangan teknologi dalam dunia pendidikan
- [15] <https://jurnalpost.com/perkembanganteknologiidalampendidikan/41610/#:ext=Teknologi%20dalam%20Pendidikan%20adalah%20metode,mencapai%20bentuk%20Pendidikan%20yang%20efektif> Dikutip 21 juli 2023
- [16] Pengertian pembelajaran
- [17] <https://www.zonareferensi.com/pengertian-belajar/> Dikutip 22 juni 2023
- [18] Ridwan Abdul Hanan1, Ibnu Fajar2, Surya Amami Pramuditya3, Muchamad Subali Noto4 (2018).” Desain Bahan Ajar Berbasis Augmented Reality pada Materi Bangun Ruang Bidang Datar (FKIP Universitas Swadaya Gunung Jati Cirebon)
- [19] Rujianto Eko Saputro1, Dhanar Intan Surya Saputra2 (2014).” Pengembangan Media Pembelajaran Mengenal Organ Pencernaan Manusia Menggunakan Teknologi Augmented Reality (STMIK AMIKOM Purwokerto)
- [20] Sampoernaacademy.sch.id <https://www.sampoernaacademy.sch.id/id/bangunruan/> Dikutip 18 juni 2023