



Development of interactive learning media based on augmented reality about animal to improve students' cognitive ability

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ABSTRACT

Education is essential to students' intellectual and social growth. Effective learning affects children's cognitive development. Tech-based learning can be new and participatory, therefore the research goal is to use AR to master complicated ideas like animal knowledge. AR-based interactive learning material lets students see animal imagery in 3D, hear animal sounds, and observe animal activity online. For systematic learning material development, the research approach uses ADDIE. The research produced animal recognition AR apps for Android smartphones that have undergone a blackbox testing process with 5 valid scenarios. The material evaluation showed 7 aspects of assessment, including the quality of 3D object visualization from AR apps, which scored very good, and 6 other aspects, including the suitability of animal material, which scored good. Sound and language's impact on student's cognitive capacities, including understanding, learning experiences, and motivation. According to the evaluation of AR application material, it can improve students' cognitive abilities in learning to recognize animals, which can be used in the teaching and learning process, and 3D object visualization from AR applications can help students understand learning.

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1. INTRODUCTION

Education serves as a fundamental cornerstone in the intellectual and social growth of students. The impact of effective learning on the cognitive development of children is substantial at the primary education level (Akour & Alenezi, 2022; Meng & Sumettikoon, 2022). An essential component of education at this level is a comprehension of the natural world, which includes an awareness of animals. Familiarity with the characteristics and ecological functions of various animal species is a fundamental requirement for comprehending the natural world (Haryanto et al., 2019; Savitri et al., 2019).

In the current era of digital and information technology, students have become accustomed to technological devices. Therefore, the use of technology in education is becoming increasingly important. Augmented Reality (AR) technology is one innovation that promises to increase learning effectiveness (Aditama, Yanti, et al., 2023; Aditama & Setiawan, 2020; Akbar et al., 2023; Çeken & Taşkın, 2022), especially when understanding complex concepts, such as animal knowledge.

In the traditional approach, learning about animals is often limited to pictures in textbooks or static images on classroom walls. It is not always capable of exploring animal diversity in depth or activating students' critical thinking. However, with interactive learning media based on augmented reality, students have the opportunity to be more actively involved in learning (Fitria, 2023; Hadi et al., 2022; Putra & Mudra, 2022).

By utilizing AR, students can obtain interactive visualizations of animal images in textbooks or learning materials with the help of mobile devices or tablets. They can see these animals in a 3D environment, hear animal sounds, and even see animal behavior virtually (Irfansyah & Anifah, 2022; Mufida et al., 2021; Yanti et al., 2023). This can stimulate students' curiosity, help them better understand the characteristics of animals, and strengthen cognitive skills such as observation, comparison and analysis through visualization of animal shapes, movements and sounds.

Previous research (Chung et al., 2018; Savitri et al., 2019; Setiawan et al., 2021; Solehatin et al., 2023; Sudipa et al., 2022a, 2022b) have demonstrated the benefits of using augmented reality technology in educational contexts. So this research focuses more on the use of augmented reality-based interactive learning media about animal knowledge which can influence the cognitive abilities of elementary school students.

By understanding the potential use of AR in learning about animals, this research aims to provide a deeper contribution to the development of more effective and interactive learning methods, with a focus on improving the cognitive abilities of elementary school students. It is hoped that the results of this research can provide valuable guidance for educators and curriculum developers in efforts to improve the quality of basic education. This study can provide research implications especially in supporting theories about cognitive learning, especially in the context of understanding animals. By using AR, students can have a more concrete learning experience and allow them to visualize abstract concepts about animals in a more tangible way.

2. RESEARCH METHOD

The present study falls under the category of research and development (R&D). The ADDIE concept is employed in the creation of Augmented Reality animal learning. The ADDIE model is a prominent systematic learning design paradigm that provides guidance for the development of efficient, dynamic, and supportive educational practices (Aditama et al., 2021; Adnyana et al., 2019; Ranuharja et al., 2021). The design and production of learning materials, which is an integral part of the system approach, has been implemented in several methodological methods for creating text, audiovisual, and computer-based learning materials (Aditama et al., 2022; Aditama, Maswari, et al., 2023; Lubis et al., 2022; Rachmavita, 2020). The method of material evaluation was carried out at Ubung Kaja Elementary School. This study encompasses multiple subjects, specifically subject matter experts, consisting of two elementary school teachers, and primary school students, totaling ten individuals. The process of data gathering involves the utilization of a questionnaire, specifically designed to gather information pertaining to the outcomes of the evaluation as evaluated by subject matter experts.

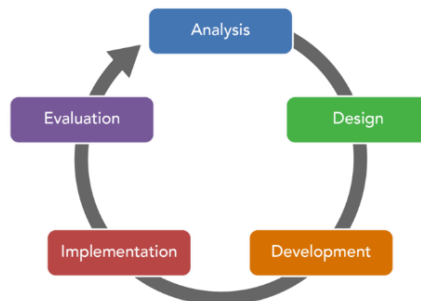


Figure 1. ADDIE Model

Based on Figure 1, the stages of the ADDIE method can be explained, namely consisting of the analysis stage, design stage, development stage, implementation stage and evaluation stage.

- a. **Analysis Stage:** At this stage there is a needs analysis, where it is necessary to identify what should be taught about animal knowledge and how AR technology can help achieve these goals. Detailing the content to be presented and identifying important aspects of animal knowledge that need to be emphasized. This also includes determining the type of animal to be described and the best way to communicate that information with the help of AR.
- b. **Design Stage:** involves developing a plan for AR-based interactive learning media. This includes designing the user interface, visual content, interactive scenarios, and determining the AR technology to be used. The team also had to design interactive elements, such as actions students could take when they interacted with AR objects.
- c. **Development Stage:** At this stage, there is a process of creating AR-based learning media according to the plan that has been made previously. The process of creating 3D animal models, creating AR elements, and integrating all components into one functioning unit is carried out.
- d. **Implementation Stage:** After the learning media has been tested and declared ready, the next step is to implement it in the elementary school learning environment. This may involve training teachers and students or end users in the use of AR technology.
- e. **Evaluation Stage:** After implementation is complete, AR-based learning media must be tested. This involves testing the functionality of the learning media. In the evaluation process there is also an assessment of AR-based learning media by the appropriate target group, in this case, elementary school students. Feedback from students and teachers will help in improving the content and interactivity of learning media.

3. RESULTS AND DISCUSSIONS

3.1 Augmented Reality Needs and Workflow Analysis

In this process, a needs analysis is carried out in the form of required learning material related to animals based on an interview process with 2 elementary school teachers as material experts, so that a needs analysis is made in the form of animal material containing animal shapes, animal definitions, as well as animal sounds and videos of animals that can be used. seen through the AR application to help students stimulate and observe the shapes, sounds and movements of animals. Through 3D AR object visualization, animal recognition can also provide a more interactive learning experience for students. Next, a workflow analysis of the AR application was made which is intended to make it easier to carry out the design and development process. The workflow of the animal recognition AR application can be seen in Figure 2 below.

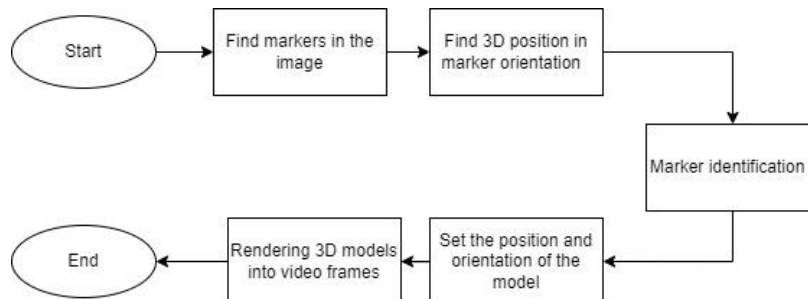


Figure 2. Animal Recognition AR Application Workflow

The workflow of this animal recognition AR application uses Augmented Reality Markers which are square black and white illustrations with thick black borders and a white background. In the initial workflow, the device used will search for the marker in the image so that after that the 3D position is obtained from the marker orientation. The device will recognize the position and orientation of the marker and create a 3D virtual world, namely the point (0,0,0) and 3 axes, namely X, Y, and Z. With markerless AR, it will make it easier for users to identify markers so that the application can display the position and shape of the model, then it will display the 3D shape of the model which has gone through the rendering process, apart from the 3D model shape it can also display video frames from the introduction animal.

3.2 Augmented Reality (AR) Application Interface Design

In this process, object design is carried out from the augmented reality application for introducing animals as an interactive and informative learning medium, the animal content design is made in the form of flashcards to attract more attention from children, in this design the names of the animals are made in Indonesian and English, and there are There is a markerless that can be used to display 3D AR objects when the image is scanned by the user.



Figure 3. Animal Flash Card Design
(Source: Author)

Development and Implementation of Augmented Reality (AR) Applications

In the development process of the animal recognition AR application using Unity software. Designing in Unity has several stages, namely, mapping markers from palm

leaves then entering coding and functions. After that, insert a 3-dimensional object according to the shape of the animal. Then the process of implementing the AR application on Android smartphone devices continues. Through printed animal flashcards, you can then scan the target image from the AR application that has gone through the development process.



Figure 4. Target image display from AR application
(Source: Author)

Based on Figure 4, it can be explained that the user can scan the target AR object that is on the animal flashcard, then can position it to scan using the AR application that has been installed on the smartphone device.

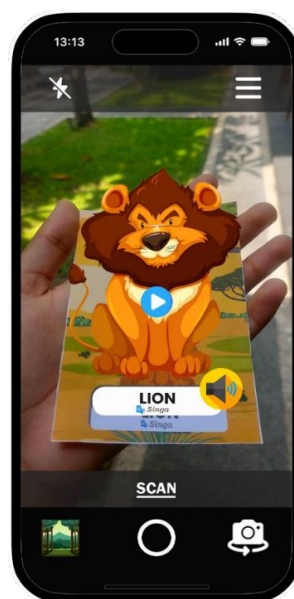


Figure 5. 3D Animal Model Object View
(Source: Author)

Based on Figure 5, the 3D appearance of the lion animal flashcard can be explained. In the 3D display, the user can move the lion by zooming in and out and there is a rotation process. The volume button is used to play sounds from 3D animal objects as well as increase and decrease the sound. There is a play button in the middle position of the 3D object to display the video if the play button is clicked.

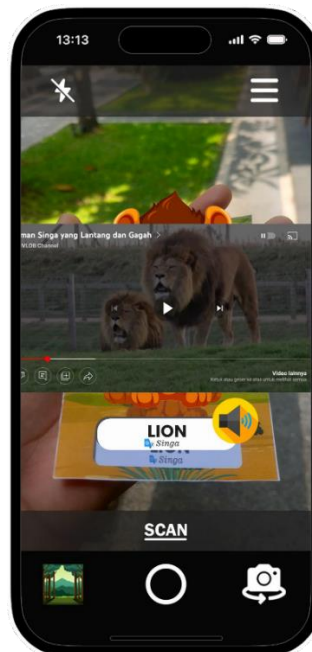


Figure 6. Animal video display on 3D objects in the AR application
(Source: Author)

Based on Figure 6, we can explain the appearance of animal videos that can be watched by children. On the play video button there is a video URL link which can be filled in with the URL of a self-made video or using a video source on the internet. This can certainly add interesting features that can be accessed by children, the videos displayed can be adjusted to the type of animal. The video feature can be aimed at increasing children's knowledge regarding the movements and shapes of animals.

3.3 Animal Recognition AR Application Testing

In the AR application testing process, there is a process of testing the functionality of the AR application using black box testing. Blackbox testing is carried out to determine whether the application functions are running according to their objectives and evaluate the suitability of the application to user needs. This is the result of Blackbox testing.

Table 1. Blackbox Testing of the Animal Recognition AR Application

Numbers	Tested components	Expected output	Results
1	Application installation	The application has been successfully installed on the smartphone	Succeed
2	Scan button	The camera opens and the camera scans the marker and displays a 3D animal object	Succeed
3	Voice button	The application makes animal sounds	Succeed
4	Play Video button	Show animal videos	Succeed
5	Close Application button	Exit the application	Succeed

Based on table 1, it can be explained that there are 5 application functionality testing scenarios using Blackbox testing, including the application installation process, scan feature, voice feature, play video feature and application close button. From the overall black box testing, the results were obtained that the test was valid and the application could run according to the expected output from each feature of the animal recognition AR application.

Next, there is an evaluation of the material and features of the animal recognition AR application testing by 2 material experts, namely teachers and students at SD 2 Ubung Kaja. The assessment carried out concerns aspects (1) suitability of material (2) suitability of information (3) quality of visualization of 3D objects (4) clarity of sound and language (5) ability to increase students' understanding (6) Increasing students' learning experience (6) improving student's motivation to study. Each aspect of the assessment uses a Likert rating scale, namely a value of 1 to 5 which indicates a scale of 5 which is very good, scale 4 which is good, scale 3 which is sufficient, scale 2 which is poor and scale 1 which is very poor. The results of the material evaluation can be seen in Table 1 below:

Table 1. Animal Material Evaluation Results

No	Assessment Aspects	Rating Average	Results
1	Suitability of material about animals in AR applications	4	Good
2	Suitability of animal shape, sound and movement information in AR applications	4.5	Good
3	The quality of 3D Object visualization in recognizing animals	5	Very good
4	Use of voice and language that is easy to understand	4	Good
5	Able to increase students' understanding of animals	4	Good
6	Adding to students' learning experiences related to animals	4	Good
7	Increase students' learning motivation in getting to know animals	4	Good

Source: author's data processing results

Based on the results of the material expert evaluation in table 1, it can be explained that from the 7 aspects of the assessment, the results obtained were that the quality aspect of 3D object visualization from the AR application received a score in the very good category, 6 other aspects obtained a score in the good category, namely suitability of material about animals, suitability of shape information. , animal sounds and movements. Aspects of the use of sound and language, as well as their relation to students' cognitive abilities, namely increasing understanding, increasing learning experiences and increasing students' learning motivation. From the evaluation assessment of the AR application material, there are aspects that show it can improve students' cognitive abilities in learning to recognize animals so that this application can be used in the teaching and learning process and can add to students' learning experience by visualizing 3D objects from the AR application so that it can make it easier for students to understand learning. Comparison with previous research shows that this animal learning AR media can be an alternative learning for elementary schools with advantages in the aspects of The quality of 3D Object visualization in recognizing animals and Suitability of animal shape, sound and movement information in AR applications.

4. CONCLUSION

The study concludes that AR technology can be used to learn about animals and develop more novel and dynamic learning ways for visualizing animal things with markerless augmented reality. The needs analysis suggests that learning media should show animal shape, motion, and sound. Thus, the interface design of the AR application contributes to an engaging learning experience as well as students can have a more concrete learning

experience and allows them to visualize abstract concepts about animals in a more tangible way. Flashcards with Indonesian and English animal names exhibit animal information. Unity software is used to design and implement the AR app, which requires marker mapping, coding, and 3D objects. Android cellphones can use this software by scanning animal flashcard photos. The research produced animal recognition AR apps for Android devices that passed blackbox testing with five realistic scenarios and material evaluation. 7 aspects of assessment found that 3D object visualization from AR applications scored very good, 6 other aspects scored good, and the suitability of animal material, shape, sound, and motion scored good. Sound and language's impact on pupils' cognitive capacities, including understanding, learning experiences, and motivation. The evaluation of AR application material shows that it can improve students' cognitive abilities in learning to recognize animals, so it can be used in the teaching and learning process and add to students' learning experience with 3D object visualization from AR applications to make learning easier. Future studies could add at least three motion objects and each animal's food kind.

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