

Application of Augmented Reality Technology in Android-based Creative and Interactive Learning Simulation

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ABSTRACT

Creative learning media is media made by teachers tailored to the subject matter/subject matter, theme/subtheme so that it really suits the material and the needs of students. Interactive learning media can encourage students to learn independently, resulting in student-centred learning. As a result, the utilisation of technology to create effective learning media is necessary. Virtual technology accurately represents real objects when providing information. Augmented Reality is one example of virtual technology. Augmented reality is a concept that combines digital data into the virtual world and displays it in real time. Augmented reality uses the use of objects as markers to display 3-dimensional images, videos, audio, text, and visuals, as well as virtual 3-dimensional tools and practicum materials and simulation videos in learning. Since 3-dimensional objects, text, images, video, and audio can be displayed to students in real time, learning media using augmented reality technology with markerbased tracking method can easily improve student understanding. This research method uses quantitative research method based on literature study and DDD-E development method. At the design stage the author uses a structured design method, namely the Unified Modelling Language (UML) which includes Use Case, and activity diagrams, navigation structures and storyboards. This application is designed with Unity 3D software using the Vuforia sdk. So the results of the above design are implemented into an application called Pustaka Nusantara Application which can display 3-dimensional objects to support creative learning media and realise an interactive learning system.

Keywords: *Augmented Reality, markerbased tracking, quantitative, DDD-E, UML, Unity 3D, Vuforia, creative learning media, interactive learning system*

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INTRODUCTION

Badan Pusat Statistik (BPS) noted that the percentage of mobile phone users in Indonesia reached 67.88% in 2022. This figure increased by 2.01% points compared to the previous year which was 65.87% (bps.go.id, 2024a). The percentage of mobile phone users in Indonesia tends to show an increase from year to year and is in line with

the number of Indonesian residents who increase every year. With the influence of the industrial revolution changing to the digital era, where everything is connected automatically and uses computer technology and information systems. One solution that can be done is to create a technology-assisted learning environment. Various efforts to improve the quality of education have been and will continue to be made, including the completion of school infrastructure (Abdullah, 2018). The development of technological innovation in today's modern era is impossible to avoid. Technological developments in all areas of life are no exception to the field of education (Irawan, 2020). One of the things that can be done to make the learning process creative and interactive is by selecting and using the right learning media.

Creative learning media is media made by teachers tailored to the subject matter/subject matter, theme/subtheme so that it really suits the material and the needs of students. Interactive learning media can encourage students to learn independently, resulting in student-centred learning. As a result, the utilisation of technology to create effective learning media is necessary. Virtual technology accurately represents real objects when providing information. Augmented Reality is one example of virtual technology. Augmented reality is a concept that combines digital data into the virtual world and displays it in real time. Augmented reality uses the use of objects as markers to display 3-dimensional images, videos, audio, text, and visuals, as well as virtual 3-dimensional tools and practicum materials and simulation videos in learning. Since 3-dimensional objects, texts, images, videos, and audios can be displayed to students in real time, learning media using augmented reality technology can easily improve students' understanding of this type of interactive learning where students can provide feedback. Augmented Reality (AR) has been widely recognized as an effective technology for enhancing the learning experience in various educational contexts (Aji & Purbojo, 2023; Buditjahjanto & Irfansyah, 2023). The interactive and immersive nature of AR can help students better understand complex concepts, increase their motivation, creativity, and engagement in the learning process (Muhammad, 2022; Risdianto et al., 2023).

In the context of cultural subjects in Indonesia, AR can be particularly useful for enhancing the learning experience. AR can be used to create interactive simulations that allow students to explore and interact with virtual representations of cultural artifacts, historical sites, and other cultural elements. This can help students develop a deeper understanding and appreciation of their cultural heritage (ESTHER, 2024; Panou et al., 2018). The development of these AR applications often follows a structured design and development process, such as the DDD-E (Decide, Design, Develop, Evaluate) model (Wahidah et al., 2020). This model provides a systematic approach to the design and implementation of multimedia-based learning tools, ensuring that the final product meets educational and user requirements (Wahidah et al., 2020). Furthermore, the use of AR in learning simulations can be particularly beneficial for students in Indonesia, where the infrastructure for online learning may be uneven, especially in terms of internet connectivity (Risdianto et al., 2023)). AR-based learning

can provide an alternative to traditional online learning, as it can be accessed through mobile devices and does not require a stable internet connection (Risdiyanto et al., 2023).

Overall, the application of AR technology in creative and interactive learning simulations based on Android with cultural subjects in Indonesia has the potential to enhance the learning experience, increase student engagement and motivation, and provide an alternative to traditional online learning methods in areas with limited internet infrastructure.

METHOD

The DDD-E model, which stands for Decide, Design, Develop, and Evaluate, is a well-established research and development methodology that can be applied to the creation of AR applications and experiences (ATAHAN & Uyangör, 2021; Nopriana et al., 2023). This model allows for a structured and iterative approach to the development of AR systems, ensuring that the final product meets the needs and requirements of the target users (Challenor & Ma, 2019; Wannapiroon et al., 2021). In the context of AR research, the DDD-E model can be particularly useful for addressing learning obstacles and designing effective digital modules and learning materials (Ahmad, 2021; Nopriana et al., 2023). By analyzing student learning challenges and incorporating feedback from experts and users, the DDD-E approach can help researchers develop AR-based educational tools that are both engaging and pedagogically sound (Ahmad, 2021; Santos et al., 2014).

This research framework starts from problem formulation. At this stage, the researcher needs to identify and define the problem that will be discussed in the research. The research problem must be formulated clearly and specifically. The next stage is the data collection and management stage, which is the stage where researchers collect the data needed to answer research questions. Data can be collected using various methods, such as observation, interviews, questionnaires, or experiments. Next is the data analysis stage, where researchers analyse the data that has been collected to find patterns or relationships between variables. Data analysis can be done with various methods, such as statistical, qualitative, or mixed. After the data analysis stage, researchers proceed to the application design stage. The application design stage is the stage where researchers design augmented reality applications that will be used for research. This stage is important to ensure that the application designed is in accordance with the research objectives. After that, the application testing stage, the application testing stage is the stage where researchers test the augmented reality application that has been designed. This stage aims to ensure that the application is feasible or not for public use.

FINDING AND DISCUSSION

Problem formulation

Problem formulation is the first step in research. At this stage, researchers must identify and define the problems that will be discussed in the research. The problem formulation of this research is how the implementation of augmented reality system works in learning simulation and how to make augmented reality system that can be a creative and interactive learning media. From the formulation of the problem, the researcher proceeds to the next stage to build the application concept with the Limitation of the problem This research focuses on the implementation of augmented reality for the implementation of creative and interactive learning. The Android-based augmented reality application will only display 3-dimensional virtual objects. This research will focus on the subject of elementary school students. This research uses a medium for learning in the form of an android application.

Data Collection and Management

The data to be collected in this study are primary data and secondary data. Primary data is data collected directly by researchers from the source. Secondary data is data that has been collected by others. Primary data will be collected through observation, questionnaire, and experimentation methods. Secondary data will be collected through literature study. The collected data will be processed and analysed using qualitative analysis method. Here is the usage data smartphone at ages 5 years and above.

Age Group	Proportion of Individuals Who Own/Control Mobile Phones by Age Group (Percent)		
	2021	2022	2023
<15	38.27	40.25	36.99
15-24	90.78	91.82	92.14
25-64	72.10	74.09	74.80
65+	25.79	27.46	26.87

Figure 1. Smartphone usage data by age

Source: (bps.go.id, 2024b)

An overview of the current system in studying cultural objects using the method of reading books manually to get information, where I consider this learning method to be too boring and less interesting. The following is an illustration of the problem:

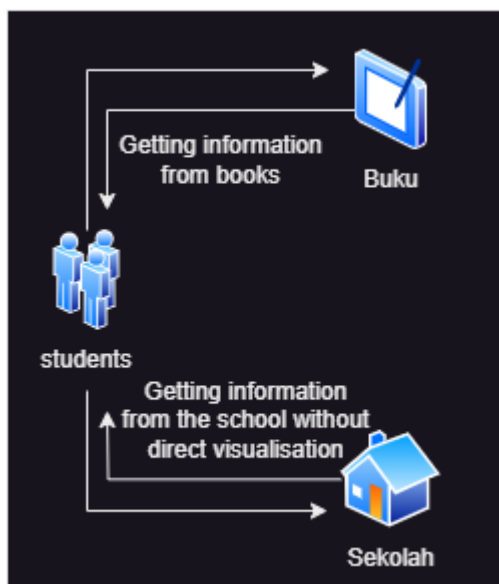


Figure 1. Analysis of the current system

The proposed system explains the description of the design of a new system for learning the introduction of traditional weapons using smartphones with markerbased tracking augmented reality learning methods using vuforia sdk. The application can bring up 3-dimensional objects as an introduction to props and information. The illustration can be seen in the picture below:



Figure 2. Analysis of the proposed system

It can be seen in Figure 4 above that students can see 3-dimensional objects of cultural objects and information through augmented reality mobile applications on smartphones. The augmented reality mobile application displays 3-dimensional objects and their information by scanning the marker that has been provided then the

application manages the scanned marker to the vuforia sdk and sends data in the form of 3-dimensional objects and information to the application. Students can receive direct information about cultural objects and know directly the shape of 3-dimensional objects of fine art objects. The system architecture in this study uses the augmented reality application system markerbased tracking method interacting with each other to produce the desired output. Interaction between hardware and software. The camera hardware captures images of the real world. The software performs data processing on the images captured by the camera. The software renders virtual objects on the display screen.

Interface Design

User interface is the interface that users use to interact with augmented reality applications. User interface can be in the form of buttons, icons, or menus. In accordance with the research topic, the user interface was created based on the theme of culture and education. where the user can choose between the start, information, music, help, and exit menus. If the user chooses the start menu, the user will enter the home activity page which has two menus, namely the map menu which contains an explanation of the culture of each region and the target marker to bring up 3-dimensional objects, and the question menu which contains questions. If the user selects the information menu, the system will bring up an information page about a brief description of the application. Furthermore, the music menu, the user can switch on or off the background music from the application. If the user selects the help menu, a page will appear on how the application works. And if the user selects the exit menu, the user exits the application.



Figure 3. Home Screen

Displays a home page with a feature about the app with a "?" symbol and a sound to switch the background music on or off. The top left displays the name of the app and the centre button is the start button to start the activity.



Figure 4. Activity Home Screen

This page contains the main menu of the application, namely the Map. The top left button has a function to return to the previous page.



Figure 5. Map Screen

Map page, this page displays a map of Indonesia as a whole and will bring up sub menus when clicked per region. The top right feature is a button to return to the home page.



Figure 6. Activity Map Screen

This page displays the name, territory, and general description of the selected region and there are 3 barcodes to bring up weapons, traditional houses, and home region clothes in 3D. There are 2 buttons, namely the back feature and the camera. The camera functions to scan the qr-code of the object in question.



Figure 7. House Marker Screen

This screen will appear when the user presses the home button and will change according to what is pressed. On this screen also appears a barcode screen on the left, which will be scanned with a camera and will bring up a 3D object. On the right is a brief discussion of the cultural object in question.



Figure 8. Camera Screen

This page is used to scan the marker and bring up the 3D object.

Application testing

The application presentation stage is the stage where researchers present the augmented reality application that has been designed. This stage is important to ensure that the application can be operated easily by students. Here the researcher will test the application before the application will enter the next stage, namely testing and evaluating the application. Researchers presented the beta version of the application which had the aim of introducing the application and how to use the application.

Table 1. Application test parameters

NO	Requirement tested	Point tested	Status
1	Home Screen	Display the Home screen.	Passed
2	Home Activity Screen	Users will be directed to the application activity page, namely the Map page	Passed
3	Map Screen	The user will be asked to select a destination on the map and will enter the MapActivity page which will display a brief cultural description and the target marker.	Passed
4	Map Activity Screen	Users are asked to interact with the buttons.	Passed
6	House Marker Screen	The user is asked to scan the marker to see if it shows the corresponding image or not..	Passed
7	Camera Screen	Users will be directed to the	Passed

		camera page which functions to scan the marker to bring up 3D objects.	
8	Exit	User exits the application.	Passed

CONCLUSION

Based on the discussion related to learning simulation using augmented reality system, the learning simulation applied is the concept of creative and interactive learning by utilising markerbased tracking method of augmented reality system that will scan the target to bring up 3-dimensional objects. For the discussion of augmented reality systems into creative and interactive learning media by utilising the android application platform, this can work. Learning system with an application will help the learning process to pursue. By using objects as teaching materials, students will understand more quickly. With this learning system, teachers will be easier to teach and students will be more interactive. The interaction will create a creative and interactive learning environment.

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