

Development of Android Application for Insect Animal Recognition Based on Augmented Reality as Interactive Learning Media

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Abstract— This study aims to develop Augmented reality applications as an interesting and interactive learning media and facilitates the introduction of insect species in a 3-dimensional format. The method used to design this system is the prototype method and application testing is used Usability testing. The results of usability testing show a success rate of 97.39%, which indicates that the functions in the application can run well and the Insect World application is easy to operate by 4th grade elementary school students. The results of usability testing on the overall questionnaire showed a percentage of 92.02%. This shows that the Insect World application can help users or students in understanding the material by presenting insect objects in three-dimensional form as well as information in the form of audio and text.

Index Terms— Augmented reality, Insects, Learning Media Introduction, Prototype Method, Usability Testing

I. INTRODUCTION

Education is the main foundation in the intellectual and social development of an individual. According to Prasetyo, at the elementary school level, students' mindset about knowledge will be carried over to a higher level. This is because at the primary school level is the basic place of knowledge that is instilled in students. Natural Science Education (IPA) at school or madrasah must be able to provide provisions for students so that they can live harmoniously in accordance with the times [1].

One area of interest in the context of education is the use of Augmented Reality (AR) as a learning tool. Augmented reality is a technology that combines the

real world with the virtual world. In other words, Augmented Reality (AR) presents an object in the form of video or photos images into the real world in three-dimensional form [2]. In the context of education, AR can create an immersive learning experience and interact with real objects, including insect animals.

In particular, similar research has been conducted by Tarnng and found that a virtual butterfly ecology system, using augmented reality technology and mobile learning, effectively increased students' learning motivation and interest in ecology [3].

Insect species are an interesting and important group of animals in the natural sciences. Insects are living creatures that are often found in everyday life. Insects have many roles in human life. However, the important role of insects in human life is not yet known to the wider community [4]. They have a very high diversity and play an important role in the ecosystem. However, understanding these animals can be challenging for children in elementary school. Presenting insect species in a learning experience that is closer to real life can help overcome these barriers.

Many primary schools in Indonesia and around the world still face obstacles in facilitating students' interactions with real animals in a learning context. These constraints may include limited access to real animals, safety concerns, or logistical constraints. According to Riski, visualized learning tends to be more quickly understood by children and is safer and for teachers to make it easier to convey material [5].

AR applications can help students to "meet" and learn about insects in a safe and interactive virtual setting is a very relevant and important step in improving children's understanding of insect life. AR provides an opportunity for experiential learning and immersive experiences that are impossible to achieve through traditional learning methods.

With this background, this study aims to develop an AR Application of Insect Type Animals that is in accordance with the IPAS book of grade 4 Elementary School. Where this application will match the latest curriculum that offers a more dynamic and student

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needs-oriented approach. The method used to design this system is the Prototype method and Usability testing which is used for the analysis, design, and testing stages of the system.

This research has certain limitations to ensure a clear focus. First, the Augmented Reality (AR) application developed will only be based on the Android operating system. Second, the objects to be used in the application are insects listed in the IPAS (Natural and Social Sciences) book of grade 4 Elementary School in Indonesia. In addition, this research focuses on grade 4 students at the elementary school level as the main subject of AR application users. Finally, this research will focus on the experience and perception of students as the main users of the application as well as the role of teachers as facilitators in the learning process.

II. LITERATURE REVIEW

A. Augmented Reality

In simple terms, the Augmented reality system works as follows: The camera of the smartphone will detect a marker object or marker that has been provided, then the camera will recognize and mark the marker pattern and then compare it with the database owned. If the database is suitable, the information on the marker will be displayed as a three-dimensional object or animation according to what has been made before [6].

The use of Augmented reality is very useful for interactive and real learning media and directly by students. In addition, learning media using Augmented reality can increase students' interest in learning because of the nature of Augmented reality that combines the virtual world and the real world that can increase the imagination of students with the real world directly. Augmented Reality is interactive which makes learners to see the situation in real and direct and can imagine the results of the learning process provided by educators to students [7].

B. Android

Android is a mobile operating system used for various devices, such as smartphones, tablets, and computers, and is a free and open source platform [8].

Android applications are software that runs on the Android platform, which consists of an operating system, middleware, user interface, and application software [9].

C. Unity

Unity is an application used to create games or often also called a game engine. Basically, Unity is a 3D-based game engine, but Unity can also be used to make 2D games [10]. In game development with Unity, you can create a new project, add assets, create game objects, add scripts, add features and functions, perform testing and debugging, and finally, publish the game.

D. Blender

Blender is a free and open source 3D design software. Blender supports all 3D concepts from modeling,

rigging, animation, simulation, rendering, compositing and motion tracking, video editing and 2D animation pipeline [10].

E. Vuforia

Vuforia is a plugin for Unity 3D software used in the development of Augmented Reality (AR) applications. Vuforia is used in combination with Unity 3D and Blender to develop AR applications that can display 2D or 3D objects in a real environment with the help of a camera. Vuforia allows developers to create AR applications that can detect physical markers and display virtual content associated with those markers [11].

F. Learning Media

Learning media is recognized as one of the success factors of learning. With media, students can be motivated, actively involved physically and psychologically, maximize all the senses of students in learning, and make learning more meaningful. A medium is a means of communication and a source of information. Derived from Latin meaning "between", the term refers to anything that carries information between a source and a receiver [12].

By using Augmented reality as an alternative learning media, it is expected that learning activities can be more interesting for students. Other benefits obtained are more advanced learning media by utilizing current technological developments. Through Augmented reality can be one solution to overcome modules or trainers that are quite expensive and cannot be purchased by schools. Students can still do practicum by seeing items like the original, but in virtual form [13].

G. Prototype Method

The book entitled Prototyping made by [14] explains that Prototyping is an approach based on an evolutionary view of software research and has an impact on the overall research process. Prototyping involves creating an initial working version (Prototype) of the future application system and experimenting with it.

Prototyping exists as an experimental method used to help gain the experience needed to build usable software. The techniques used here go beyond conventional software engineering methods.

According to [15] the Prototype method can improve the quality of teaching and promote the development of higher quality education.

H. Insect

Insects are animals that have an important role in an ecosystem. The role of insects in the ecosystem includes pollinators, decomposers, predators and parasitoids. The presence of insects in a place can be an indicator of biodiversity, ecosystem health, and landscape degradation [16].

1) Grasshopper

Locusts are a type of insect belonging to the order *Orthoptera* and family *Acrididae*. They are known for

their ability to form large, mobile swarms that can consume large amounts of vegetation in a short period of time. Locusts are herbivores and feed on a wide variety of plants, including grasses, cereals and legumes. Locusts are considered a pest if their population increases rapidly and causes significant damage to crops and pastures [17].

2) *Dragonflies*

Dragonflies are a group of insects that belong to the order *Odonata*. They are characterized by their large and colorful wings, long and slender bodies, and large and compound eyes. Dragonflies are found all over the world, and there are more than 5,000 known species. Dragonflies are important predators in many ecosystems, and their larvae, known as naiads, are aquatic and feed on a variety of small invertebrates [18].

3) *Butterflies*

Butterflies are insects that belong to the order *Lepidoptera*. Butterflies are characterized by their large and colorful wings, which are covered with small scales. Butterflies are found all over the world and are important pollinators in many ecosystems. Butterflies have a complex life cycle, which includes four stages: egg, larva (caterpillar), chrysalis (cocoon), and adult. Butterflies are known for their beautiful wing patterns and are often used as symbols of beauty, transformation, and freedom [19].

4) *Flies*

Flies are a group of insects that belong to the order *Diptera*. They are characterized by their one pair of wings, which are modified into a pair of knob-like structures called dumbbells. Flies are found all over the world and are known for their ability to adapt to a variety of environments. They are important pollinators and play a vital role in decomposing organic matter and recycling nutrients in ecosystems. Flies have a complex life cycle, which includes four stages: egg, larva, pupa, and adult [20].

5) *Bees*

Bees are a group of insects belonging to the order *Hymenoptera*, which includes species such as *Apis mellifera*, the honeybee, and *Megachilidae*, the leaf-eating bees. Bees are important pollinators and play a vital role in ecosystems by facilitating the reproduction of many plant species. They are also an important source of honey, beeswax and royal jelly. Bees have a complex social structure, with colonies consisting of queens, worker bees and drones. They are known for their ability to communicate with each other through a dance language, which helps them find food sources and navigate [21].

6) *Mosquitoes*

Mosquitoes are a group of insects belonging to the order *Diptera*, which includes species such as *Anopheles*, *Culex*, and *Aedes*. Mosquitoes are known as vectors of many diseases, including malaria, dengue fever, yellow fever, and Zika virus. Mosquitoes are also important pollinators and play a vital role in the ecosystem. Mosquitoes have a complex life cycle, which includes four stages: egg, larva, pupa, and adult

[22].

7) *Ants*

Ants are a group of insects belonging to the order *Hymenoptera*, which includes species such as *Formicidae*, ants, and *Vespoidea*, wasps and bees. Ants are known for their highly organized and cooperative behavior, living in colonies that can range from a few individuals to millions. They are important pollinators and play a vital role in ecosystems by facilitating the reproduction of many plant species. Ants are also known for their ability to adapt to a variety of environments and are affected by various abiotic factors, such as temperature, which can affect foraging behavior and nest preferences [23].

I. *Population and Sample*

Population is a speculation area that includes a certain number of components or subjects and is not entirely resolved to be studied by scientists so that concentration is carried out so that the end or conclusion can be drawn. Meanwhile, the sample can be interpreted as part of a population and the sample used can represent the entire population [24].

J. *Usability Testing*

Usability testing is a method for evaluating the effectiveness of a product or service, with a focus on its usability for its intended purpose [25]. Usability testing can improve project efficiency and productivity by integrating product processes, identifying issues early on, and addressing them during each stage of research. [26]. According to [27] an application is called usable if its functions can be carried out effectively, efficiently, and satisfactorily.

K. *Likert Scale*

The Likert Scale method is a method used to measure the level of user satisfaction using a Likert scale. The Likert scale is a measurement scale developed by Likert in 1932. The Likert scale has three or more question items combined to form a score or value that represents individual characteristics, such as knowledge, attitudes and behavior. The Likert scale can also be said to be a psychometric scale that is commonly used in questionnaires and is the most widely used scale for research [28].

L. *Previous Research*

First previous study entitled The Use of Augmented Reality in High Schools in Indonesia explains that there are advantages to the use of this media in learning, namely from the interactive side, because augmented reality displays three-dimensional objects with an attractive interface and close to the real form so that it can increase the reasoning power and imagination of students. Therefore, the use of augmented reality in learning at the Senior High School level is diverse and considered suitable, so in this study researchers tried to create Interactive Learning Media for elementary school children using augmented reality applications [6].

Second previous research conducted in junior high

school about implementation of augmented reality for biology learning media. This research explained that this Augmented reality learning application can improve students' understanding of the organs of the excretory system in humans. From the questionnaire run by researchers on students of SMPN1 Sukoharjo with the question "Do you like the way of learning Biology subject material about the human excretory system using android applications?" got results of 75% favored by students in the pre-test and 93% favored in the post-test [29].

Augmented reality application technology also improving the teaching process of elementary school students. Augmented reality applications made can be implemented into learning media in elementary school English subjects and run well. And based on the survey results using the method of distributing student questionnaires on Augmented reality-based learning media applications in English subjects, it can be concluded that this learning application is very interactive and easy to use, so that by applying this learning media application can help improve the teaching process that is more interesting and easy to understand [30].

Another research about AR explained that the application of the introduction of herbal leaf plants can be used as an alternative learning media in schools that generally deliver material using teaching media books or other media that have not implemented augmented reality technology that has been packaged into the android platform. Based on the results of field feasibility tests from two classifications of users for respondents from teachers / teachers get the final result of 86%, and for student respondents the final result is 93% which means that the application made gets a very agreeable assessment [31].

This research focuses on the development of Augmented reality applications as learning media for elementary school children. This application is designed to provide an interesting and interactive learning experience, with a focus on insect-type animals that are an important part of Indonesia's natural ecosystem.

III. RESEARCH METHODOLOGY

A. Application Design Method and Testing

In developing an Android application for the introduction of augmented reality-based insect animals, researchers adopted a system design method using the Prototype approach. This method allows researchers to create an initial model of the application quickly, which is then improved and developed based on feedback received from users. The design phase involved creating several Prototype iterations that were based on an initial understanding of user needs and a pre-designed application design. Each such iteration is tested and evaluated together with users to identify the needs and shortcomings of the application, as well as to determine any improvements or further development required.

Furthermore, in the system testing stage, researchers

used the Usability testing method involving potential users of the application, specifically grade 4 elementary school children, to evaluate their experience in using the application. This testing was conducted by taking into account the factors of interface design, learning materials, and user satisfaction, as well as using questionnaires to evaluate ease of navigation, clarity of instructions, and interaction with application features. The results of the testing are used to determine the extent to which the app meets user needs and to identify areas that require further refinement or improvement before the app can be officially released. Thus, the system design method using the Prototype approach and system testing using the Usability testing method provides a structured and iterative approach in developing Android applications as interactive learning media for elementary school children.

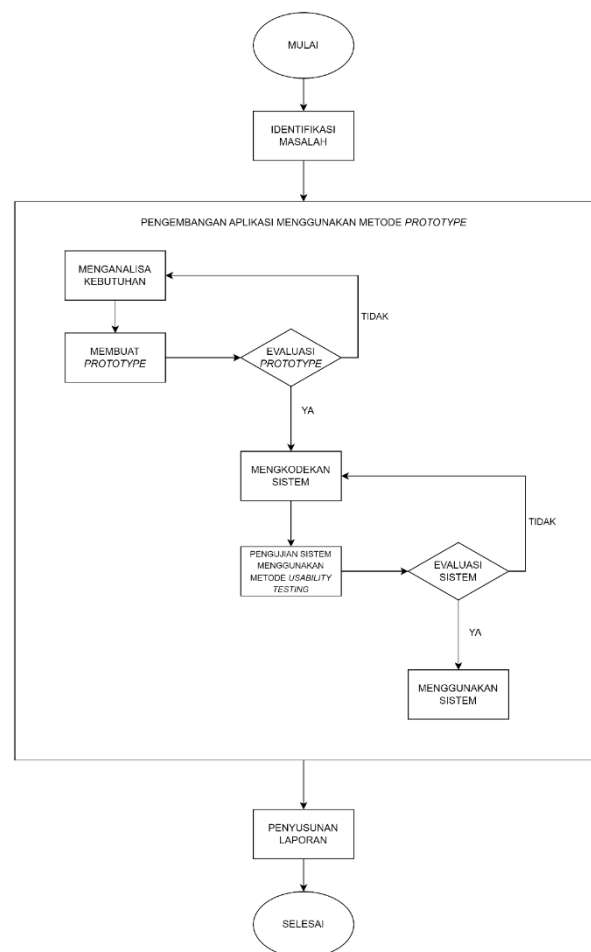


Fig. 1 Research Flowchart

B. Application Development Tools

1) Software

Software or supporting software in designing Augmented reality applications in this study, namely:

- Blender 4.0
- Unity 3.5.2
- Vuforia 10.22
- Canva

2) Hardware

The hardware used in the design is a laptop with specifications:

- Processor: AMD Hexa Core Ryzen 5 6600H
- RAM: 16GB DDR5
- Storage: 512GB SSD
- Graphic Card: AMD Radeon Graphics

C. Respondent Characteristics

The population in the implementation of this study was 74 students in grade 4 at Primary School 03 Manado. From the total population a sample was taken to represent the entire population. The sampling method in this study is using Simple Random Sampling which is used to select samples by ignoring the levels contained in a population and obtained one class with 23 students.

IV. RESULT AND DISCUSSION

A. Application Requirements Analysis

An application needs analysis was conducted to deeply understand the needs of users, especially elementary school children, in learning about insect animals. The analysis included identifying relevant materials, interface design preferences that appeal to them, as well as additional features that could enhance the interactive learning experience. The main finding of this analysis is the importance of presenting learning materials in an engaging and interactive way in order to maintain children's interest in learning. In addition, information about insect animals should be presented in a way that is appropriate to their cognitive level in order to be well understood.

B. Creating Application Prototypes

This prototype was created to roughly describe the user interface layout, key features, and content presented in the final application. This prototype serves as an initial concept that will be evaluated by users to get initial feedback before further development.



Figure 2 Creating Interface Design

Figure 2 is the process of creating an interface design. This design will later be used in the AR application using Unity. Designs made with Canva include buttons, main page background, guide page and about page.



Fig. 3 Creating a 3D Model

Figure 3 is the process of modeling insect animals

into 3D model.

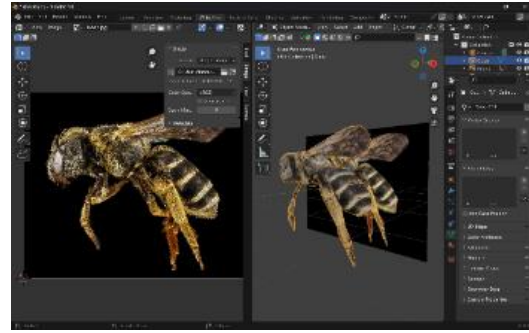


Fig. 4 Coloring a 3D Model

Figure 4 is the process of coloring the model 3D (Texturing).



Fig. 5 Animating a 3D Model

Figure 5 is the process of animating the 3d insect model that has been created and colored.

This 3D models of insect animals that will appear in the AR application. 3D models are made using Blender. The process of making 3D models includes modeling, coloring the model (texturing), and animating the model (rendering).



Fig. 6 App Creation

Figure 6 is the creation of the application created using Unity. The creation of the application starts by inserting the interface design into the application and adding the 3D model that has been created.

C. Evaluating the Application Prototype

The application (Prototype) that has been made is evaluated by teachers and developers. From the evaluation results, several aspects were found that need to be improved in the application, including 3D objects that are too static or do not move, as well as the design of application buttons that are less attractive. The teacher also requested that some other animals be added and that each 3D model have a voice narration or audiobook so that students can learn audio and visual.

D. Coding the App

Based on the feedback from the Prototype evaluation, a thorough coding process of the app began. This process involved implementing the designed features, adding 3D models to the app, and audio narration. The Android programming language was used to build a responsive and interactive app.



Fig. 7 Adding a 3D Model

Figure 7 is the process of adding 3D models of insect animals used in the application. The added animals are 3d models that were previously created in blender. Added animals such as grasshoppers, dragonflies, ants, and others.

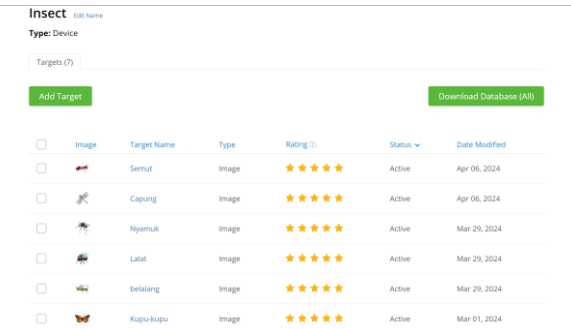


Fig. 8 Adding a 3D Model

Figure 8 is the process of integrating augmented reality into an application. Later, after being integrated, augmented reality can bring up the 3d model that has been created when the marker is scanned.

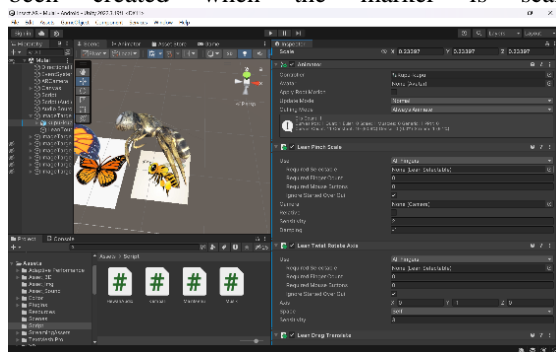


Fig. 9 Implementing features

Figure 9 is the process of implementing the features in the application. The features created are such as enlarging objects, carrying objects, rotating objects and also the functions of the buttons.

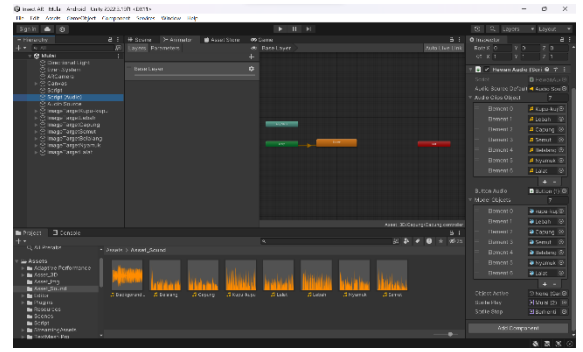


Fig. 10 Adding Voice Narration

Figure 10 is the process of adding voice narration to each insect 3D model.

After going through a series of production processes, here is the application that has been created and exported to the Android application.

1) Splash Screen

The splash screen will appear first when opening "Insect World" for 5 seconds before entering the main page.

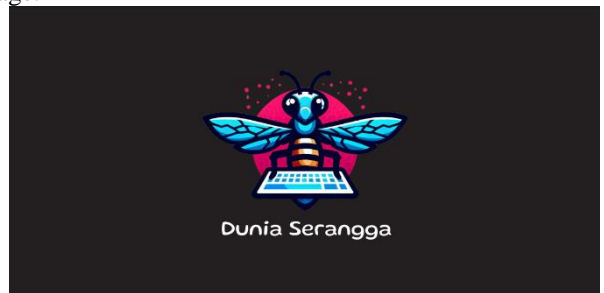


Fig. 11 Splash Screen

2) Main Page

The main page contains 4 buttons consisting of the Start button to open the AR camera, the About button opens a page about this application, the Guide button opens the application usage page, and the Exit button to close this application.



Fig. 12 Main Page

3) Start AR

This page will open the camera on the device which later when scanning the marker that has been prepared will bring up a 3D model of an insect animal and there is also a Back button to return to the main page and a Start button to start the voice narration of the scanned animal.



Fig. 13 Butterfly 3D Object View



Fig. 14 Bee 3D Object View

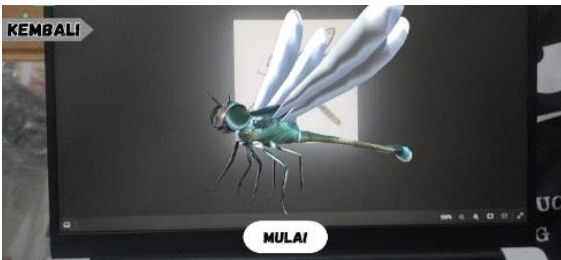


Fig. 15 Dragonfly 3D Object View

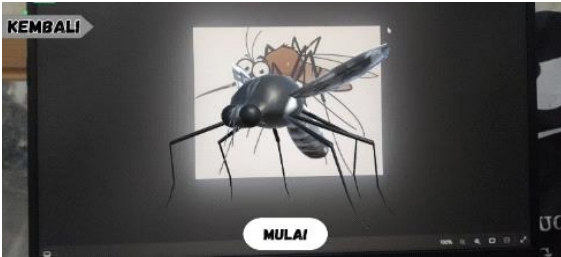


Fig. 16 Mosquito 3D Object View



Fig. 17 Locust 3D Object View

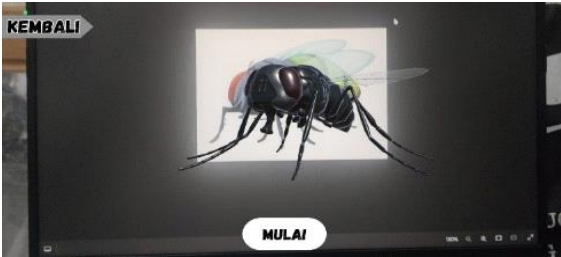


Fig. 18 Fly 3D Object View



Fig. 19 Ants 3D Object View

E. Testing the Application

Usability testing is done by giving a number of questions (questionnaires) to respondents and also given tasks to complete (success rate), success rate is done in order to determine the level of ease of users using the application and also find out whether the application is successfully built properly.

Testing was carried out on 23 respondents. Before starting the test, the respondents were first explained about the AR application and how to use the Insect World AR application.

In usability testing with success rate, 10 tasks are used to be done by respondents, namely:

- Task 1: Install the Insect World application from a QR code or Google Drive link.
- Task 2: Turn off and play the music in the app again.
- Task 3: Return to the main page and navigate to the About page.
- Task 4: Open the app and navigate to the Guide page.
- Task 5: Allow camera usage and go to the Start page.
- Task 6: Use the camera to Scan the marker associated with the 3D insect model.
- Task 7: Play the audio of the 3D animal models in the app.
- Task 8: Open the information panel of the 3D models in the app.
- Task 9: Interact with the 3D insect models and use the available features.
- Task 10: Try to exit the app by pressing the back and exit buttons.

After the respondents have completed the tasks given, the success rate of the tasks will be calculated. To calculate the success rate, the following formula is used:

$$Success\ Rate = \frac{S + (P \times 0.5)}{Total\ Task} \times 100\%$$

Table. 1 Success Rate "Dunia Serangga"

R	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1	S	S	S	S	S	S	S	S	S	S
2	S	S	S	S	S	S	S	S	S	S
3	S	S	S	S	S	S	S	S	S	S
4	S	S	S	S	S	S	S	S	S	S
5	S	S	S	S	S	S	S	S	S	S
6	S	S	S	S	S	PS	PS	PS	S	S
7	S	S	S	S	S	S	S	S	S	S
8	S	S	S	S	S	S	S	S	S	S
9	S	S	S	S	S	S	S	S	S	S
10	S	S	S	S	S	PS	PS	PS	S	S

11	S	S	S	S	S	PS	PS	PS	S	S
12	S	S	S	S	S	S	S	S	S	S
13	S	S	S	S	S	S	S	S	S	S
14	S	S	S	S	S	S	S	S	S	S
15	S	S	S	S	S	PS	PS	PS	S	S
16	S	S	S	S	S	S	S	S	S	S
17	S	S	S	S	S	S	S	S	S	S
18	S	S	S	S	S	S	S	S	S	S
19	S	S	S	S	S	S	S	S	S	S
20	S	S	S	S	S	S	S	S	S	S
21	S	S	S	S	S	S	S	S	S	S
22	S	S	S	S	S	S	S	S	S	S
23	S	S	S	S	S	S	S	S	S	S

4	3	3	3	3	3	3	3	3	3
5	3	2	3	3	3	3	3	3	3
6	3	3	3	3	2	3	3	3	2
7	3	3	3	3	3	3	3	3	3
8	3	3	3	3	3	2	3	3	3
9	3	3	3	3	3	2	3	3	3
10	3	3	3	3	3	2	2	3	3
11	3	2	3	3	2	3	2	2	2
12	3	3	3	3	3	3	3	3	3
13	3	3	3	3	3	3	3	3	3
14	3	3	3	3	3	3	3	3	3
15	2	2	3	3	2	3	3	3	3
16	3	3	3	3	2	3	3	3	2
17	3	3	3	3	2	3	3	3	2
18	3	3	3	3	2	3	3	3	3
19	3	3	3	3	2	3	3	3	3
20	3	3	3	3	2	3	3	3	3
21	2	3	3	3	3	3	3	3	3
22	2	2	3	2	1	2	3	3	2
23	3	3	3	3	3	3	3	3	2
Total	65 / 69	64 / 69	66 / 69	66 / 69	57 / 69	64 / 69	64 / 69	62 / 69	

Description:

R = Respondent

T = Task

S = Success, meaning the respondent made no mistakes at all in doing the task.

PS = Partial Success, meaning the respondent made some mistakes in performing the task.

F = Failure, meaning the respondent did not succeed in performing the task.

Insect World Success Rate = $\frac{(218 + (12 \times 0.5))}{230} \times 100\% = 97.39\%$

From testing the success rate of the Insect World application, the result is 97.39%, which means that the Insect World application is successfully made and easy to use.

In the usability testing process with a questionnaire, 8 questions were used, namely:

1. Q.1 = Is this application easy to use?
2. Q.2 = Do you feel this application helps you learn about insect animals?
3. Q.3 = Do you feel this app provides enough information about insect animals?
4. Q.4 = Do you like the way this app looks?
5. Q.5 = Do you like the music used in this app?
6. Q.6 = Do you like the real insect models that are displayed?
7. Q.7 = Do you like learning with apps like this?
8. Q.8 = Do you feel this application does not require adult assistance to use?

Each question uses a 1-3 Likert scale to make it easier for respondents to answer, where the answer options are: point 1 for 'Dislike / No', point 2 for 'Ordinary', and point 3 for 'Yes / Like'.

To analyze the percentage of the results of each question, the formula is used:

Question Percentage = $\frac{\text{Question Total Score}}{\text{Question Maximum Score}} \times 100\%$

Table. 2 Questionnaire Answers

Respondents	Q.1	Q.2	Q.3	Q.4	Q.5	Q.6	Q.7	Q.8
1	2	3	2	2	1	2	2	2
2	3	3	2	2	3	3	2	3
3	3	2	2	3	3	3	2	3

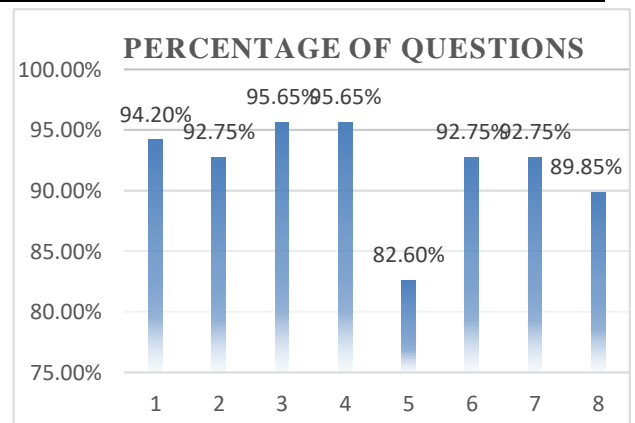


Fig. 20 Ants 3D Object View

Percentage of Question 1 = $\frac{65}{69} \times 100\% = 94.20\%$

In the first question, the percentage result is 94.20% of the respondents' answers, this result shows that the majority of users feel that this application is easy to use, which reflects the effectiveness of interface design and good user experience.

Percentage of Question 2 = $\frac{64}{69} \times 100\% = 92.75\%$

In the second question, the percentage result is 92.75% of the respondents' answers, this result shows that respondents feel helped in learning insect animals through this application. This shows that the application has successfully achieved its main purpose as an interactive learning media.

Percentage of Question 3 = $\frac{66}{69} \times 100\% = 95.65\%$

In the third question, the result of 95.65% shows that this application succeeds in providing adequate and useful information for users in understanding insect

animals.

$$\text{Percentage of Question 4} = \frac{66}{69} \times 100\% = 95.65\%$$

In the fourth question, the result is 95.56%, this result shows that the visual design of the application is well received and liked by users, which contributes to a positive user experience.

$$\text{Percentage of Question 5} = \frac{57}{69} \times 100\% = 82.60\%$$

In the fifth question, the result is 82.60%, which shows that the majority like the music in the application.

$$\text{Percentage of Question 6} = \frac{64}{69} \times 100\% = 92.75\%$$

In the sixth question, the result is 92.75%, indicating that the realistic visual representation of insect animals in the application is effective in attracting user interest.

$$\text{Percentage of Question 7} = \frac{64}{69} \times 100\% = 92.75\%$$

In the seventh question, the result is 92.75%, this result shows that the majority of users enjoy the interactive learning process provided by the application, signaling the success of the application in creating a fun and interesting learning environment.

$$\text{Percentage of Question 8} = \frac{62}{69} \times 100\% = 89.85\%$$

In the eighth question, the result was 89.85%. This indicates that most children can use the app independently, but there is room for further simplification to make it easier for all children to use.

Based on the test results, it can be concluded that the majority of respondents indicate that this application functions well and is easy to use. Positive responses were also seen in the perception of learning about insect animals provided by the application. The appearance of the application and the real model of insects displayed are also favored by the majority of respondents, and most like the learning experience using this Insect World augmented reality application.

F. Evaluating the Application

After testing was completed, the application was re-evaluated with the 4th grade teacher. The evaluation was done by directly interviewing the 4th grade teacher. The questions asked to the teacher correspond to the questions given to the students and are discussed one by one based on the answers given by the students. Based on the evaluation results with the 4th grade teacher, it can be concluded that the Insect World application can function properly and is easy to use which can be seen from question 1 with a percentage result of 94.20%.

A positive response was seen in the students' perception of the learning provided by this app. Grade 4 teachers noted that students were more enthusiastic and engaged in the learning process when using this augmented reality application. The appearance of the application and the real insect models displayed were also liked by the majority of respondents, including teachers who assessed that this visualization helped students understand the material better, this can be seen from question 3 which received a percentage result of 95.65%. Students and teachers also liked the interactive and innovative learning experience using the Insect World application.

Based on the evaluation results above and the overall percentage of 92.02%, it can be concluded that the Insect World application does not require further improvement because the application has met the requirements and expectations of users.

G. Stage of Using the App

After passing all stages of development and evaluation, the Insect World application is ready to be used by elementary school children as an interactive learning media about insect animals.

V. CONCLUSION

The conclusion of this research is that the application of Augmented Reality (AR) Insect World can be an interactive learning facility for students to learn insect animals. From the results of application development using the prototype method and testing using usability testing, the Insect World application was successfully built. The results of usability testing show a success rate of 97.39%, which indicates that the functions in the application can run well and the Insect World application is easy to operate by 4th grade elementary school students. The results of usability testing on the overall questionnaire showed a percentage of 92.02%. This shows that the Insect World application can help users or students in understanding the material by presenting insect objects in three-dimensional form as well as information in the form of audio and text.

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