International Journal
of Applied Information Technology
http://journals.telkomuniversity.ac.id/ijait/

FloNa: Children Educational App for Indonesian Endangered Species Based on Augmented Reality

Amir Hasanudin Fauzi *, Rahmadi Wijaya, Alfian Akbar Gozali, Endra Wahyu Wardana, Ageng Prasetio, Neca Aqila

School of Applied Science, Telkom University, Indonesia
{amir_hf, rahmadi, alfian} @tass.telkomuniversity.ac.id, {endrawardana182, prasetioageng, necaqila} @gmail.com

ARTICLE INFO

Received 11 October 2019
Revised 15 January 2020
Accepted 4 February 2020
Available online 29 February 2020

Keywords
Augmented reality, educational application, endangered species

ABSTRACT

Indonesia has an enormous number of endangered species of flora (plants) as well as fauna (animals). Several factors influence endangered species such as lack of early education in this problem. Whereas, children, especially in school ages, have the most potential role in the future to solve this problem. To influence the behavior and attitudes of children towards wildlife, Conservation Education is the solution. By providing appropriate and effective conservation education, future conservation behavior can change in a positive direction. To address this opportunity, we proposed FloNa, a mobile app to educate children about Indonesian endangered species. FloNa is empowered by augmented reality to help children imagine and observe the real form of endangered plants and animals. Furthermore, we conducted experiments to analyze the efficiency of this app to overcome this problem. The alpha testing result shows that FloNa has a robust design and implementation. Moreover, from the beta testing result, we could conclude that FloNa could significantly support and promote endangered species conservation education for children in Indonesia.

* Corresponding author at:
School of Applied Science, Telkom University,
Jl. Telekomunikasi No. 1, Terusan Buah Batu, Bandung, 40257
Indonesia.
E-mail address: rahmadi@tass.telkomuniversity.ac.id

ORCID ID:
- First Author: 0000-0001-7873-810X
- Third Author: 0000-0001-9377-9532

https://doi.org/10.25124/ijait.v3i02.2292
Paper_reg_number IJAIT000030207 2019

1. Introduction

Indonesia as an archipelago country has an enormous number of unique species of flora (plants) as well as fauna (animals). Indonesia has 13,000 equatorial islands, contains 10 percent of the world's total rain forest area and is home to an estimated 4,000 species of trees, 500 species of mammals, and over 1,500 species of birds [1]. There are several factors making Indonesia one of a few countries which have more than a thousand different species in the world. The tropical climate in Indonesia is one of the factors which make flora and fauna 'easy' to life. Moreover, sand fertility which is spread in most places in Indonesia makes a lot of unique plants grow and animals live. Unfortunately, there are many Indonesian species are endangered to its extinction. There are around 294 species of flora and fauna which are included as endangered species in Indonesia according to Government Laws No.7 year 1999 about "the variety of plants and animals which are guarded by the government" [2].

To influence the behavior and attitudes of people, especially children towards wildlife, the Conservation Education Program is the solution [3]. By providing appropriate and effective conservation education, future conservation behavior can change in a positive direction [4]. Educators have a complex task in developing positive conservation attitudes for children. Appropriate information and long-term retention of that information are key to quality conservation education [5]. Whereas, children who are also students have the most potential role in the future to preserve Indonesian wildlife, especially the endangered species. An approach needs to be developed to engage children in the act of positive conservation behavior.

In another hand, children in the millennial generation tend to use a smartphone for a long time [6]. This could be an opportunity to use a smartphone as a tool for educating children about Indonesian endangered species. Regarding this opportunity, we proposed FloNa as a solution to teach children about Indonesia's endangered species. FloNa is a mobile app to educate children about Indonesian endangered species. FloNa uses augmented reality technology to help children imagine and observe the real form of endangered plants and animals.

This paper consists of seven sections. The remainder of this paper is organized as follows. Chapter 2 talks about Endangered Species in Indonesia. Chapter 3 explains the design and implementation of FloNa including the augmented reality technology behind it. Chapter 4 talks about our experimental results and its analysis. Chapter 5 as the last chapter of this paper concludes and discusses this work.

2. Endangered Species in Indonesia

Endangered species are species that have a few lefts of them, so they could extinct from the planet. Factors such as climate change, hunting, habitat loss, and disease are the causes of endangered species decreased population and limited range [7].

The pulp and paper industry both legal and illegal logging demand a lot of wood, hardwood and plywood products. This causes deforestation in forests in Indonesia, which is three percent of the world's forests. This deforestation causes the third largest global carbon emissions in the world.

The major problem in this region is wildlife trade. The growing number of roads and logging trails, accelerate the activity of rampant poaching, poses a grave threat to tigers and rhinos, Borneo and Sumatra's endangered species [8].

Because of these circumstances, not only the population of endangered species is declining, but also their habitat. That is why Indonesia has an enormous number of endangered species.

2.1. Endangered Flora

In specific, according to [1], Indonesia has an estimated 4,000 species of trees and many of them are counted as endangered species by the Indonesian government [2]. These endangered species such as corpse flower, black orchid, and titan arum which are shown in Figure 1, Figure 2, and Figure 3, respectively.

Figure 1 Corpse Flower (*Rafflesia Arnoldii*) [9]

Figure 2 Black Orchid (*Coelogyne pandurata*) [10]

Figure 3 Titan Arum (*Amorphophallus titanium*) [11]

2.2. Endangered Fauna

Moreover, according to [1], Indonesia has an estimated 400 unique species of mammal. There are also several of them which are included as an endangered species by the Indonesian government [2]. Figure 4, Figure 5, and Figure 6 which show the picture of Sumatran elephants, Sumatran tiger, and Komodo respectively are examples of endangered animals in Indonesia.

Figure 4 Elephant (*Elephas maximus sumatranus*) [12]

Figure 5 Sumatran Tiger (*Panthera tigris sondaica*) [13]

Figure 6 Komodo Dragon (*Varanus komodoensis*) [14]

2.3. Endangered Species Education in Indonesia

There is a huge number of endangered Indonesian flora and fauna. This fact drives the Indonesian government, academics, and researchers to arrange and promote endangered species education in Indonesia [15]. However, this approach is still using conventional education with physical textbooks and classroom teaching style. This kind of education tends to have time, material, and perspective limitations. Figure 7 is an example of Indonesian flora and fauna education book.

Figure 7 Flora and Fauna Education Book Example [16]

3. Proposed Solution

FloNa is our proposed solution to address the lack of endangered species conservation education in Indonesia. FloNa is a mobile app for children which is based on augmented reality (AR). FloNa would be accompanied by a book which explains about various endangered species in Indonesia and is equipped with several AR markers. If the reader scans the book page with FloNa, they will see a 3D version of the species explained on that page. FloNa also supports interactivity which enriches the user experience in learning about endangered species in Indonesia.

3.1. Related Research

The level of attention and satisfaction of students in traditional middle schools' classroom has increased by using Augmented Reality technology, compared to conventional slide-based learning environments [17]. Moreover, research shows that the negative effects of learning disabilities such as Attention Deficit Disorder (ADD) can be reduced by applying AR-based education methods [18].

Interactive AR Learning System based on Augmented Reality and interactive touch screens were developed. Learning material delivered about fish conservation in Taiwan. The target of this system is so that children can learn about the importance of fish conservation by combining games with the concept of AR books. The evaluation results show this interactive AR learning shows positive usability [19].

From the related research mentioned above that the use of Augmented Reality technology gives positive feedback on the learning environment and can be applied to any form of education. This is the main target of the FloNa application to combine these factors and deliver a product that uses the benefits of current technology and applies it in the context of wildlife conservation education, specifically the education of endangered species conservation.

3.2. Analysis and Design

We conducted three main procedures to analyze and design FloNa: (1) system analysis for focusing the problem and system architecture, (2) user interface design for prototyping the app appearance and experience, a (3) software design for abstracting the problem to application development.

1. System Analysis. We conducted an analysis of the overall design of our system by prospective/target user surveys and current solution observation. Afterward, we designed a FloNa system architecture, user interface design, and software design. Figure 8 below shows the system architecture overview of FloNa.

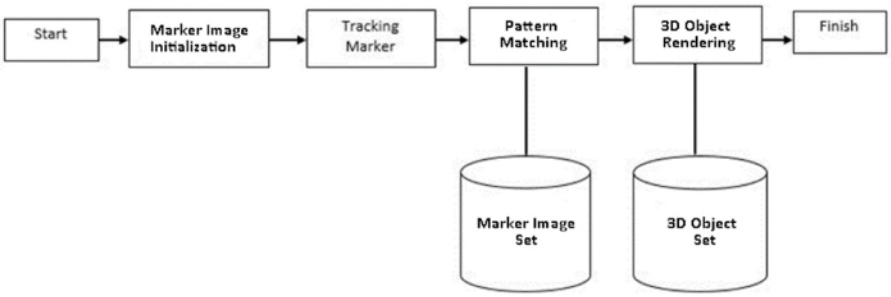


Figure 8 FloNa System Architecture

2. User Interface Design. We prototyped FloNa user interface by using the principle of good design: simplicity, directness, and real-time feedback. Table 1 shows the user interface prototype design for FloNa.

Table 1. FloNa User Interface Design

No	User Interface Design	Explanation
1		Splash Screen. The user will see the splash screen first when the application ran.
2		Main Menu. Display the main menu of the application, there are three buttons on the menu: Fauna, Flora and About Developer.

3		Flora/Fauna Menu. Scan the selected fauna marker and the correspondence 3D object will appear with the addition of two buttons. These two buttons have a function to display the growth of the selected flora/fauna. The button below is to return to the previous page.

3. Software Design. While designing the software, we used the UML software design concept. Figure 9 is the use case diagram of FloNa which shows the interaction between the user and our app. Both Figure 10 and Figure 11 are the FloNa activity diagrams of Flora and Fauna respectively. For deployment needs, we also design the component diagram shown in Figure 12 to explain the interaction between class components.

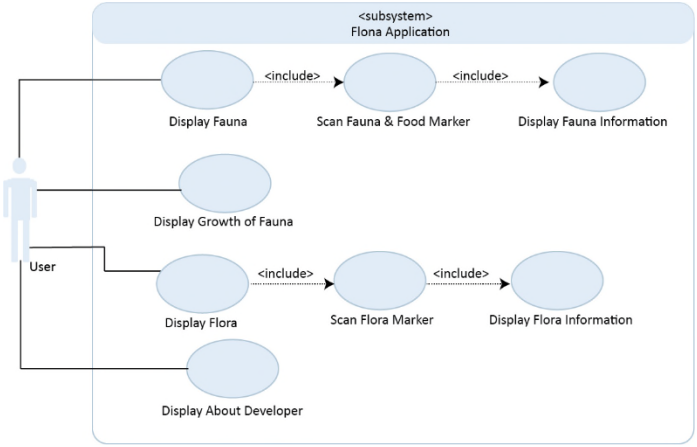


Figure 9 Use Case Diagram of FloNa

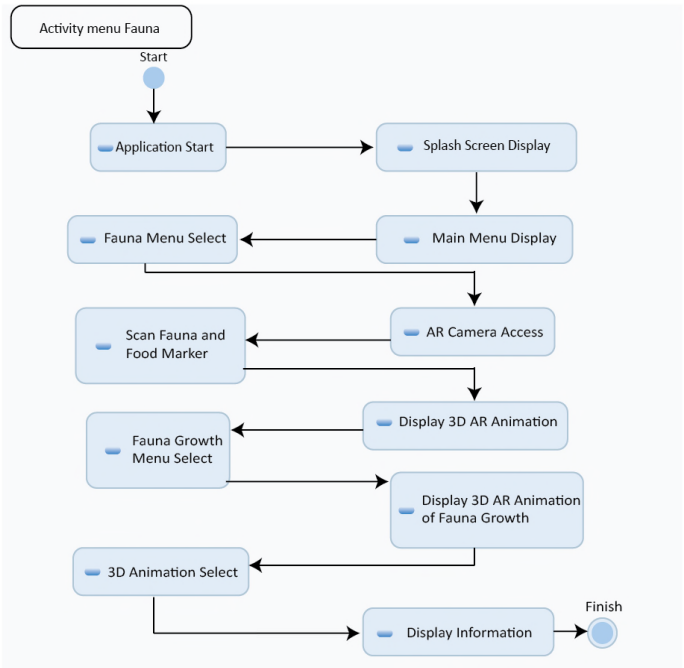


Figure 10 Fauna Activity Diagram of FloNa

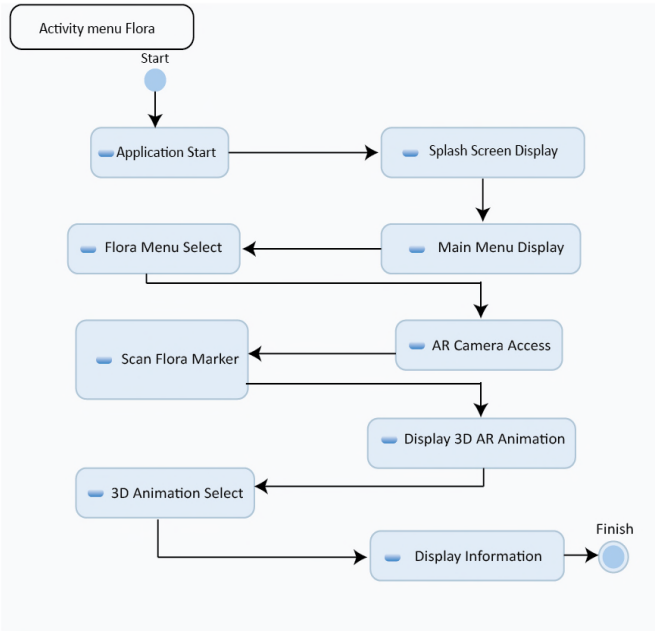


Figure 11 Flora Activity Diagram of FloNa

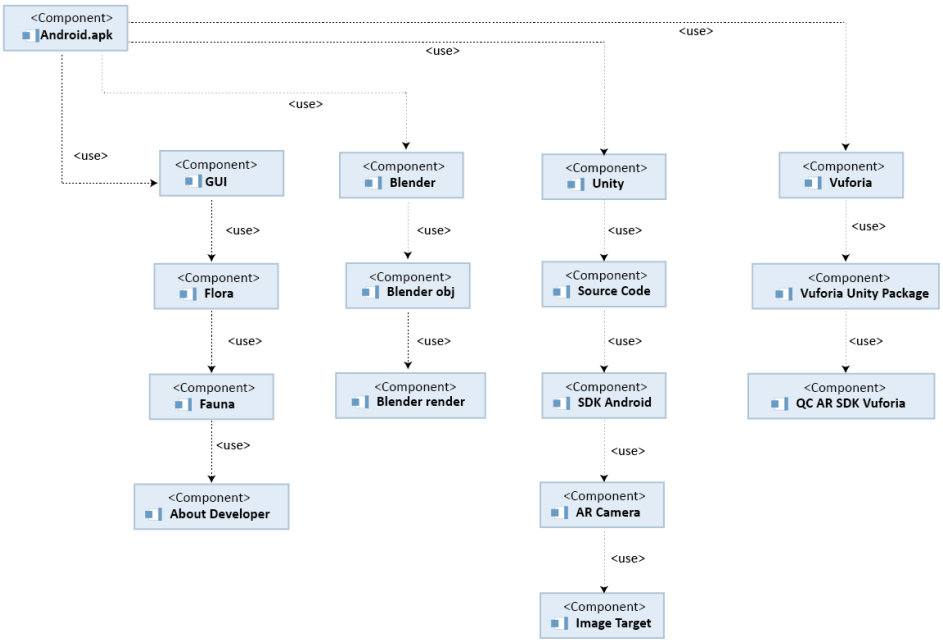


Figure 12 Component Diagram of FloNa

3.3. Implementation

Based on FloNa system analysis and design, we developed our proposed app. As mentioned before, to assist the endangered species education for children effectively, we used augmented reality (AR). By using this technology, children would be easier to observe and imagine the endangered species. Moreover, the use of AR, the education of endangered species would be more interesting because of its ability to represent the flora and fauna interactively in real-time.

1. Augmented Reality Engine
   We adopted several technologies to support the implementation of FloNa such as:

a. Vuforia SDK – a software development kit used to support all components and environment in developing of AR app [20].
b. Unity 3D – a game engine for interactivity purposes [21].
c. Blender 3D – a software to build our 3D markers of flora and fauna [22].
d. Android – a mobile operating system as FloNa app platform [23].

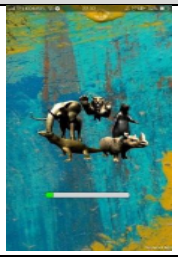
2. FloNa Marker Design
We design the marker of flora and fauna as realistic as possible without ignoring its interestingness and interactivity. Table 2 shows the example of FloNa marker design.

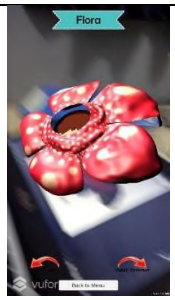
Table 2 FloNa Marker Design

No	3D Objects	Explanation
1		Adult, Young, and Baby Elephant
2		Adult, Young, and Baby Tiger
3		Adult, Young, and Baby Komodo
4		Animal Foods

3. FloNa Screenshot
Table 3 displays the screenshot of our app.

Table 3 FloNa Screenshot

No	Screenshot	Explanation
1		Splash Screen Display of "FloNa" Application.

No	Screenshot	Explanation
2		Main Menu Display of the Application, there are three menu buttons: “Fauna”, “Flora” and “About Developer”
3		The display of Fauna Menu. There are two buttons that can be used to view the growth of the selected fauna. The rotate buttons below can be used to rotate the 3D Object to the left or right.
4		The Display of Flora Menu. The rotate buttons below can be used to rotate the 3D Object to the left or right.
5		The detailed information display of selected flora/fauna.

4. Experimental Results

We conducted experiments to validate and verify the quality of FloNa. There are two kinds of experiments: alpha (developer) testing and beta (user) testing.

1. Alpha (Developer) Testing. We completed the alpha testing to validate both functional and non-functional requirements. Functional requirements are including button and marker tests. Non-functional requirements are including user interface and experience tests. The alpha testing shows that FloNa could meet all test cases successfully.
2. Beta (User) Testing. We managed the beta (user) testing to verify all app functionalities to our target users directly. Our target users are classified into two:

    a. Elementary school students (10-11 years old).
    b. Elementary school teachers.

There are six questions we gave to the users in A-E rank (A means strongly disagree and E means strongly agree). These questions are:

Q1. Does FloNa have an interesting display/interface?
Q2. Is FloNa easy to be used?
Q3. Can FloNa help you to learn Indonesia's endangered species?
Q4. Is your knowledge of Indonesia endangered species increased after using FloNa?
Q5. Do you want to use FloNa as an educational tool for learning Indonesia's endangered species?
Q6. Will you recommend FloNa as an educational tool for your friends?

Figure 13 Figure 18 show the result of question Q1-Q6 respectively.

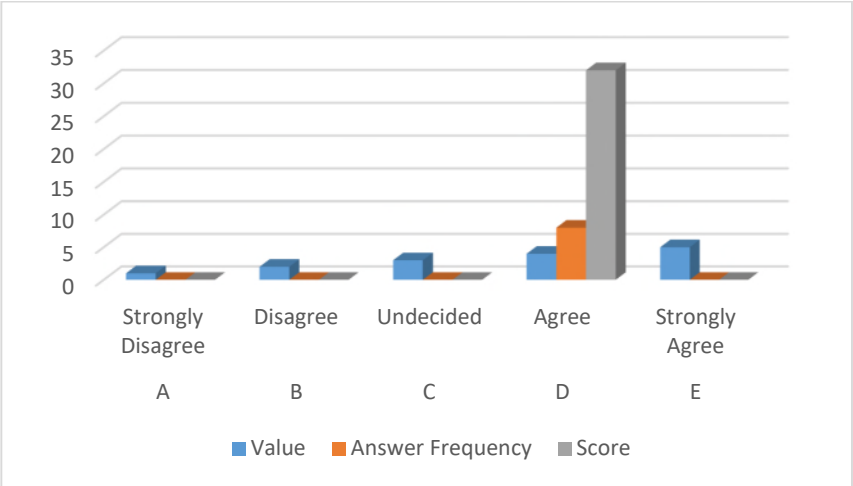


Figure 13 The Result of Question Q1

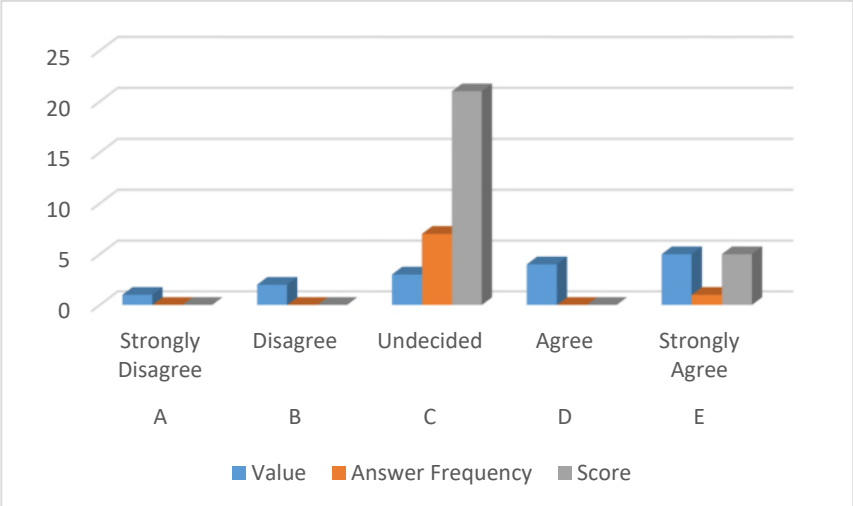


Figure 14 The Result of Question Q2

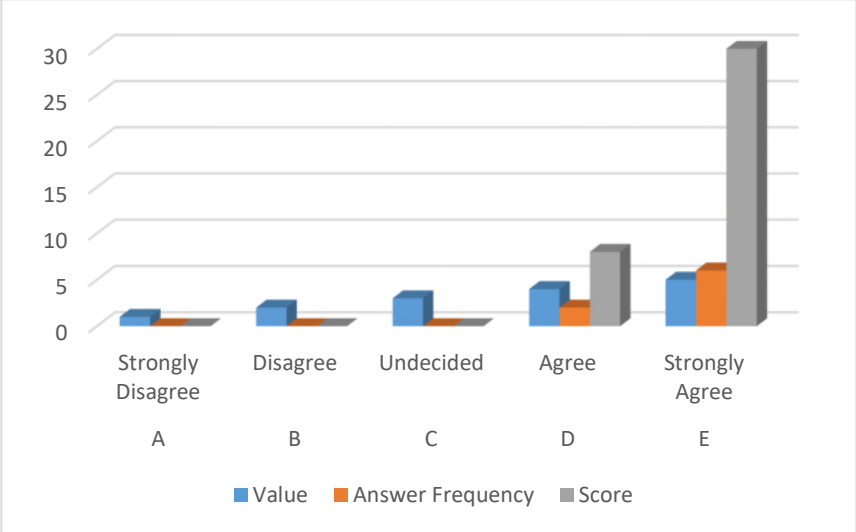


Figure 15 The Result of Question Q3

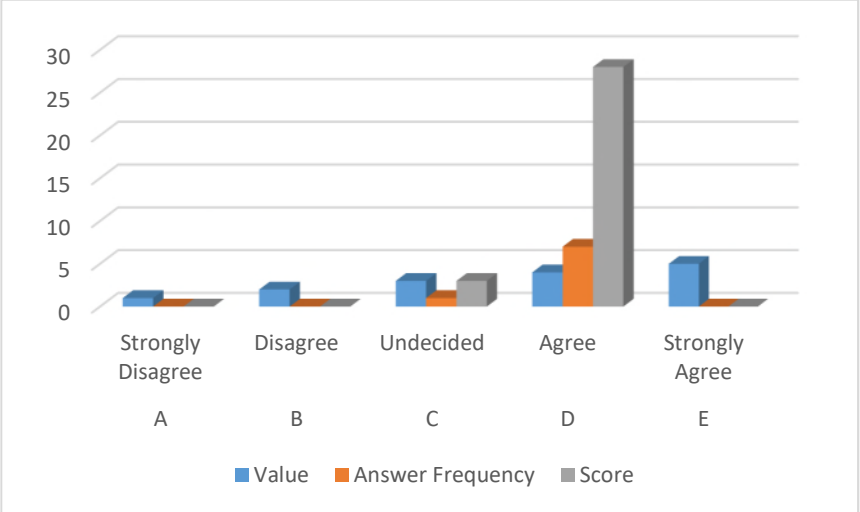


Figure 16 The Result of Question Q4

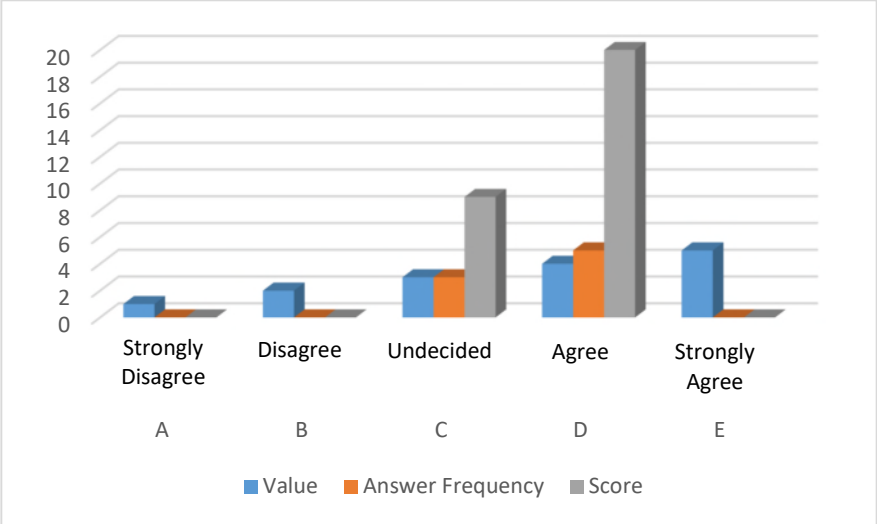


Figure 17 The Result of Question Q5

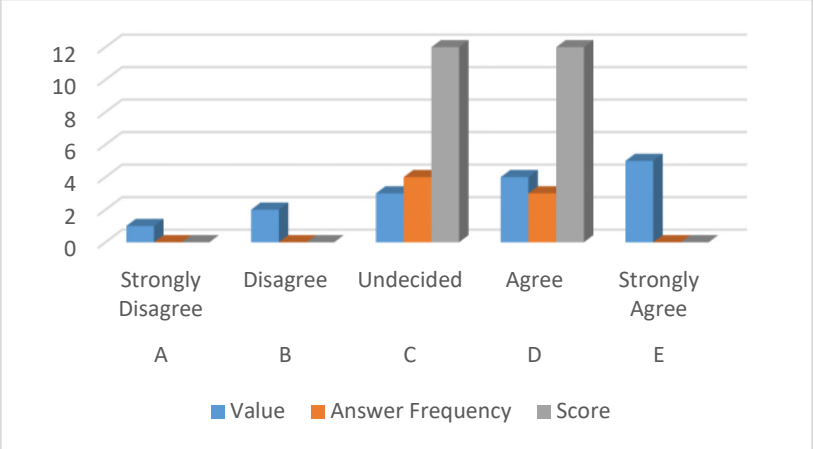


Figure 18 The Result of Question Q6

Regarding the beta test results, we analyze the total results as shown below where $\tilde{Q}_i$ is the average score of Q_i. This last result supports our hypothesis that FloNa can support the learning of Indonesia's endangered species better than the current education way.

$$Total = \sum_{i=1}^{6} \frac{\tilde{Q}_i}{6} = \frac{\tilde{Q}_1 + \tilde{Q}_2 + \tilde{Q}_3 + \tilde{Q}_4 + \tilde{Q}_5 + \tilde{Q}_6}{6}$$
$$= \frac{4 + 3.45 + 4.75 + 3.88 + 3.6 + 3}{6}$$
$$= \frac{22.68}{6} = 3.78$$

5. Conclusions

FloNa is our proposed solution to educate children about endangered species in Indonesia including flora (plants) and fauna (animals). We adopted mobile and augmented reality technology to build FloNa. Our processes developing FloNa include system analysis, user interface design, software design, and the application development itself. FloNa uses Vuforia SDL, Unity 3D, Blender 3D, and Android to empower its interactivity. In addition, we design the marker of flora and fauna as realistic as possible without ignoring its interestingness and interactivity.

The experimental result shows that FloNa could alternatively support the conservation education of Indonesia wildlife, especially the endangered species. FloNa could get score 3.78 of 5 which means the most target users agree that FloNa could help them and they are likely to recommend it to their friends, families, or students. However, a more depth investigation is needed to further validate its reliability by managing an automated unit, stress, and UI testing. Further verification to more users is still needed for the next development iteration.

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