

OCEANLENS: AUGMENTED REALITY EXPERIENCE OF PULAU REDANG MARINE LIFE

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Abstract—Pulau Redang, a well-known marine tourism spot in Malaysia, is facing serious environmental problems such as coral reef damage, pollution, and loss of marine life due to rising tourist activities. Traditional ways of teaching conservation often do not catch the attention of tourists, so new methods are needed to spread awareness and encourage responsible behavior. This study introduces OceanLens, an Augmented Reality (AR) mobile application designed to help users learn about marine conservation in a fun and interactive way. The app lets users explore digital 3D models of marine life, coral reefs, and pollution effects, making it easier to understand the impact of human actions on the ocean. Using the ADDIE model for development and a mix of surveys and usability testing, the study evaluated how well OceanLens helps users learn, stay engaged, and change behavior. Results show that AR helps users better understand and care about marine ecosystems, leading to more environmentally friendly actions. However, there were some challenges, such as poor internet connection at Pulau Redang, which can affect the AR experience. Also, some users had trouble using the app on certain devices, showing the need for better optimization. This study suggests that AR can be a powerful tool in conservation education. Other mobile apps, like Seek by iNaturalist or WWF Free Rivers, can also be useful for environmental learning in Malaysia. Future improvements could include adding more languages, AI features, and using AR in other ecotourism locations. By combining technology and education, OceanLens aims to support sustainable tourism and protect Malaysia's marine heritage for future generations.

Keywords—Augmented Reality (AR), Pulau Redang marine life, OceanLens application, conservation.

I. INTRODUCTION

Pulau Redang, located in Kuala Nerus, Terengganu, Malaysia, is famous for its beautiful beaches, clear waters, and rich marine life. It attracts many tourists for activities like snorkeling, diving, and jungle trekking. Visitors often enjoy seeing coral reefs, turtles, and baby sharks while exploring the marine park.

With its scenic views and comfortable accommodation, Pulau Redang is considered a paradise for nature lovers and travelers.

However, the growing number of tourists has started to harm the marine environment. Overcrowding and irresponsible tourism activities have led to damage to coral reef areas. Reports show that live coral cover has decreased by 35.5%, caused by climate change, pollution, and careless snorkeling or diving. Waste from tourism has also led to harmful algal blooms, which further damage the coral and marine habitats.

II. LITERATURE REVIEW

A. Case Study 1: Seafood Watch App

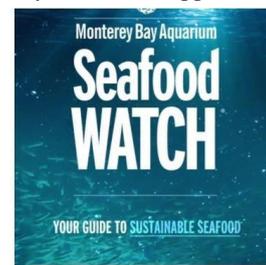


Figure 1: Seafood Watch App

Seafood Watch, created by the Monterey Bay Aquarium, is an app designed to promote sustainable seafood consumption. It categorizes seafood into Best Choices, Good Alternatives, and species to Avoid. These recommendations are based on extensive research into fishing and farming practices, considering their environmental impact and long-term sustainability. The app empowers consumers and businesses by providing easily accessible guidelines for environmentally conscious seafood decisions.

B. Case Study 2: Dive Against Debris

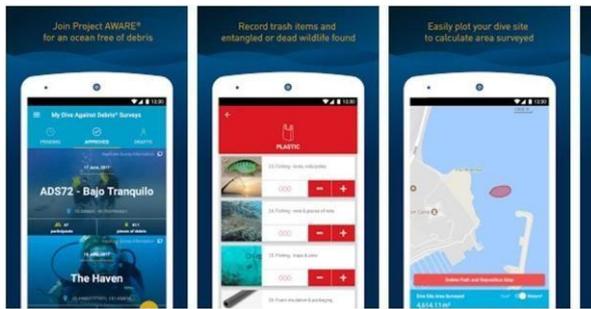


Figure 2: Dive Against Debris App

Dive Against Debris is an initiative by Project Aware designed to engage scuba divers in marine conservation by documenting underwater trash. The app allows users to log debris they find during dives, including details such as the type, quantity, and location. This data is compiled into a global database that informs policymakers, researchers, and conservationists about marine pollution trends. Since its inception, the app has enabled divers worldwide to play an active role in cleaning oceans while contributing to critical scientific data.

III. METHODOLOGY

The ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation, gives a complete structure for developing the augmented reality (AR) book and the "OceanLens the AR experience of marine life in Pulau Redang." App. This model ensures that the project's educational and experiential objectives are met effectively. The needs of students and visitors aged 20 to 30 are assessed based on their interest in and knowledge of marine life. During the design process, the objective is to develop an engaging AR experience that showcases the underwater diversity of Pulau Redang while also raising awareness about marine conservation. During development, 3D models of marine creatures and interactive AR features are developed using software such as Blender and Unity. The implementation phase entails deploying the program to users, allowing them to discover marine life in an interactive and immersive manner. Finally, the phase of evaluation determines whether the program is effective in improving users' understanding and appreciation of marine life, and also for gathering feedback for future improvements. By following the ADDIE model, this project aims to provide an engaging and educational experience that fosters a deeper connection with Pulau Redang's marine ecosystem.

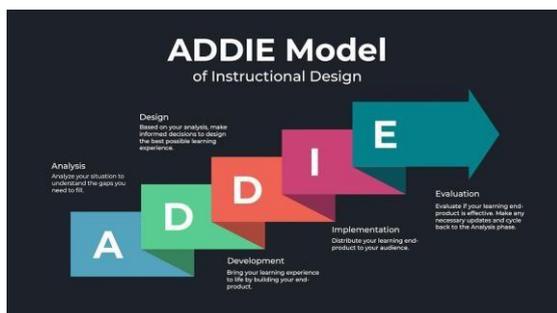


Figure 3: ADDIE model

A. Analysis phase

In the Analyze phase of the OceanLens project, the main goal is to understand how much tourists visiting Pulau Redang know about marine conservation and the challenges affecting its marine ecosystem. This includes studying tourists' knowledge of marine life, their behavior during activities like snorkeling and diving, and their awareness of the environmental impact of tourism. To collect this information, surveys and interviews will be conducted with tourists aged 20–30 who take part in water activities. This group is chosen because they are likely to use modern technology like Augmented Reality (AR), which can help lead to a change in conservation awareness. Key environmental issues such as coral reef damage, pollution, and biodiversity loss will be analyzed, especially due to increased tourist activity. These problems have greatly affected coral health and highlight the need for better education about marine conservation. The findings from this phase will help shape the design of the AR app, ensuring it meets the real needs of users and encourages sustainable tourism. Ultimately, this step lays the foundation for creating an engaging and informative AR experience that supports efforts to protect Pulau Redang's marine life.

B. Design phase

In the Design phase of the ADDIE model, the OceanLens AR app was carefully planned to give users an engaging and interactive way to learn about marine life and conservation in Pulau Redang. The design started with creating a story that invites users to explore the underwater world and discover marine animals like coral reefs, fish, and turtles. 3D models of these marine creatures were created using Blender, with realistic textures and features to bring the ocean to life. Rigging and meshing helped the models move smoothly in the AR environment. These models were then imported into Unity, where users can interact with them using their devices. Educational features were added so that users can tap on a fish to learn its name and role in the ecosystem. These interactions were powered by C# programming to make the app responsive and engaging. Adobe Illustrator was used to design user-friendly icons and buttons with simple symbols and bright colors that matched the marine theme. Adobe InDesign helped design the layout of the AR book, making sure that printed pages with images and text worked well with the app when scanned. This design approach combined 3D visuals, AR features, and storytelling to build an immersive experience. The goal was to entertain and educate users, helping them better understand and care about protecting Pulau Redang's marine life.

C. Development phase

During the Development phase of the OceanLens project, creating the 3D models and building the AR app came with both challenges and learning opportunities. At first, using Blender to design marine life models like fish, turtles, and coral reefs was difficult. The software often crashed, especially with complex designs, which slowed progress. Still, 7 out of the 10 planned models were completed, each designed with realistic textures and shapes to suit the AR experience. Next, the 3D models were imported into Unity to start building the app. Basic pages like the landing screen, instructions, and interactive scenes were created to guide users and support learning. One of the main challenges was working with the Vuforia Engine. At first, the image targets didn't work well because the images used weren't clear enough. To fix this, higher-quality images were added to improve AR

detection. After solving this issue, the app was exported as an APK file using the Android SDK, making it ready to run on Android devices. This phase showed the ups and downs of development but was also a great learning experience. It helped improve technical skills and laid the foundation for future testing and refinement of the OceanLens app.

D. Implementation phase

The main goal of the Implementation phase of the OceanLens project is to raise awareness about marine life in Pulau Redang, especially among students and tourists aged 20 to 30. This group is curious about nature and enjoys learning through technology, making them a good fit for an interactive AR experience. The app helps users explore marine life like fish, turtles, and corals while promoting the importance of ocean conservation. However, there were some limitations. The app was exported as an APK using the Android SDK, so it only works on Android devices. This means iOS users or those with older phones might not be able to use it, which reduces the number of people who can access the app. Still, focusing on Android allows the app to work well on the most common devices used by the target audience. Other challenges included the need for a strong internet connection and a good-performing phone to use the AR features smoothly. Despite these issues, the app provides a convenient and engaging way to learn about marine life. Overall, this phase helped bring the app to life, but more work is needed to make it more accessible to a wider audience.

E. Evaluation phase

In the Evaluation phase of the OceanLens project, a survey will be used to measure how well the AR app helps users learn about marine life and conservation in Pulau Redang. The survey will collect feedback from students and tourists aged 20 to 30, focusing on how engaging and informative the app is. It will cover marine species like fish, turtles, and corals, and test users' awareness of the need to protect the ocean environment.

Google Forms will be used to make it easy for users to respond and for researchers to organize the results. The responses will be analyzed using quantitative methods, including statistics, to understand the app's impact. Charts and illustrations will be used to clearly show the findings. This evaluation will help measure how users interacted with the AR features and how much the app helped increase awareness of marine conservation.

IV. PROJECT DEVELOPMENT

This chapter presents the development journey of OceanLens, an augmented reality (AR) book focused on marine education. Aimed at tourists, divers, snorkelers, and anyone curious about Pulau Redang's marine biodiversity, the project combines interactive technology with educational content to create an engaging experience. The chapter outlines each stage of development analysis, design, implementation, and evaluation while also detailing the prototyping process and final design elements, including visual styles, fonts, navigation features, sound design, and 3D marine models.

A. Software Requirement

Table 1: Software Requirements

Development Area	Software
AR Integration	Vuforia in Unity 2021.3.31f1
Image Target Setup	Vuforia Database
3D Model Creation & Rigging	Blender 2025
AR Animation	Unity 2021.3.31f1
App Scripting	C# in Visual Studio Code

B. Prototype Design

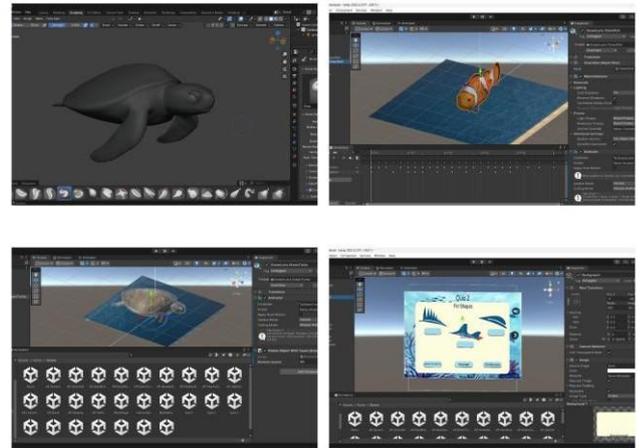


Figure 4: Prototype Design

V. TESTING AND RESULTS

This chapter presents the evaluation results and findings for the OceanLens augmented reality (AR) storybook and mobile application. The analysis focuses on key areas, including user engagement, educational effectiveness, learning outcomes, and overall usability, in real-world use. By combining quantitative data and qualitative feedback, this chapter provides a comprehensive overview of how OceanLens performs with its target audience. Visual aids, including charts, graphs, and user interaction images, are used to support and illustrate the findings. The purpose of this evaluation is to highlight the strengths of the OceanLens experience, particularly its immersive marine exploration and learning features, while also identifying opportunities for future improvements.

A. Survey Result

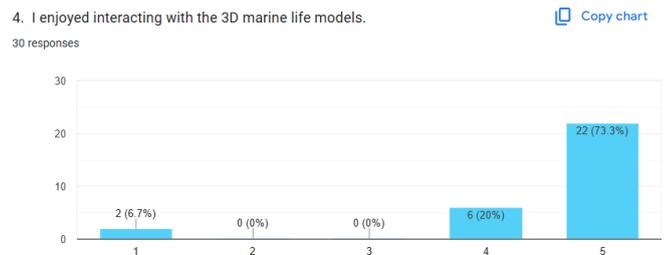


Figure 5: Survey Result

Most participants (73.3%) reported a strong enjoyment while engaging in the 3D marine life models, and another 20% gave a positive rating. None of the users selected neutral or slightly positive responses. Only a small minority (6.7%) did not enjoy the interaction. These findings highlight the effectiveness of the 3D models in enhancing the immersive and interactive experience within the OceanLens app.

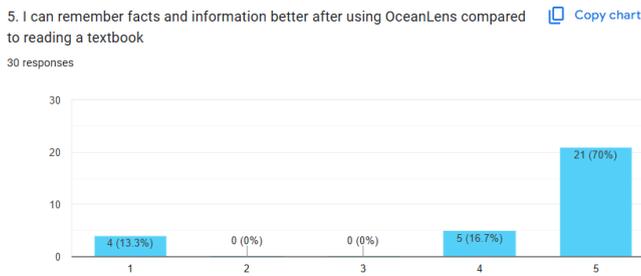


Figure 6: Survey Result

The results indicate that most participants (70%) strongly agreed that the educational content was clear and easy to understand, while 16.7% agreed. None of the respondents gave a neutral or disagreeing response, although 13.3% strongly disagreed. This suggests that the OceanLens application is generally effective in delivering educational messages about marine life clearly and engagingly, despite a small portion of users expressing dissatisfaction.

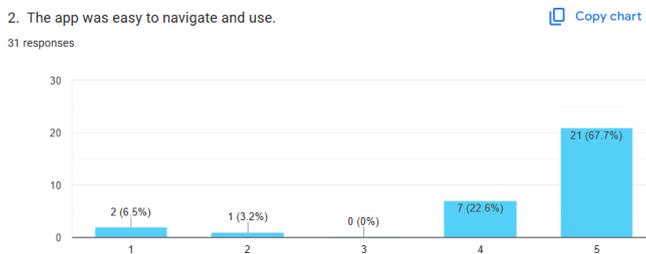


Figure 7: Survey Result

The results indicate that most participants (67.7%) strongly agreed that the app was easy to navigate and use, while 22.6% agreed. A small percentage of users expressed negative feedback, with 3.2% disagreeing and 6.5% strongly disagreeing. No respondents selected a neutral response. These findings suggest that the OceanLens application is generally user-friendly and accessible, although there remains room for improvement based on a few users' experiences.

VI. CONCLUSION

This project achieves the goal of raising awareness and promoting marine conservation through the OceanLens AR book and application. OceanLens aims to deliver an engaging and immersive experience for users, especially students and tourists, by showcasing the rich marine life of Pulau Redang. More than just an educational tool, this project introduces a new, innovative way of learning through augmented reality. It not only supports environmental education but also encourages responsible behavior and a deeper appreciation for ocean ecosystems.

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