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Designing Augmented Reality-Based Indonesian Marine Biota Book As An Educational Media

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ABSTRACT

Indonesia has a rich diversity of marine biota, with more than 35,000 species of flora and fauna, but many are unaware of its important role in the sustainability of the ecosystem. Therefore, it is important for children to learn about marine biota from an early age in order to increase their knowledge and foster concern for the preservation of marine ecosystems. This study aims to design an augmented reality (AR)-based Indonesian marine biota book as an educational medium. With AR, it is hoped that children's interest and understanding of marine biodiversity will increase. The methods used include literature review, interviewing children illustrator and ocean conservation communities, and the development of interactive AR books and applications. This book is a mini encyclopedia about species, habitats, and conservation, complete with attractive illustrations that can be scanned through an application on the Google Play Store to activate AR animation. The work process uses digital techniques in Clip Studio Paint for illustrations, animation in Adobe After Effects, and AR with Unity.

1. INTRODUCTION

Marine biota plays a crucial role in maintaining the balance of the global ecosystem. One of the most common important roles of marine biota can be seen with phytoplankton, which produces most of the oxygen we breathe and serves as the foundation for the marine food chain. Marine animals such as whales and sharks also play important roles in regulating the populations of other organisms within that food chain (Brilliyanto, 2023). Experts agree that Indonesia's oceans have the highest diversity and richness of marine biota in the world (Suharsono, 2014, p. ii). The diversity of marine species in Indonesia is estimated to reach 35,000 species (Arlinta, 2023). Unfortunately, knowledge and awareness of Indonesia's marine biota are still limited among the general public, leading to a lack of concern for conservation.

Therefore, it is essential to educate children about the ocean from an early age. As heirs to natural wealth for future generations, children need to enhance their environmental awareness, develop empathy for their surroundings, foster a love for the sea, and increase their knowledge and openness to the world (Nadianti & Adnin, 2024). In educating children, illustrated books can serve as one medium that helps enhance children's knowledge by providing structured and in-depth information on various topics. The illustrative media within them can facilitate and increase children's interest in understanding new information. Furthermore, the combination of images allows children to hone their imagination and creativity (Kheysta, 2023).

The work to be created in this design will also implement the utility of augmented reality (AR) technology. Augmented reality (AR) makes learning for children more engaging, interactive, and effective, as it

allows students to learn through interactive visual content rather than just reading books. With AR, students can better understand subjects such as biology through images and animations that clearly explain complex concepts. This method also supports learning anywhere, anytime, so that students and teachers do not have to be in a classroom. Additionally, AR can save educational costs by reducing the need for physical facilities and enabling access to digital materials (Varisha, 2023).

The educational illustrated book about Indonesia's marine biota, titled “Jelajah Biru,” will be specifically designed for children ages 10-12 (grades 4-6) from middle-class background, whose reading abilities have entered a more complex category compared to younger age groups. The specific target audience is also thought out to be categorized as Gen Alpha, Generation Alpha can be described as the children of Millennials and the younger siblings of Generation Z. This generation includes those born between 2010 and 2025. The term "Generation Alpha" emerged in 2005, determined by a survey conducted by Mark McCrindle, a social analyst and demographer. Since the previous generation had already used the last letter of the Roman alphabet, the naming convention was decided to follow the Greek alphabet, starting with “alpha”. Generation Alpha is the first generation to grow up alongside advanced technology since birth, often referred to as the "digital generation." This is evident in two-year-olds who are already adept at using software. To support this development, several countries are starting to include computer programming lessons in their primary and secondary school curricula. The aim of this curriculum is to cultivate creative students who can leverage technology to solve problems (Katyusha, 2023).

The topic of marine biota is also digestible for kids ages 10-12 (elementary 4-6) as their school curriculum has started introducing them about basic biology on living organisms. Some basic knowledge that they learn during those levels of education about living organisms are the food chain, interactions within the food chain, symbiotic relationships, how they reproduce, their habitat, categorization of species, family or genus, and even some simple learning on scientific names (Adit, 2020). This supports the appropriateness of topics in children's development regarding the knowledge they can absorb.

2. METHODS

To ensure the quality of the project, research must be conducted to further supply the author with credible information and insight. In this case, the method of research that has been carried out is descriptive qualitative and qualitative research in general. Qualitative research seeks to understand the complexities of human interactions, focusing on key concepts like process, understanding, and complexity. Furthermore, qualitative descriptive research presents data as it is, without manipulation or other treatments. The aim of this research is to provide a comprehensive depiction of an event or to expose and clarify a phenomenon that occurs. This is achieved by describing various variables related to the issue being studied. The research interprets and explains data concerning the current situation, attitudes, and perspectives within a community (Rusnadi & Rusli, 2020).

There are two types of collection methods for this research, the first to be carried out is literature review. This is done through reading books associated with Indonesia’s marine biota and gathering data and information through verified and credible websites that explain in detail about each species of marine life chosen to be shown in the mini encyclopedia. Essentially, a literature review is the process of conducting a general survey of previously published works related to various topics. The literature being reviewed or studied can include non-fiction writings such as scientific papers, theses, dissertations, or other non-fiction texts like books or articles that are not strictly academic (Gumilang, 2022). As for the second type of collection method, the author conducted an interview to further validate the relevance of the topic and gain new information that can be implemented for this particular project. Research interviews are more than just conversations and range from informal to formal. While all conversations have certain transition rules or controls by one participant or another, the rules in research interviews are stricter. Unlike casual conversations, research interviews aim to obtain information from only one side, creating an asymmetric relationship. Researchers tend to guide the interview toward uncovering participants' feelings, perceptions, and thoughts (Rachmawati, 2007).

For the first interview, it was done with an experienced children’s illustrator named Husna Aghniya, with seven years of making illustrations for children’s books for several clients. The insight gained from this interview was about the illustration and design aspect of making an educational children’s book. And lastly an interview with members of one of Indonesia’s marine conservation organizations, such as Marine Buddies Tangerang, a community initiated by WWF-Indonesia to support the management and control of Indonesia's marine resources. Their information and opinions were beneficial in knowing just what information needs to be inserted into the book and how to communicate this information without making things too complicated for kids.

With this method of research, the author hopes to gain valuable data and information that answers the issue and can be used as a guide in making relevant, educational, and interesting materials in regards to Indonesia's marine biota within the form of a mini-illustrated encyclopedia featuring augmented reality for kids ages 10-12.

Hopefully the final product will be easily accessible and interactive to help increase kids' interest in learning the importance of marine biota and conservation.

3. RESULTS AND DISCUSSION

3.1. Results

Literature Review

Before starting to design the book, the author conducted qualitative research methods such as literature review and interviews. Information was gathered from marine biota books, such as "Biodiversitas Biota Laut Indonesia" (2014) by Suharsono, as well as several trusted websites that compile data on animal and plant species, written and verified by marine experts.

From the literature study, the types of marine biota in Indonesia are divided into several categories of classes and specific species groups, such as plankton, crustaceans, mollusks, fish, marine mammals, reptiles, and many more (Suharsono, 2014, p. v). To provide more specific and focused information, the author has divided the book "Jelajah Biru" into three volumes: volume 1 on "Fish," volume 2 on "Coral Reefs," and volume 3 on "Marine Mammals and Crustaceans." Each book includes an introductory description of the class or species group, information introducing the types of animals within that group, their habitats, food sources, food chains, and finally, factors that can negatively affect the ocean and ways to protect or conserve it.

Interview

After conducting the literature study, the author interviewed a children's book illustrator to gather additional information and data regarding visual and design needs and specifications. In an interview with freelance illustrator Husna Aghniya on September 26, 2024, she explained that the illustration style usually preferred by children aged 10-12 years includes more complex illustrations with a greater variety of colors, shapes, and details that resemble real objects while still maintaining a cartoon style, and featuring more objects on a single page. Husna further explained the progression of books from toddlers to teenagers; each stage has its own age range and specific requirements and needs for readers. Ages 10-12 fall into Level C, or Intermediate Reader Level, where children are able to read paragraph-form texts fluently within a single discourse. On one page, there can be a maximum of four paragraphs, with each paragraph containing no more than five sentences, and each sentence limited to a maximum of twelve words. The vocabulary should include common words and specific terms related to the material, consisting of root words and derived words. Although most of the words used are common or basic, new terms and vocabulary can still be introduced. In addition to being able to read paragraph texts, children of this age can also understand infographics supported by text. It is also important to pay attention to the language style used; for children, it should not include vulgar words, inappropriate information or content, or information that is irrelevant to the topic being discussed.

In terms of design, the author needs to pay attention to margins and grid systems to ensure that the layout of images and text appears neat and orderly. To facilitate reading for children, the direction of images and paragraphs should support the flow of the page (for example, from left to right). Lastly, when considering illustrations, especially for educational themes, it is important to use a proportional illustration style that is not overly abstract, so that children can clearly learn the subject matter.

Continuing with the interview for research on what information or data should be included in the book on Indonesian marine biota, the interview was conducted with four members of the Marine Buddies community in Tangerang: Samantha Aulia Ramadhanti, Gisca Chairunisa, Fathima Gianty Fe Deigracia, and Natasha Irene on September 29, 2024. Marine Buddies is a community initiated by WWF-Indonesia to support the management and control of Indonesia's marine resources. This community is open to accommodating the aspirations and participation of the public in providing evaluations of marine conservation area management. Within this interview, what needs to be determined is what important information about marine biota needs to be included in the book for the target audience. The first topic discussed in this interview was which types of Indonesian marine biota are essential or important for children aged 10-12 to learn about. Samantha and Irene mentioned that animals classified as top of the food chain (such as sharks), those that are protected, and those that are commonly found are suitable as primary introductory material for them.

Moving on to the second point, the interviewers discussed what should be explained regarding marine conservation and its biota to children. There are three main topics that can be covered: the impacts of climate change, human activities on land (land waste) and at sea (shipping), the changes experienced by the ocean and its biota in adapting to these impacts, and most importantly, the actions that children can take to help with marine conservation. The third consideration is the use of language in conveying information. Since this book will serve

as an encyclopedia of marine biota, it will inevitably contain scientific terms in both English and Latin. The author asked whether these terms would be understandable or confusing for children aged 10-12. Irene and Fathima responded that the use of such language depends on the target enrichment level of the children. If targeting lower to middle-class children, it would be challenging to include too many foreign terms. To ensure that the information is evenly understood, foreign terms should, as much as possible, come with explanations or translations into the local language, while still maintaining the local language as the primary medium. The fourth point concerns interesting facts that can be included in the book, such as information that counters stereotypes (for example, sharks are not as dangerous as they are thought to be), the advantages of lesser-known species, and facts about bioinspiration. Finally, regarding the fifth and sixth points, Fathima and Gisca stated that it is important to explain the dangers posed by certain species to raise awareness among children from an early age so that they do not act carelessly when encountering these animals. Additionally, the benefits of these species should also be explained to emphasize their importance in the ecosystem. However, it is essential to clarify the context in which these species can be dangerous to avoid perpetuating negative stereotypes, as well as to emphasize that the exploitation of any species for their benefits is not a good practice.

Media for Creation

The media used to create a work is crucial. The author needs to know the form and where the work will be designed, including the materials, tools, and equipment used for the creation. Below are the specifications for the book and the tools used by the author:

BOOK SPECIFICATIONS:

1. Size: 25 x 20 cm (1 page), 50 x 20 cm (1 spread, 2 pages)
2. Material: Soft cover art carton, 260 gsm; pages made of art carton, 260 gsm
3. Number of pages: 16 pages (including cover) AR APPLICATION SPECIFICATIONS:
4. File format: APK (Android Package) for Android devices
5. Distribution media: Available on Google Play Store TOOLS:
6. Hardware
    a. Acer Swift X laptop with AMD Ryzen 5000 Series processor, 16 GB RAM, 500 GB storage, and Nvidia GeForce RTX graphic card
    b. Wacom Intuos CTH 480 Pen Tablet
    c. Logitech M185 wireless mouse
7. Software
    a. Clip Studio Paint 1.5 for graphic illustration
    b. Adobe After Effects 2020 for animation or motion graphics
    c. Unity 2022 for AR design

Techniques for Creation

The techniques used by the author are digital techniques, encompassing the illustration process, narrative or information integration, AR animation, and the creation of AR and its application. Layout, initial sketches, coloring, and final rendering of illustrations are done using Clip Studio Paint 1.5. For AR creation, 2D animations of the illustration assets are prepared using Adobe After Effects 2020. Finally, AR is developed using software like Unity 2022, which utilizes target tracking technology to enable the illustrations in the book to display the 2D animation assets. After designing the AR, the author will also use Unity 2022 to create the application to be uploaded to the Google Play Store for public download.

Creative Process

The process of creating the Indonesian marine biota encyclopedia "Jelajah Biru" consists of three stages: pre-production, production, and post-production.

1. Pre-Production Stage
    a. Establishing the concept, topic, and goals of the work
    b. Researching sources of information, data, references, and ideas through literature reviews and qualitative interviews
    c. Content design
    d. Collecting and structuring narratives or information into the book
2. Production Stage
    a. Sketching
    b. Initial coloring
    c. Final colorization (rendering)
    d. Layout design

e. Creating animations
f. Developing AR and its application
g. Printing, uploading the application to Google Play Store, and finishing

3. Post-Production Stage
   a. Preparation for exhibition
   b. Exhibition

Book Design Results

The contents of "Jelajah Biru" a mini-illustrative encyclopedia will refer to important information and also fun facts about a few Indonesian marine biotas from each of the volumes. Book 1 will be about the fish species, telling kids the definition of fish, different types of fishes, their habitat, food sources, and even ways to conserve or help aid their environment. Using Clip Studio Paint 1.5 for the illustration, animating them with Adobe After Effects 2020, then finally making and testing the AR with Unity 2022. The interesting animations of the illustration would hopefully bring the fishes alive with their movements, giving interesting additional information that cannot be attained by still image. Illustrations are drawn using cartoon style and bright variative colors, to suit the taste and interest of the target audience (kids ages 10-12).

The very first thing people see from a book would be the front and back cover, the author must make sure that it is interesting enough for new readers and also has all the visual elements that represent what the book is about. On the front cover of the book, there is a custom-made font for "Jelajah Biru Ikan". With a bold and wavy sans serif font (Paytone One) made to look like waves, the "Volume 1" using Autour One font inside a bubble and also the word "Ikan" looking like a fish, which is what the first book is about. Then, at the bottom of the front cover a text that reads "Mini Ensiklopedia Biota Laut Indonesia Untuk Anak" using Autour One as a sub heading that helps give new readers more context to what the book is about. In the middle of the front cover, a boy floating in the ocean surrounded by the different types of fishes as a spoiler to the inside.

And on the back cover, a heading to the summary of the book in bold Paytone One font that will attract attention to those who wanted to know more about the book by a few paragraphs. The text is informative and persuasive, assuring new readers to be curious and interested about the inside of the book. Using the font Andika size 14 for the summary ensures that it is big enough and readable for kids ages 10-12. The background for the back cover is connected to the illustration of the front cover, continuing the journey of fishes from left to right and corals adding the ocean atmosphere.

Figure 1

Front and Back Cover of Jelajah Biru Volume 1: Ikan and Book Mockup

On the first page of the book, a bold headline "Apa Itu Spesies Ikan" (Paytone One font) is used to lead the reader to the introduction of what is considered as fish (specifically ocean fish). Below it, a paragraph that

explains the detail to the introduction using Andika font size 14. The illustration of the first and second pages depicts the journey of fishes, the main character and explorer of the book (the boy) swimming through the sea just across the ocean floor filled with corals and seaweed. To make it user intuitive, the flow of the illustrations goes from left to right, which leads the direction of page reading onto the next pages. On the top right corner of the second page lies a text "Scan AR" and a phone icon to make aware of the use of AR, that could activate the page's animation. The AR will make the fishes and the boy swim.

Figure 2

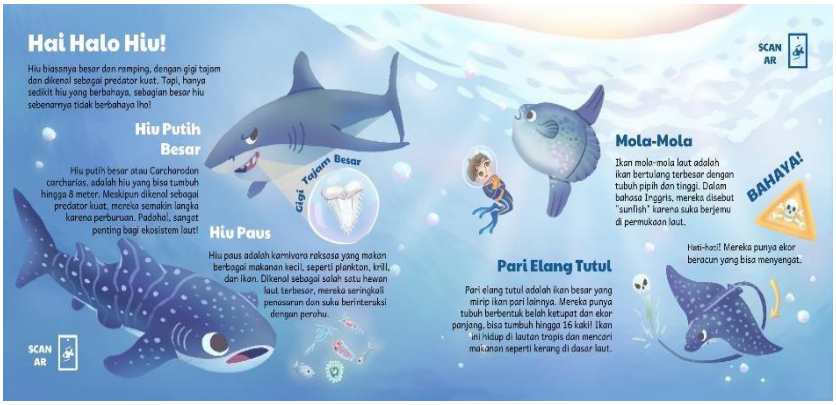
Page 1-2 of Jelajah Biru Volume 1: Ikan, Introduction

Onto the third page of the book, a bold headline "Hai Halo Hiu!" (Paytone One font) is used to lead the reader to the explanation of what is the shark species. Then, a brief paragraph that explains the detail to the headline using Andika font size 14. Referring to the headline, a further explanation of one of the 2 species of sharks in Indonesia, the Great White Shark (Hiu Putih Besar) and Whale Shark (Hiu Paus). The illustration depicts the Great White Shark bearing its sharp teeth, and a magnifying bubble that shows a zoomed in detail of its tooth. Below it, a Whale Shark barely opened its big mouth to eat the planktons beside it. An animation of the whale shark sucking up the planktons can be seen by scanning the AR of the page through the app.

The fourth page further explains another type of fish than the sharks, that are unique and fascinating. The Mola-Mola or Sunfish and Spotted Eagle Ray can also be seen animated by scanning the AR. While the Mola-Mola is animated to swim up to the surface, sunbathing below the daylight as part of its fun fact, the Spotted Eagle Ray however, was animated to show the danger of its venomous tail that can cause harm not only to the fellow marine organism but also to humans.

Figure 3

Page 3-4 of Jelajah Biru Volume 1: Ikan, Different Types of Fishes



Lastly, the author has done a test on one of the page's augmented reality features in page 3. It can be seen that the animation of the Whale Shark sucking up the planktons work well and clear, giving more depth and interactivity to the book. The illustration appeared without any loss of quality to the details or colors, nor its animation janky or lagging. This is made possible by an AR application from Unity 2022 for its target tracking technology that allows sections of the book to pop out an animation sequence, making the book even more dynamic and fun for learning.

Figure 4
Augmented Reality Feature of Jelajah Biru Volume 1: Ikan

3.2. Discussion

The results from the literature review and interviews underscore the importance of integrating both scientific accuracy and engaging design in creating the mini-illustrated encyclopedia "Jelajah Biru." The literature review revealed a rich diversity of marine biota in Indonesia, categorizing species into classes such as plankton, crustaceans, and fish, which informed the structuring of the book into three volumes. This organizational strategy not only simplifies the presentation of complex information for children but also makes the content more digestible. By focusing on specific groups, the encyclopedia can provide targeted educational material that aligns with the interests and cognitive levels of its young audience.

Meanwhile, the interviews conducted with professionals, including a children's book illustrator and members of the Marine Buddies community, highlighted key insights into the design and educational requirements necessary for this age group. Husna Aghniya's guidance on illustration style emphasizes the need for vibrant, detailed visuals that balance realism with a playful, cartoonish aesthetic. This approach is crucial for capturing the attention of children aged 10-12, who benefit from both engaging visuals and informative text. The suggested structure of paragraphs and the inclusion of small infographics further ensure that the content is accessible, fostering a better understanding of marine biota. Insights on catering and considering the reading capability of the target audience based on the criteria provided by Pusat Perbukuan are also implemented in the mini encyclopedia. These criteria of reading capability written in "Pedoman Perjenjangan Buku" approved by Indonesia's Ministry of Education and Culture, explained how kids ages 10-12 are categorized in level C as mediocre reader allowing them to be able to read paragraph and more complex sentences than the lower level (Desliana, 2023). Thus, the information conveyed in "Jelajah Biru" are within simple paragraphs which used vocabularies that are still in range of the target audience.

Furthermore, the discussions with the Marine Buddies community shed light on essential topics to address in the encyclopedia, particularly regarding marine conservation. Understanding the impacts of climate change and human activities on marine ecosystems is an important part to promote and increase the sense of environmental responsibility for the young generation. The emphasis on introducing common terms alongside scientific vocabulary supports inclusivity, ensuring that children from various backgrounds can engage with the material without feeling overwhelmed. This balance of accessibility and scientific rigor is paramount in educational resources aimed at children. From the information gathered, the project "Jelajah Biru" has also aligned its contents to emphasize the importance of educating marine biota from a young age to increase the sense of marine conservation and love for nature stated by Shabrina Andrawini, education officer of Jakarta Aquarium. A simple and kid-friendly approach is needed so that the kids can easily understand the topics as stated by Kyle Dougherty, Education Team Facilitator from Jakarta Aquarium (Ardiakurnia & Nursastri, 2018).

The creative process outlined in the project emphasizes the integration of digital techniques for illustration and augmented reality (AR) to enhance the learning experience. By utilizing software like Clip Studio Paint for illustrations and Unity for AR applications, the author creates a dynamic, interactive educational tool that allows children to explore marine life in an engaging way. The successful testing of AR features, as evidenced by the smooth animations of marine creatures, demonstrates the potential of technology to enrich educational materials. This interactivity not only captures children's imaginations but also fosters a deeper connection to the content, enhancing retention and understanding. The use of AR is also done within the understanding that is aligned with

the research done by Khilda Nistrina. It is stated that the application of augmented reality (AR) in education demonstrates significant advantages as an educational medium, particularly in understanding wave material, where students using AR find it easier to comprehend compared to those who do not. Additionally, AR allows for the visualization of complex objects and supports a flexible learning process, enabling students to study anytime and anywhere. Thus, AR facilitates realistic interactions between students and visual objects that blend with the real world (Nistrina, 2021, p. 2).

4. CONCLUSIONS AND SUGGESTIONS

The "Jelajah Biru" augmented reality-based mini encyclopedia on Indonesian marine biota effectively addresses the urgent need for marine education among children, particularly in Indonesia, a region renowned for its rich marine biodiversity. Since the knowledge and awareness about Indonesian marine biota and conservation is still minimal even among the general adult public, it is best to educate them from an early age. The earliest age range that is capable of digesting this information is from ages 10-12, as their science curriculum has started learning about living organisms. But as the younger generation and in this case, Gen Alpha started to use advanced technology even more so than their previous generation, the need to implement fun and interactive technology-featured media is evident more than ever. To effectively address those urgent needs above, the author has made a book which helps increase the interest in reading while expanding the kids' knowledge on Indonesian marine biota, through compelling illustrative visuals and information structure that can be easily absorbed within that age range. Implementation of augmented-reality technology also adds another layer of fun, interactive and memorable experience that correlates to the target audience's tech savviness, while keeping them interested and curious. By integrating scientific accuracy with engaging design and augmented reality, the mini-illustrated encyclopedia presents complex marine concepts in an accessible manner tailored for children aged 10-12. Insights from literature reviews and interviews with experts have informed a structured approach that emphasizes both educational value and visual appeal, promoting environmental awareness and conservation from an early age. The results of this project have ticked all the boxes in terms of requirement on making a visually appealing informative book on marine biota with the use of AR. The book has laid out appropriate information, illustrations and even animated AR as additional features.

Future iterations of "Jelajah Biru" should consider expanding its outreach through partnerships with schools, educational organizations or families to maximize its impact. Incorporating feedback from pilot testing with the target audience can further improve future development on the book. Hopefully for this particular iteration of the book, it can answer and fill the need of educating the young generation about the importance of marine biodiversity and ways to conserve it in an interesting way. Making sure the existence and sustainability of our ocean to be safe and everlasting while also promoting the interest in reading and learning new things.

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