“DEVELOPMENT OF AN EDUCATIONAL APPLICATION FOR INTRODUCING MARINE MAMMAL WORLD TO PRESCHOOL AND PRIMARY SCHOOL CHILDREN”

by

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Abstract

The Mediterranean Sea is a marine biodiversity hotspot, covering about 2.5 million km² and hosting around 6.3% of the world's marine species. Among its diverse fauna, marine mammals are included such as seals, whales, dolphins, and the critically endangered Mediterranean monk seal (Monachus monachus). However, anthropogenic pressures, habitat loss, pollution, overexploitation, invasive species, and climate change pose significant threats to marine mammal populations. Educating younger generations about these challenges and the importance of marine conservation is crucial. This master thesis aims to develop an educational application in the form of a game that familiarizes preschool and primary school children with the Mediterranean marine mammal biodiversity. To achieve this, the study utilizes state-of-the-art technologies and a multidisciplinary approach. The selected technology for application development is Unity 2D/3D, a widely used game engine known for its versatility and user-friendly features. Unity's capability to design games in both 2D and 3D environments, along with its extraction options to various platforms and electronic devices, makes it an ideal choice. The application will utilize touch screen functionality through kiosks to improve user-friendliness for children in educational settings like aquariums and schools, providing interactive experience. The educational game will consist of multiple elements, including species cards with graphics, photographs, and videos, accompanied by information on food preferences and typical habitats. Additionally, interactive mini-games will be incorporated, offering randomized content to maintain user engagement and provide learning experiences. The developed application can be utilized at major Greek scientific/research events such as Researchers Night and the Athens Science Festival, offering an interactive and enjoyable learning experience for children. Furthermore, its permanent installation in aquariums like Cretaquarium and the aquarium in Rhodes, as well as its availability for visiting schools through tablets or mobile devices, can enhance marine mammal education. By leveraging state-of-the-art technology, this master thesis contributes to the field of educational technology and promotes innovative approaches to marine conservation education. The developed application serves as an example of how interactive and immersive learning experiences can be created to engage and educate young learners about the Mediterranean marine mammal world.

Σύνοψη

Η Μεσόγειος Θάλασσα είναι ένα καίριο σημείο θαλάσσιας βιοποικιλότητας, που καλύπτει περίπου 2,5 εκατομμύρια km² και φιλοξενεί περίπου το 6,3% των θαλάσσιων ειδών του κόσμου Μεταξύ της ποικιλόμορφης πανίδας της, τα θαλάσσια θηλαστικά όπως φώκιες, φάλαινες, δελφίνια και η μεσογειακή φώκια (Monachus monachus). Ωστόσο, οι ανθρωπογενείς πιέσεις, η απώλεια ενδιαιτημάτων, η ρύπανση, η υπερεκμετάλλευση, τα χωροκατακτητικά είδη και η κλιματική αλλαγή αποτελούν σημαντικές απειλές για τους πληθυσμούς των θαλάσσιων θηλαστικών. Η εκπαίδευση των νεότερων γενεών σχετικά με αυτές τις προκλήσεις και τη σημασία της διατήρησης της θάλασσας είναι ζωτικής σημασίας. Αυτή η μεταπτυχιακή διατριβή στοχεύει στην ανάπτυξη μιας εκπαιδευτικής εφαρμογής με τη μορφή ενός παιχνιδιού που εξοικειώνει τα παιδιά προσχολικής και πρωτοβάθμιας εκπαίδευσης με τη βιοποικιλότητα των θαλάσσιων θηλαστικών της Μεσογείου. Για την επίτευξη αυτού του στόχου, η μελέτη χρησιμοποιεί τεχνολογίες αιχμής και μια διεπιστημονική προσέγγιση. Η εφαρμογή θα χρησιμοποιεί τη λειτουργικότητα της οθόνης αφής ενσωματωμένη σε κιοσκι για τη βελτίωση της φιλικότητας προς τον χρήστη για τα παιδιά σε εκπαιδευτικά περιβάλλοντα όπως ενυδρεία και σχολεία, παρέχοντας μια βελτιωμένη διαδραστική εμπειρία. Το εκπαιδευτικό παιχνίδι θα αποτελείται από πολλά στοιχεία, συμπεριλαμβανομένων καρτών ειδών με γραφικά, φωτογραφίες και βίντεο, συνοδευόμενα από πληροφορίες για τα θαλάσσια θηλαστικά της Μεσογείου. Επιπλέον, θα ενσωματωθούν διαδραστικά μίνι παιχνίδια, που προσφέρουν τυχαιοποιημένο περιεχόμενο για την παροχή ποικίλων μαθησιακών εμπειριών. Η εφαρμογή μπορεί να χρησιμοποιηθεί σε μεγάλες εκδηλώσεις, καθώς και εκπαιδευτικά φεστιβάλ, προσφέροντας μια διαδραστική και ευχάριστη εμπειρία μάθησης για τα παιδιά. Επιπλέον, η μόνιμη εγκατάστασή του σε ενυδρεία όπως το Cretaquarium στην Κρήτη και το ενυδρείο στη Ρόδο, καθώς και η διαθεσιμότητά του για επίσκεψη σε σχολεία μέσω tablet ή φορητών συσκευών, μπορεί να ενισχύσει την εκπαίδευση για τα θαλάσσια θηλαστικά. Αξιοποιώντας την τεχνολογία αιχμής, και συγκεκριμένα το Unity 2D/3D, αυτή η μεταπτυχιακή διατριβή συμβάλλει στον τομέα της εκπαιδευτικής τεχνολογίας και προωθεί καινοτόμες προσεγγίσεις στην εκπαίδευση για τη διατήρηση της θάλασσας. Η εφαρμογή που αναπτύχθηκε χρησιμεύει ως παράδειγμα του τρόπου με τον οποίο μπορούν να δημιουργηθούν διαδραστικές και καθηλωτικές εμπειρίες μάθησης για να εμπλακούν και να εκπαιδεύσουν νεαρούς μαθητές σχετικά με τον κόσμο των θαλάσσιων θηλαστικών της Μεσογείου.

Table of Contents

List of Figures

List of Tables

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To my family and friends, whose unwavering encouragement and understanding sustained me through the challenges of this endeavor, I express my deepest appreciation.

Dedication

This thesis is dedicated to my beloved family—my husband, Filippos, and our two precious little ones, Alexandros and Danae. Their unwavering love, understanding, and joyous presence have been the cornerstone of my academic journey.

Preface

This thesis represents the culmination of dedicated research, design, and implementation efforts aimed at creating an innovative educational application titled "Marine Mammals: Into the World of Mediterranean Marine Mammals." As the author, I embarked on this journey with a passion for combining technology, education, and environmental awareness.

Background and Context:

Chapter 1 introduces the context and background that motivated the development of the application. The rich biodiversity of the Mediterranean Sea, coupled with the pressing challenges faced by marine mammals, laid the foundation for this exploration into marine conservation education.

Objectives of the Study:

Outlined in Chapter 1, the objectives delineate the mission to create an engaging educational tool for preschool and primary school children, fostering an early understanding of marine life and the importance of conservation.

Contribution of the Study:

Chapter 1 also highlights the multifaceted contribution of this study. From technological innovation using Unity 2D/3D[10] to fostering interdisciplinary collaboration, the study aims to bridge the gap between marine conservation education and technology.

Research and Implementation:

Chapters 2 through 5 unfold the research journey, encompassing the gathering of requirements, a comprehensive review of state-of-the-art technologies, and the meticulous software design and implementation of the educational application.

Results and Discussion:

Chapter 6 delves into the practical application and impact of the developed application. Conclusions drawn from the research and implementation process are presented, reflecting on the achieved milestones and the potential future implications of this work.

This thesis is not just an academic exercise; it represents a commitment to the critical cause of marine conservation education. It is my sincere hope that this work contributes to the broader dialogue surrounding innovative educational technologies and their role in fostering environmental awareness among the younger generation.

Chapter 1 - Introduction

1.1 Background and context

Educational games can be beneficial to kids. Especially games that have something to teach them in their real everyday life. This article outlines an educational application called “Marine Mammals”. Educating younger people about the importance of marine conservation is crucial. This master thesis aims to develop an educational application in the form of a game that familiarizes preschool and primary school children with the Mediterranean marine mammal biodiversity.

1.2 Objectives of the study

The primary objective of this master's thesis is to conduct comprehensive research on the state of marine life in the Mediterranean region and utilize serious game methodologies to develop an engaging and educational game tailored for preschool and primary school children. By combining scientific knowledge, interactive gameplay, and immersive technologies, the study aims to contribute to the field of educational technology and promote innovative approaches to marine conservation education. Specifically, the thesis seeks to identify best practices and methodologies in the domains of serious games and teaching preschool and primary school students through games. Through an in-depth literature review, examination of academic publications, research papers, and case studies, the study will identify successful approaches, effective learning strategies, and engaging game mechanics that have been proven impactful for young learners.

1.3 Methodology and approach

To achieve the objectives outlined above, this study will employ a comprehensive methodology that takes into account existing implementations related to marine life and incorporates best practices for engaging young children's attention. The selected technology

for application development is Unity 2D/3D[10], a widely used game engine known for its versatility and user-friendly features. Unity's capability to develop games in both 2D and 3D environments, along with its extraction options to various platforms (e.g., Windows, Unix, Android) and electronic devices (e.g., mobile, tablet, PC), makes it an ideal choice. The application will be specifically designed for tablet devices, which are widely used by children and have been proven to hold their interest. The User Interface (UI) of the application will consist of visually appealing 2D elements, including text, buttons, and images, carefully crafted to comply with child-friendly design principles. Furthermore, the application will feature an array of mini-games, such as quizzes, puzzles, and matching games, which foster the development of essential skills such as spatial awareness, problem-solving, critical thinking, and 21st-century skills. The learning content will be presented in various formats, encompassing text, video, and audio, to cater to the diverse learning needs and specificities of every child. Additionally, gamification elements, such as health bars and time trials, will be incorporated to heighten learners' motivation, engagement, and provide a continuous stream of challenges throughout the learning process. The study will also explore touch screen functionality through kiosks to improve user-friendliness for children. By adopting this methodology and approach, the thesis aims to develop an educational application that is both effective and enjoyable for preschool and primary school children, fostering their engagement and understanding of the Mediterranean marine mammal world.

1.4 Contribution to the study

The contribution of this master's thesis is multifaceted. This thesis contributes to the field of education by creating an innovative and engaging educational application that introduces young learners to the world of marine mammals. It also serves as a valuable educational tool for preschool and primary school children, promoting marine conservation awareness from an early age. By utilizing state-of-the-art technologies, such as the Unity 2D/3D game engine and touch screen functionality, this thesis promotes the innovative use of technology for educational purposes. The application's adaptability to various platforms and devices enhances its accessibility and impact. It also adopts a multidisciplinary approach, blending marine science, educational technology, and game design principles.

The developed application has real-world applications at major events, educational festivals, and aquariums, providing interactive and enjoyable learning experiences for

children. This practical implementation highlights the project's potential to influence marine conservation education beyond the academic realm.

By offering multilingual support, this application has the potential to reach a global audience. This contribution expands the educational impact of the project, making it accessible to diverse cultures and regions. The application also focuses on marine mammal education and conservation aligns with the growing importance of environmental awareness. It contributes to efforts aimed at safeguarding the Mediterranean marine ecosystem and its inhabitants. Emphasizing the non-commercial and open-source nature of the project fosters collaboration within the educational and tech communities. This collaborative ethos encourages collective efforts to improve and expand the application for the benefit of learners worldwide.

In summary, this master's thesis makes a significant contribution by bridging the gap between marine conservation education and technology, creating an engaging educational application that fosters environmental awareness and conservation among young learners. It also underscores the potential of interdisciplinary collaboration and open-source initiatives in the field of educational technology.

The rest of the thesis is structured as follows: In Chapter 2 we explore the Background and motivations for this project. Chapter 3 continues with the State-of-the-art technologies used for this application. Then, Chapter 4 goes into the Software Design and Chapter 5 covers the Implementation. Finally in Chapter 6 discusses the results and looks ahead to the future.

Chapter 2 - Background

2.1 Marine Biodiversity, threats and solutions

The Mediterranean Sea is like a vast playground for marine life, hosting creatures ranging from playful dolphins to the majestic whales. Among these inhabitants is the endangered Mediterranean monk seal. Unfortunately, human activities such as pollution, habitat loss, and climate change are threatening the marine mammal populations. Preserving these species is vital, and educating the younger generation about marine conservation becomes crucial. Recognizing the importance of instilling awareness and understanding of marine life challenges, this master's thesis aims to leverage serious game methodologies. The goal is to develop an engaging and educational game specifically tailored for preschool and primary school children.

Utilizing state-of-the-art technologies and a multidisciplinary approach, the chosen platform for game development is Unity 2D/3D. Renowned for its versatility and user-friendly features, Unity allows the creation of games for various platforms and electronic devices, making it an ideal choice. The educational game's components include species cards with graphics, photographs, and videos, featuring information on food preferences and typical habitats. Interactive mini-games, such as memory games, puzzle makers, and quizzes, enhance user engagement, providing diverse learning experiences.

The developed application is designed not only for individual learning but also for communal events like Researchers Night, Athens Science Festival, and educational festivals. Its installation in aquariums such as Cretaquarium and the aquarium in Rhodes offers continuous access to educational content, enriching marine mammal education. To lay a solid foundation for game design, extensive research explores best practices and methodologies in serious game design. A thorough literature review and empirical research methods, including surveys and interviews, aim to establish a theoretical framework and gather insights for effective serious game development.

2.2 Background History

The idea of this project was given after the successful launch of the entertaining application TurtleSOS. TurtleSOS, is an educational application/game where a player

interacts with a touch screen. The screen in the beginning includes a reading about the Loggerhead Turtles (Caretta caretta) and the story behind the game [Figure 2.2.1].

Figure 2.2.1. TurtleSoS Game/Application

The game starts on a sandy beach with the turtle eggs not open yet. When the eggs open the little turtles try to reach the water but the beach is full of trash and the player has to put all the garbage to the trash can before the eggs open or to try to make a path for the turtles to manage to get into the water [Figure 2.2.2]. In the background of the application, you can observe the island Dia. There is a compelling story to share when explaining to young educators the reality that several turtles are born even here, on our island of Crete.

Figure 2.2.2. TurtleSoS Game screen

Taking inspiration from the success of the 'TurtleSOS' retro application, a widely acclaimed tool in school visits and exhibitions that continues to lead the way at the Cretaquarium's entrance [Figure 2.2.3], our proposed app seeks to build upon this foundation. It will feature a combination of engaging gameplay, informative videos, rich graphics, and other interactive elements, ensuring that children are attracted to the learning experience while immersing themselves in the world of Mediterranean marine mammals."

Figure 2.2.3. TurtleSoS Application installed at a kiosk at Cretaquarium busy entrance

Chapter 3 - State-of-the-art

3.1 Searching similar applications

In the ever-evolving landscape of educational and interactive applications designed for children, our exploration led us to discover a variety of engaging experiences that blend learning with entertainment. Notable among these are Toca Life: World | Aquarium [21], The Freshwater Access Game [22], Starfall ABCs [23], Oceans for Kids - Learn Sea Animals [24], Ocean Adventure Game for Kids [25], Ocean Life - Sea Turtle Adventure [26], Splash Math - Games for Preschool and Grade School Kids [27], The Earth - by Tinybop [28], and Sago Mini Ocean Swimmer [29]. Each app caters to a unique aspect of a child's developmental journey, introducing them to the wonders of the ocean, educating about global issues like water access, fostering foundational literacy skills, and exploring the interconnectedness of nature. As we embark on our own venture, "Marine Mammals," we draw inspiration from these diverse applications, seeking to integrate elements that captivate young minds while delivering meaningful educational content. This comparative analysis serves as a foundation for refining our approach and ensuring our app stands out in the dynamic realm of educational technology for children.

1.Toca Life World: Aquarium [21] **:** It is an interactive and imaginative application designed for children. Toca Life World is a game with endless possibilities, where you design and decorate a whole world and fill it with fun characters you collect, create and play. The app fosters creativity by allowing kids to create their own stories and scenarios within an aquarium. Through playful interactions, Toca Life World introduces children to the wonders of marine life in a fun and engaging way, encouraging curiosity and imaginative play.

2. Aquation: The Freshwater Access Game [22]**:** Developed by Thirst Project, is a serious game with an educational focus. Unlike traditional games, Aquation combines entertainment with a mission to raise awareness about the global water crisis. Players embark on a journey to understand the challenges of freshwater access, making decisions that impact water resources. This game provides an interactive and informative experience, aiming to inspire players to think critically about water conservation and the importance of sustainable water management.

3. Starfall ABCs [23]**:** Created by Starfall Education, is an educational app designed to help young learners develop foundational skills in reading and language. While not marine-themed, it stands out for its effectiveness in teaching the alphabet through interactive activities. The app engages children with colorful visuals and interactive exercises that make learning the ABCs enjoyable. Starfall ABCs serves as a valuable tool for parents and educators seeking to introduce literacy concepts to preschoolers in an interactive and accessible way.

4. Oceans for Kids - Learn Sea Animals [24]**:** This app focuses on educating children about marine life and sea animals through interactive games, quizzes, and informative content. It provides a playful and educational environment for kids to explore the wonders of the ocean.

5. Ocean Adventure Game for Kids [25]: This game helps your kids & toddler to explore the ocean. This app offers an engaging way for children to learn about various fish in the ocean. It includes appealing graphics to make learning about animals entertaining.

6. Ocean Life - Sea Turtle Adventure [26]: This app centers around sea turtles and their underwater environment. It combines educational content with interactive gameplay, allowing users to navigate a cute little turtle through the vast ocean by tapping on the screen. The game also provides rewards for successfully avoiding obstacles, ensuring the turtle reaches its destination safely.

7. Splash Math - Games for Preschool and Grade School Kids [27] : While not marine-focused, Splash Math incorporates gamified elements to teach mathematics to children. It showcases the potential for combining education and entertainment in an interactive learning environment.

8. The Earth - by Tinybop [28] **:** Tinybop is known for its educational apps. "The Earth" app allows children to explore different ecosystems, learn about animals, and understand the interconnectedness of nature. It includes interactive features and engaging visuals.

9. Sago Mini Ocean Swimmer [29] : Sago Mini creates engaging apps for young children. In this particular app, kids can explore the ocean, meet underwater creatures, and engage in various activities. It combines playfulness with educational elements.

10. Trivia Quiz: Questions & Answers [30] **:** General knowledge puzzle is a very interesting and popular offline game that puts your general knowledge to the test. With a plethora of questions covering various topics, it provides an excellent opportunity to showcase your intelligence and give your brain a good workout. The game challenges players

to choose the correct answer from a set of four options, making it both entertaining and educational. Whether you're looking to prove your cleverness or simply enjoy some brain training, Trivia Quiz offers a diverse range of questions to keep you engaged and learning.

11. SeAdventure [31] : SeAdventure is a platform game in which the player, using an avatar, swims through waste lost in the sea . As said before, to allow the users to acquire knowledge about the environment they are living in, the game set is the Mediterranean Sea and the characters are the four species which currently would be at risk of extinction and the most interesting species for the children aged between 8-10. The four species are: red tuna, great white shark, turtle (Caretta Caretta) and the hippocampus. [31]

3.2 Comparing similar applications with Marine Mammals

Toca Life World: Aquarium [21], The Freshwater Access Game [22], Starfall ABCs [23], Oceans for Kids - Learn Sea Animals [24], Ocean Adventure Game for Kids [25], Ocean Life - Sea Turtle Adventure [26], Splash Math - Games for Preschool and Grade School Kids [27], The Earth - by Tinybop [28], Sago Mini Ocean Swimmer [29] and Trivia Quiz: Questions & Answers [30], SeAdventure [31] represent commendable contributions to the educational app landscape, each with its unique focus and approach. These applications cater to various aspects of early childhood education, fostering exploration, knowledge acquisition, and skill development. As we navigate the development of our application, "Marine Mammals," we draw insights from the success and innovation demonstrated by these apps, aiming to create an engaging and impactful learning experience for our young users.

Toca Life world immerses children in a vibrant underwater world, fostering creativity and imagination. While our app, "Marine Mammals," shares the theme of marine life, our emphasis lies in imparting specific knowledge about Mediterranean marine mammals, adding an educational layer to the immersive experience.

On the other hand, **Aquation: The Freshwater Access** Game takes a serious approach, addressing global issues like water access. In comparison, "Marine Mammals" align more with nature conservation, emphasizing the importance of protecting the Mediterranean marine ecosystem and its inhabitants. Our app combines entertainment with a strong educational message, encouraging awareness about marine conservation from an early age.

Starfall ABCs, a literacy-focused app, excels in building foundational language skills. In contrast, "Marine Mammals" complements its educational content with interactive games, offering a holistic learning experience. By integrating engaging mini-games, quizzes, and puzzles, our app promotes active participation and critical thinking, adding an extra layer of fun to the educational journey.

Similar to Marine Mammals, **Oceans for Kids - Learn Sea Animals** app focuses on educating children about marine life and sea animals through interactive games, quizzes, and informative content. Both aim to provide a playful and educational environment for kids to explore the wonders of the ocean.

Like Marine Mammals, **Ocean Adventure Game for Kids** app offers an engaging way for children to learn about various sea creatures. It uses appealing graphics to make learning about animals entertaining, aligning with the interactive and visually appealing approach seen in Marine Mammals.

Ocean Life - Sea Turtle Adventure, much like Marine Mammals, centers around marine life, specifically sea turtles. It combines educational content with interactive gameplay, using rewards and obstacles to keep children engaged in the learning process. Both apps aim to make learning about the ocean enjoyable

Although not marine-focused, **Splash Math** shares the concept of combining education and entertainment through gamified elements. This parallels the approach in Marine Mammals, where interactive mini-games are used to make learning about marine life engaging for children.

While not exclusively focused on marine life, **The Earth** app by Tinybop allows children to explore ecosystems, learn about animals, and understand nature's interconnectedness. This aligns with the educational and exploratory aspects found in Marine Mammals

Similar to Marine Mammals, **Sago Mini** creates engaging apps for young children. In this ocean-themed app, kids can explore and meet underwater creatures, combining playfulness with educational elements, much like Marine Mammals' approach.

While Marine Mammals focuses on educating users, especially young learners, about marine life and conservation through interactive games, **Trivia Quiz: Questions & Answers** caters to a broader audience with a general knowledge puzzle format. While both apps involve answering questions, Marine Mammals integrates this into a broader educational context, including features like species cards, mini-games, and interactive learning. On the other hand, Trivia Quiz offers a diverse range of questions covering various topics, providing

users with a more traditional quiz experience focused on general knowledge and brain training.

The SeaAdventure serial game approach

A notable approach with valuable results was the **SeAdventure** serious game application, which addresses environmental issues with a specific focus on marine litter. In recent years, policies and governance in the environmental sector have increasingly emphasized participatory and community-based processes, aligning with the broader objectives of the Blue Growth Actions of the Interreg Med Program of the European Union. This shift towards greater citizen involvement recognizes the significant impact of human behavior on marine environments, highlighting the need for changes in individual behaviors to ensure the sustainable use of the ocean and its resources. **SeAdventure**, by introducing the problem of marine litter through a serious game and explainer video, contributes to enhancing ocean literacy, particularly focusing on the biodiversity of the Mediterranean sea. The success of this serious game in imparting knowledge and awareness underscores the effectiveness of new educational approaches for young learners

The research emphasizes the importance of ocean literacy interventions from an early age, highlighting the role of educational approaches, such as serious games, in promoting sustainable behavior. The study's findings confirm the efficacy of this approach, demonstrating that children can effectively acquire knowledge through new technologies, contributing to the broader goal of fostering a sense of responsibility for the oceans and their ecosystems. The data analysis revealed a noteworthy decrease in the average number of wrong answers from the pre-test to the post-test and an even lower number in the retention test. This indicates a positive learning gain, suggesting that the game effectively contributes to knowledge acquisition. Notably, questions related to the environmental impact of plastic and beach waste showed a significant improvement, highlighting the game's positive influence on children's awareness of marine conservation.

The users' perceived usability of the SeAdventure game was generally positive. A significant majority of pupils found the game easy to use, underlining its learnability. The transition to a touchscreen interface could be an avenue for improvement, given that some students found difficulty using keyboard commands. Importantly, all pupils expressed enjoyment while playing the game, emphasizing its potential for engagement.

Data on users' perceptions of the game's usefulness were promising. A significant proportion believed that they had increased their knowledge about marine species and

pollution through the game. Moreover, the majority stated that the game was useful for learning new information. These findings highlight the educational impact and perceived value of the SeAdventure game.

The Ocean Literacy Serious Game, with its focus on broader marine issues and the specific threat of marine litter, stands as a complementary counterpart to the Marine Mammals application. While Marine Mammals zeroes in on the fascinating world of marine mammals, the Ocean Literacy Serious Game SeAdventure broadens its narrative to encompass a wider understanding of marine ecosystems and the environmental challenges they face. Both applications share the common thread of employing interactive and engaging methodologies to impart essential knowledge about the oceans to young learners.

In the case of SeAdventure Serious Game, the emphasis on participatory and community-based processes aligns with contemporary policies and governance approaches to marine issues. The recognition that greater citizen involvement is crucial for the sustainable use of oceans resonates with the broader environmental goals of the Marine Mammals application. The two applications collectively contribute to nurturing ocean literacy among young users, encouraging a sense of responsibility and awareness toward marine environments, whether by focusing on charismatic marine mammals or addressing broader marine conservation issues.

Inspired by these popular apps, "Marine Mammals" aims to stand out by providing a unique and enriching learning experience about Mediterranean marine life. It's designed especially for young learners to make learning about marine animals fun and interesting.

3.3 Choosing of a game engine

The list of gathered initial requirements gives us an overview of supported features expected from the graphical and other subsystems of the application. As the point of the thesis and the project itself is not a reimplementation of all subsystems the game usually has, a good choice could be to use some already existing solution for it. For the purpose of making a right choice, the following list of special requirements was created. The chosen engine should:

- Have a low cost entry level
- Be able to produce a rendered image of reasonable quality

- Be able to be run on a regular PC
- Be extendible
- Be available for a reasonable price/free license for educational/research purposes.
- Form the community around
- Have support of various modern features e.g. animations, graphics etc

These requirements led to the selection of the Unity [10] game engine. There is a survey behind evaluating possibilities and perspectives with respect to other game engines and the combination of engines. The results and conclusions about features of each considered product are listed below.

3.4 Why Unity?

There are a lot of game and graphical engines in the market now, such as Cry Engine, Unreal Development Kit (UDK) [19], Unreal Engine itself, Unity 3d [10], etc. Unity 3D is one of the most popular game engines. In this chapter we will shortly describe why Unity was chosen for our project.

According to Unity CEO John Riccitiello, more than half [18] of all mobile games are built in Unity. Why is this technology so popular?

Cross-platform Compatibility: One of the key advantages of Unity is that it is cross-platform. It means that you can develop your game for your dreamed platform, including Windows, Linux, WebGL, Android, iOS, PlayStation 4, tvOS, Xbox One, Stadia, Oculus Rift, Magic Leap [20], and many others.It also allows you to build your application once and then deploy it across more than 20 platforms to captivate audiences across formats.This feature is especially essential for education and training systems: today, people expect to access the learning experience anytime and anywhere.

Reduced Development Time: Unity also provides development teams with a large variety of tools that can help you develop your educational game more quickly and efficiently, such as add-ons, templates, textures, 2D or 3D models, animations, music, lighting, and sounds.For instance, Unity offers many placeholder assets that allow developers to easily create prototypes and perform iterations at a fast pace[20].

A Large Variety of Tools [20] : Unity provides a large number of tools to help you implement all your creative plans and develop outstanding visual products. For example, with the help of Unity, you can create 2D, 3D, and VR games with beautiful visual effects.Unity

also allows you to make the lighting of your educational game unified and coherent. This effect will reflect the parameters of the real world, which, in turn, will increase the trust and interest of users in your product.

Increased User Engagement [20] *:* The use of Unity games as part of teaching helps to establish a favorable atmosphere around the necessary topic and create a positive attitude to learning.By playing these games, students become more motivated, pay more attention to studying, and start actively participating in the implementation of assigned tasks. By the way, the ability to create visual effects for your application allows you to increase the involvement of customers in the created context and give them an unforgettable experience of using the product.

Improved Competitiveness [20] : One of the main advantages of using Unity is that you will get a successful and unique gaming product in the end. Unity technology allows you to create a system that will distinguish you from your competitors in our industry and increase your market share.

Chapter 4 - Software Design

4.1 System Textual Analysis

4.1.1 Textual description

Title: "Marine Mammals: Into the World of Mediterranean Marine Mammals"

Description: "Marine Mammals" is an educational app designed to take kids aged 6 and up, as well as curious minds of all ages, on an exciting journey through the world of Mediterranean marine mammals.

Captivating Graphics: Immerse yourself in stunning 2D and 3D visuals that bring the marine world to life. Vibrant colors and lifelike animations make every encounter with marine mammals a breathtaking experience.

Interactive Learning: Learn about marine mammals through species cards with graphics, photos, and videos. Discover each creature's unique features, habitats, and what they eat.

Engaging Mini-Games: Challenge yourself with a variety of mini-games, including memory games, puzzle makers, and quizzes. These games keep the learning experience, promoting active engagement and critical thinking.

Educational Content: Dive into a world of educational content presented in various formats, such as text, video, and audio. Tailored to different learning styles, this content ensures that every child can absorb knowledge at their own pace.

Gamification Elements: Stay motivated with gamification elements like health bars and time trials, adding an extra layer of fun and competition to the learning process. Earn rewards and celebrate achievements along the way.

Non-Commercial and Open Source: "Marine Mammals" is a non-commercial and open-source project, emphasizing its dedication to education and community collaboration.

Target Audience:

- Primary: Children aged 6 and above

- Secondary: All individuals interested in exploring the Mediterranean marine mammal world

Platform Compatibility:

- Initially available for personal computers (PCs)
- Future plans to expand to tablet and mobile applications for broader accessibility

4.2 Requirement list (functional & non-functional)

4.2.1 Functional Requirements:

Table 4.2.1. Functional Requirements

ID	TITLE	DESCRIPTION
FR-01	Species Cards	The application must display interactive species cards for various marine mammals, containing graphics, photographs, videos, and information on their food preferences and typical habitats.
FR-02	Mini-Games	The application should include a variety of mini-games, such as memory games, puzzle makers, and quizzes, to provide engaging and interactive learning experiences.
FR-03	Content Formats	Educational content must be presented in multiple formats, including text, video, and audio, to accommodate different learning styles.
FR-04	Gamification Elements	Gamification elements, such as health bars and time trials, should be integrated into the mini-games to enhance motivation and engagement.

FR-05	Target Platforms	Initially, the application should be compatible with personal computers (PCs). Future development plans include adapting the application for tablet and mobile platforms.
FR-06	Open Source	The application will be developed as an open-source project, encouraging collaboration and contributions from the community.
FR-07	Age-Appropriate Design	The user interface (UI) and content must be designed to meet the needs and preferences of children aged 6 and above, ensuring a child-friendly and safe environment.

4.2.2 Non-Functional Requirements:

Table 4.2.2. Non-Functional Requirements

NFR-01	Performance	The application must run smoothly with minimal load times, ensuring a responsive and enjoyable user experience
NFR-02	Accessibility	The application should adhere to accessibility standards to ensure that it can be used by individuals with disabilities, including those with visual or auditory impairments.
NFR-03	Scalability	The system should be designed to accommodate future updates and additions, allowing for the seamless integration of new mini-games and content.
NFR-04	Security	User data and privacy must be protected. The application should have safeguards in place to prevent unauthorized access and data breaches.
NFR-05	Compatibility	The application should be compatible with a wide range of PC operating systems and screen resolutions, ensuring accessibility to a broad user base.

NFR-06	Community Engagement	The open-source nature of the project should foster community engagement, encouraging individuals to contribute to its development and improvement.
NFR-07	Educational Impact	The application should be designed with a focus on delivering meaningful educational content, promoting marine conservation awareness and knowledge.

4.3 Use Cases

In the following section we analyze a Use Case scenario [Figure 4.3.1] for the application Marine Mammals.

4.3.1 Use Case Scenario

Exploring Marine Mammals at Cretaquarium

Actor: Emmi - A 9-year-old student on a school trip to Cretaquarium.
Goal: Emmi wants to learn about marine mammals in an interactive and engaging way during her visit to Cretaquarium.

Preconditions: Emmi is at Cretaquarium, where interactive kiosks with the educational application are available. Emmi has a basic understanding of using touch screen devices.

Main Scenario:

- Emmi's Arrival: Emmi arrives at Cretaquarium and is excited to explore marine life. She sees an interactive kiosk with the application near the marine mammal exhibit.
- Interaction with the Kiosk: Emmi approaches the kiosk, which features a big, colorful button that says "Let's Meet Them" along with images of different marine mammals. Emma taps the button to start her journey.

- Choosing a Marine Mammal: On the next screen, Emmi sees images and names of different marine mammals, including seals, dolphins, and the Mediterranean monk seal. She selects the Mediterranean monk seal because it's her favorite.
- Learning about the Monk Seal: The application presents Emmi with detailed information about the Mediterranean monk seal, including its physical characteristics, habitat, and diet. She watches a short video of the seal swimming gracefully.
- Interactive Games: Emmi enjoys the interactive games within the application. She selects a memory game that challenges her to match different marine mammals. Emmi plays the game, which helps her learn more about the creatures in a fun way.
- Earning Rewards: After successfully completing the memory game, Emmi earns a virtual reward in the form of a "seal badge." She's excited to see her progress.
- Quiz Time: Emmi decides to take a quiz about marine mammals. The quiz is engaging with colorful graphics, and Emmi answers the questions with the timer ticking, adding an element of excitement.
- Completion: After the quiz, Emmi completes her learning journey about the Mediterranean monk seal. She feels more connected to these creatures and is inspired to learn more about marine conservation.

Postconditions: Emmi has gained knowledge about the Mediterranean monk seal and other marine mammals in an engaging way. She has collected virtual rewards and feels a sense of accomplishment. Emmi continues her visit to Cretaquarium with a deeper appreciation for marine life and conservation.

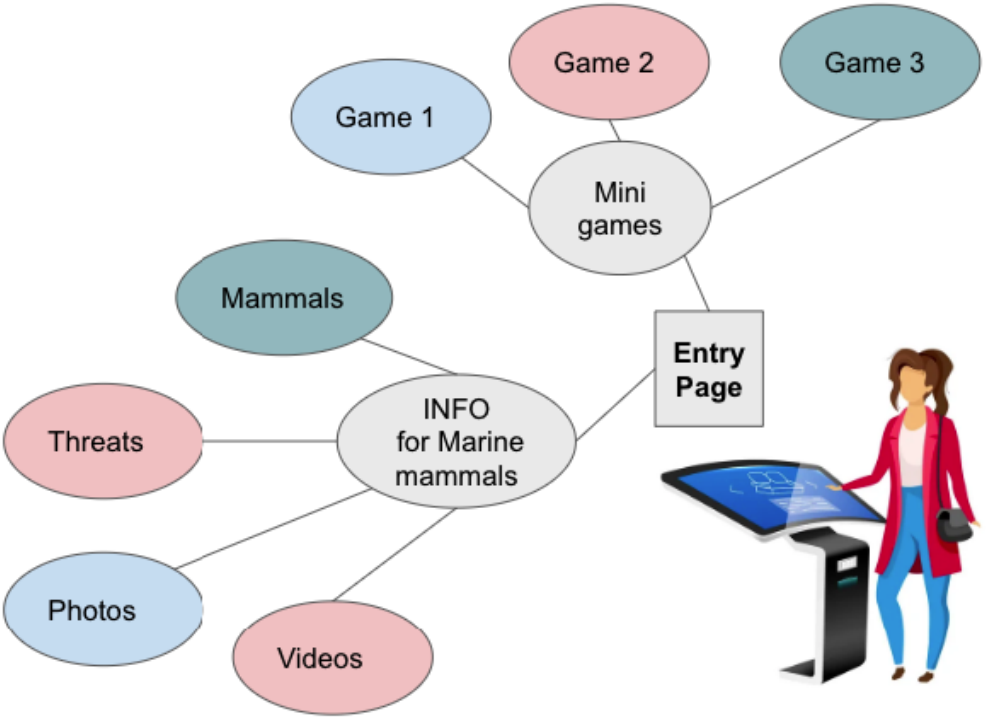


Figure 4.3.1. Use Case Marine Mammals

4.3.2 List of Actors/Roles

In the following section we analyze a list of the roles/Actors [Figure 4.3.2] for the application Marine Mammals.

Child (User):

Description: The primary user of the application, typically a child aged 6 and above

Responsibilities: Interacts with the application, plays mini-games, explores species cards, and learns about marine mammals.

Educator/Parent/Guardian (User):

Description: Responsible for the child using the application or a teacher or educator who may use the application in a classroom setting.

Responsibilities: Monitor the child's use, or educate with guidance / utilizes the application as an educational tool, tracks student progress, and provides guidance.

Administrator (User):

Description: Oversees the management and maintenance of the application.

Responsibilities: Manages user accounts, monitors application performance, and ensures data security.

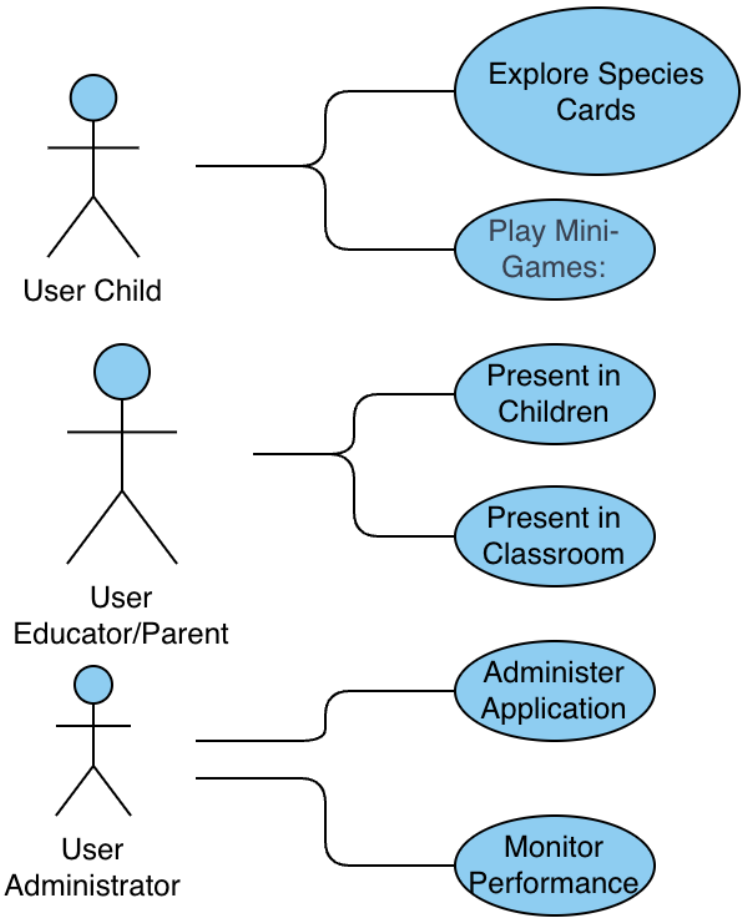


Figure 4.3.2. List of Roles/Actors use cases

4.3.3 Use Case UML diagram (VP)

In the following section we analyze the use case of the system [Figure 4.3.3] for the application Marine Mammals. Creating a Use Case Diagram in Visual Paradigm (VP) typically involves representing actors, use cases, and their relationships. Here's a textual description of Use Case Diagram for the application:

Use Case Diagram for "Marine Mammals" Educational Application:

Actors:

- Child: Represents the primary user, a child visiting an aquarium.

- Teacher: Represents a teacher who may use the application as an educational tool in the classroom.
- Administrator: Represents a system administrator responsible for maintaining the application.
- Cretaquarium Visitor: Represents visitors at Cretaquarium interacting with the application on kiosks.

Use Cases:

- Explore Marine Mammals: This use case involves selecting and learning about various marine mammals.
- Interactive Games: Users can play educational games related to marine mammals.
- Language Selection: Users can switch between different languages for the application.
- Quiz: This use case involves answering questions about marine mammals.
- Administrator Management: For system administrators to manage application content and user data.
- Teacher Mode: Enables teachers to use the application in a classroom setting for educational purposes.
- Installation and Maintenance: For system administrators to install and maintain the application.
- Cretaquarium Kiosk Interaction: Specific use case for users interacting with the application at Cretaquarium kiosks.

Associations:

Child (Emmi) interacts with:

- Explore Marine Mammals
- Interactive Games
- Language Selection
- Quiz

Teacher interacts with:

- Interactive Games
- Language Selection
- Quiz

Teacher Mode

Administrator interacts with:

- Administrator Management
- Installation and Maintenance

Cretaquarium Visitor interacts with:

- Explore Marine Mammals
- Interactive Games
- Language Selection

Cretaquarium Kiosk Interaction

Include and Extend Relationships:

Interactive Games includes:

- Memory Game
- Puzzle Game
- Multiple Choice Quiz

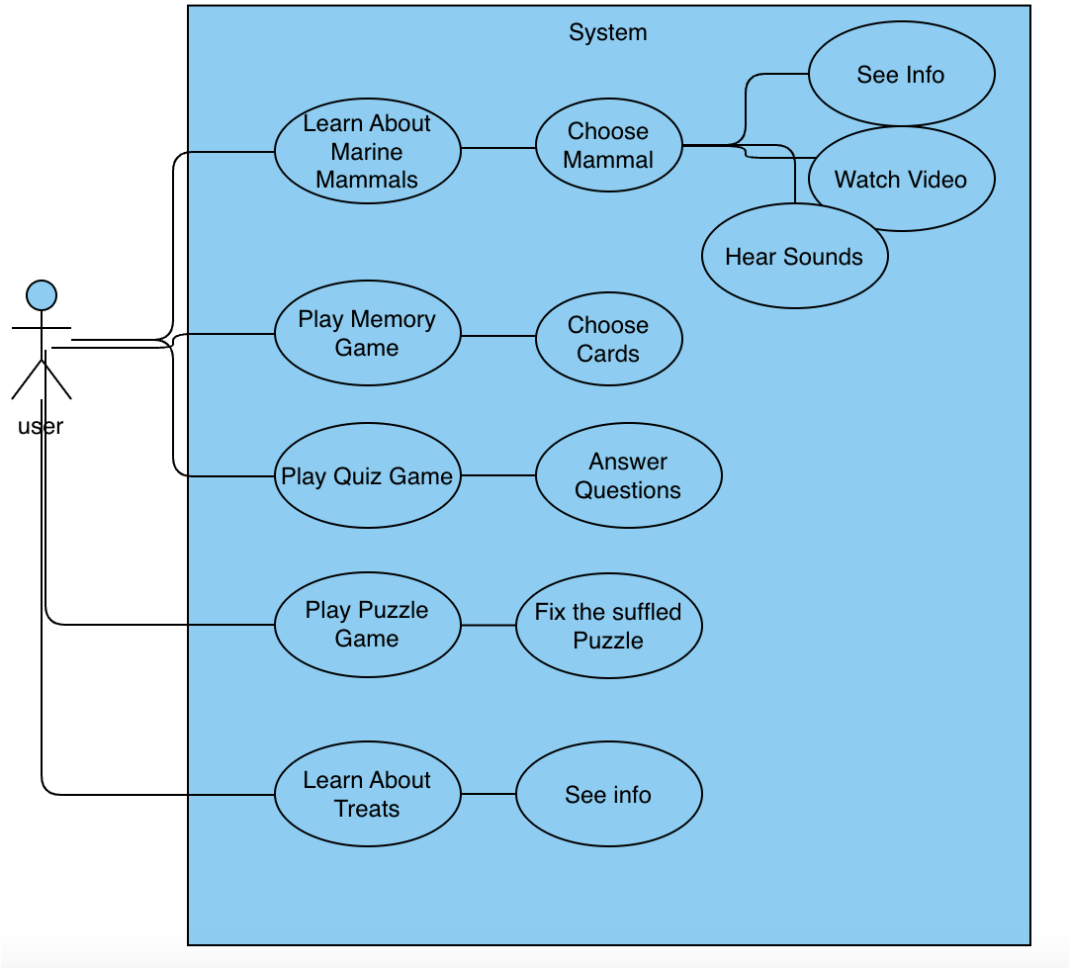


Figure 4.3.3. Use Case diagram of the system

4.4 List of requirements

The following requirements have been identified for the development of the educational application:

- Non-Commercial Project: The project is intended to be non-commercial, focusing on educational purposes rather than profit.
- Open Source: The application will be developed as an open-source project, allowing for collaboration and community contributions.
- Target Platforms: The initial target platform for the application is personal computers (PCs), ensuring accessibility for a wide range of users.The future goal includes expanding the application to tablet and mobile devices to cater to a broader audience.

- Scalability: The application should be designed in a scalable manner, allowing for potential future updates and enhancements.The system architecture should be flexible to accommodate the addition of new mini-games and interactive elements.
- Target Audience: The primary target audience for the application is children aged 6 and above years old, as they are the main focus of the educational content. However, the application can also cater to other age groups, including adults, who are interested in learning about marine mammals.

By following these requirements, the development of the educational application will ensure its non-commercial nature, foster community collaboration, support multiple platforms, facilitate future expansion, and cater to the intended target audience.

4.5 Planned system overview

The planned system, titled "Marine Mammals: Explore the World of Mediterranean Marine Mammals," is an interactive educational application designed to offer an engaging and immersive experience for children aged 6 and above, as well as individuals of all ages interested in the captivating world of Mediterranean marine mammals. This system is conceived as an open-source, non-commercial initiative, underscoring its commitment to education and community participation.

- Interactive Species Cards: Users will have the opportunity to explore interactive species cards that showcase a variety of Mediterranean marine mammals. These cards include graphics, photographs, videos, and comprehensive information regarding each creature's characteristics, habitats, and dietary preferences.
- Engaging Mini-Games: The system will house a collection of entertaining and educational mini-games. From memory challenges to puzzle-solving and knowledge quizzes, these games will deliver varied and stimulating learning experiences.
- Multifaceted Learning Content: Educational content will be presented in diverse formats, encompassing text, video, and audio. This approach ensures that users with different learning styles can benefit from the content.
- Motivation and Gamification: To maintain engagement, gamification elements, such as health bars and time trials, will be integrated into the mini-games. These features

will reward user progress and provide a continuous stream of challenges throughout the learning journey.

- Target Platforms: The initial release of the application will target personal computers (PCs), ensuring accessibility to a wide audience. Future development plans will extend compatibility to tablet and mobile platforms, accommodating users who prefer mobile learning experiences.
- Community Involvement: One of the system's unique aspects is its open-source nature. It actively encourages community engagement, inviting individuals to contribute to its development and refinement. Contributors from the open-source community may submit code enhancements, content updates, or suggestions to enhance the application's educational value.
- Child-Friendly Design: The system will feature a child-friendly user interface (UI) and content that cater to the needs and preferences of our primary users: children aged 6 and above. The design ensures a safe and engaging learning environment for young explorers.

In summary, the planned system "Marine Mammals" embodies an exciting voyage into the world of Mediterranean marine mammals. With interactive species cards, engaging mini-games, versatile learning content, and a commitment to open-source collaboration, it aims to foster marine conservation awareness and knowledge in an enjoyable and educational manner.

Chapter 5 - Implementation

5.1 Mock Ups

The development of "Marine Mammals: Into the World of Marine Mammals" started by creating detailed mock-ups. The mock-ups illustrate the layout and design of the user interface, showing how various elements, such as species cards, mini-games, and navigation menus, will be presented to users. These mock-ups allow for early user experience (UX) evaluations, providing a basis for refining the application's design and usability to meet the needs of the target audience.

In the following table presents some of the first mockups created at a powerpoint at the beginning of the project

Table 5.1.1. Mockup screens while designing the Marine Mammals Application

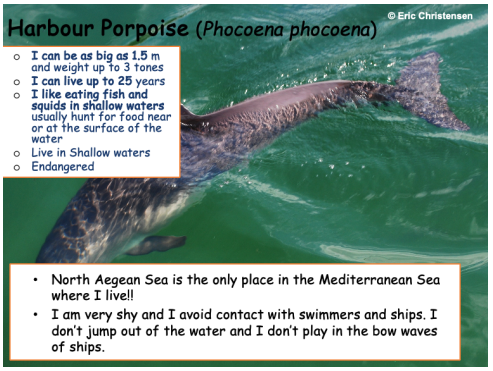
<table>
<tr>
<td>Into the world of marine mammals

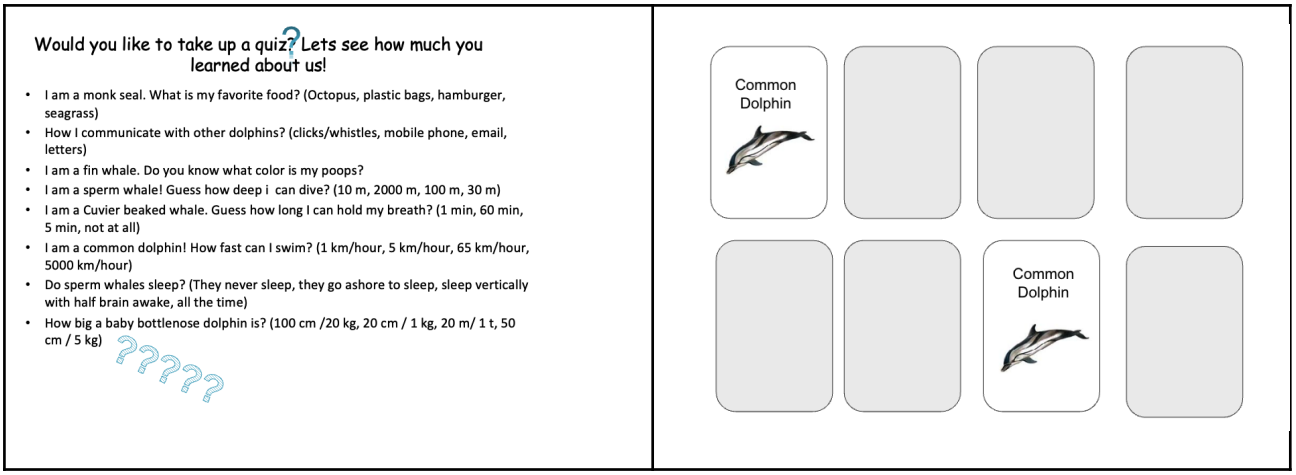
Dolphins, whales, porpoise, monk seal</td>
<td>All marine mammals are not the same! Do you know how many of us live in a regular basis in Greek waters? Click the images below to find out about us

Clickable images
  </td>
</tr>
<tr>
<td>Marine mammals are not fish! As marine mammals we are warm-blooded, give birth to live young, breathe air and produce milk to feed our children.

Not all marine mammals are the same! Cetacean and pinnipeds are two distinct

As cetacean we have a unique way to find their food and locate any obstacle in the ocean: Echolocation system

3 clickable images
❑ Would you like to learn more about us?
❑ Find us!!
❑ Travel with us!!
Video and clicks and whistles on click</td>
<td> 
</td>
</tr>
</table>



5.1.1 Intro Page

At the basic level, an intro page [Figure 5.1.1] shows what the main screen of the application looks like. Buttons or icons for different activities, like exploring species cards or playing games. As a multi language application, there will always be two flags buttons so that the user can change the language at any time.

At the center of the screen, you'll see two buttons. One says "Learn," and the other says "Play." These buttons are like doors to different parts of the app. If you press "Learn," you'll enter the section where you can explore and discover info about marine mammals. If you choose "Play," you'll step into a world of fun games and challenges. In the upper corner, there's a place where you can pick your preferred language. We've made it accessible in two languages: English and Greek. Just tap on the flag icon with your chosen language, and all the content in the app will switch to that language. Right in the middle of the screen, there's our app's logo. It's a cool and friendly logo with a picture that represents the marine world. When you see this logo, you'll know you're in "Marine Mammals," ready for an adventure.

Figure 5.1.1. Intro page mockup

5.1.2 Detailed Info for Each Species

In this mock-up, we're diving into the "Learn" section of our educational app, "Marine Mammals." This is where you get to explore fascinating marine creatures up close. On this screen [Figure 5.1.2], you'll find a list of nine beautiful images, each representing a different Mediterranean marine mammal. These images are like windows into the underwater world. You can see seals, whales, and more. Just tap on one of these images to learn about that particular animal. Below each image, will be the name of the marine mammal.

Figure 5.1.2. List of mammals screen mockup

General Descriptions: When you tap on one of the images or names, a new screen [Figure 5.1.3] will appear with detailed information. You'll learn about what these creatures look like, where they live, what they eat, and other interesting facts. It's like having a mini encyclopedia about each marine mammal right in front of you.

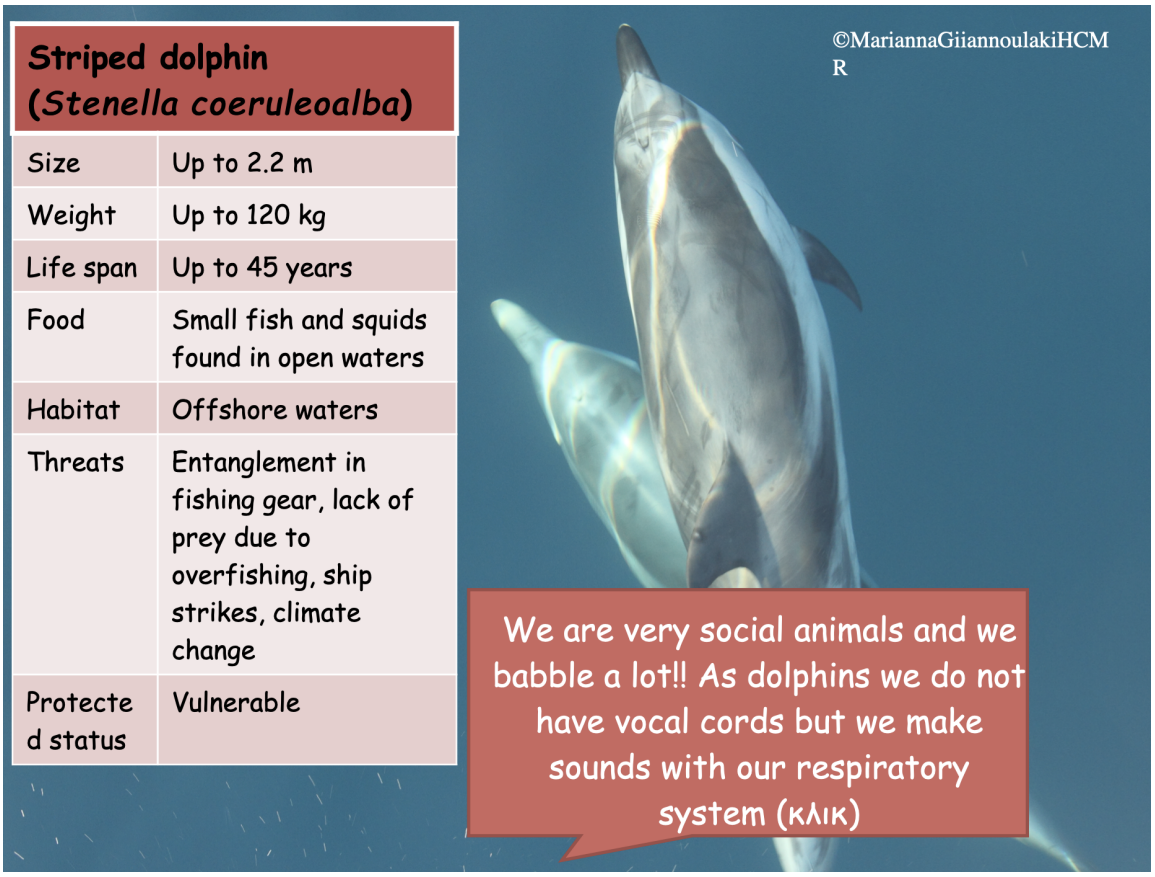


Figure 5.1.3. Species detailed info mockup

5.1.3 The Three Different Games

Here's a peek at the "Play" section of our educational app.

Memory Game: When you tap on the "Memory Game" option, you'll be taken to a screen [Figure 5.1.4] where you'll see a grid of cards. These cards are face-down, hiding pictures of marine mammals. Your mission is to flip them over and match the pairs. It's like a marine mammal memory adventure

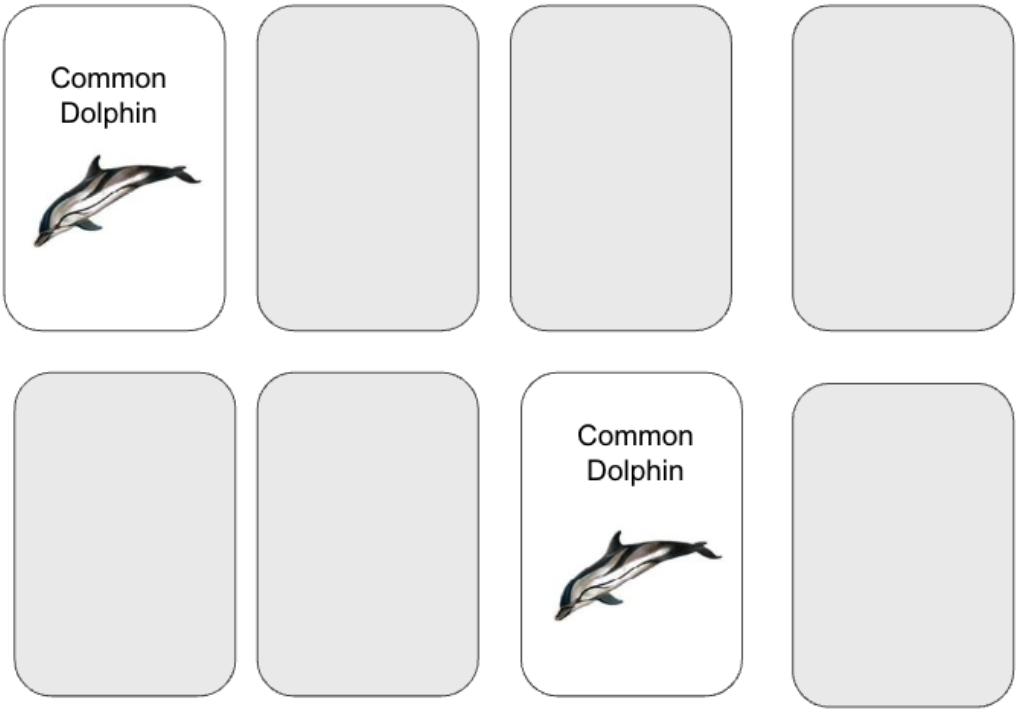


Figure 5.1.4. Memory Game mockup

Quiz: Selecting the "Quiz" option will lead you to a screen with a series of questions about marine mammals. You'll need to choose the correct answers from multiple-choice options. Each correct answer earns you points, and you can compete to beat your own high score or challenge your friends.

Sliding Puzzle: Picking "Puzzle" takes you to a screen [Figure 5.1.5] with a marine mammal picture and the aim of the Game is to rearrange shuffled segments of the image, to reconstruct the complete picture. Players need to slide the puzzle pieces into the correct order.

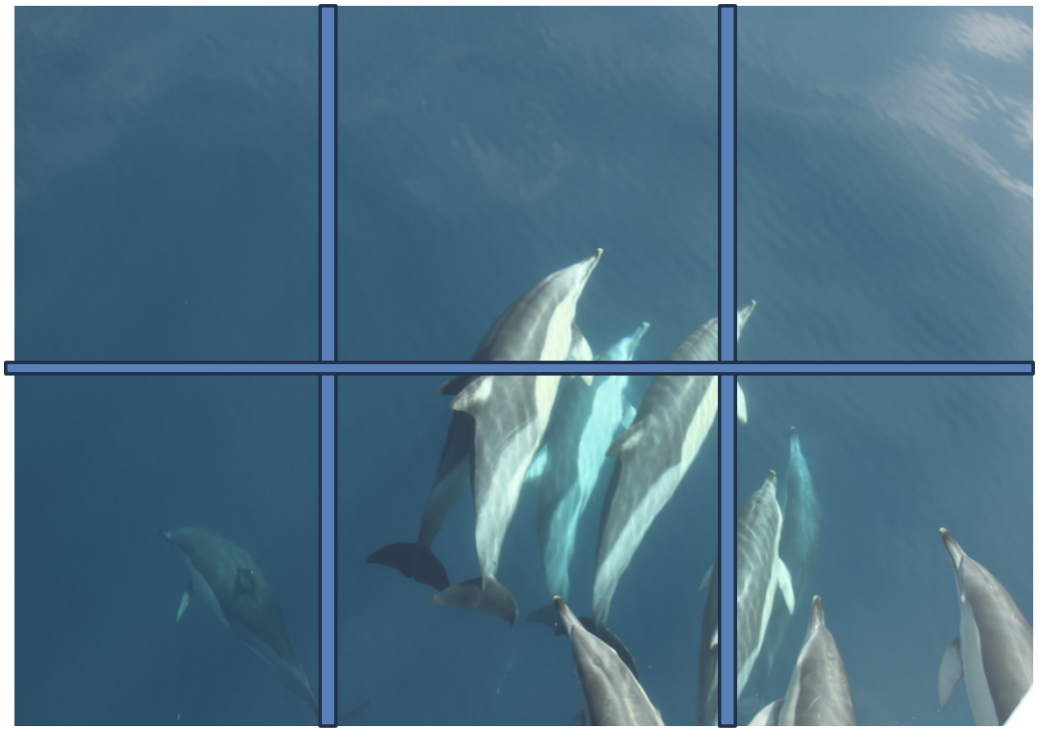


Figure 5.1.5. Sliding Puzzle Game mockup

You can test your memory with the Memory Game, learn more with the Quiz [Figure 5.1.6], and sharpen your problem-solving skills with the Puzzle. Each game is an exciting way to explore and have fun while you're discovering the world of Mediterranean marine mammals.

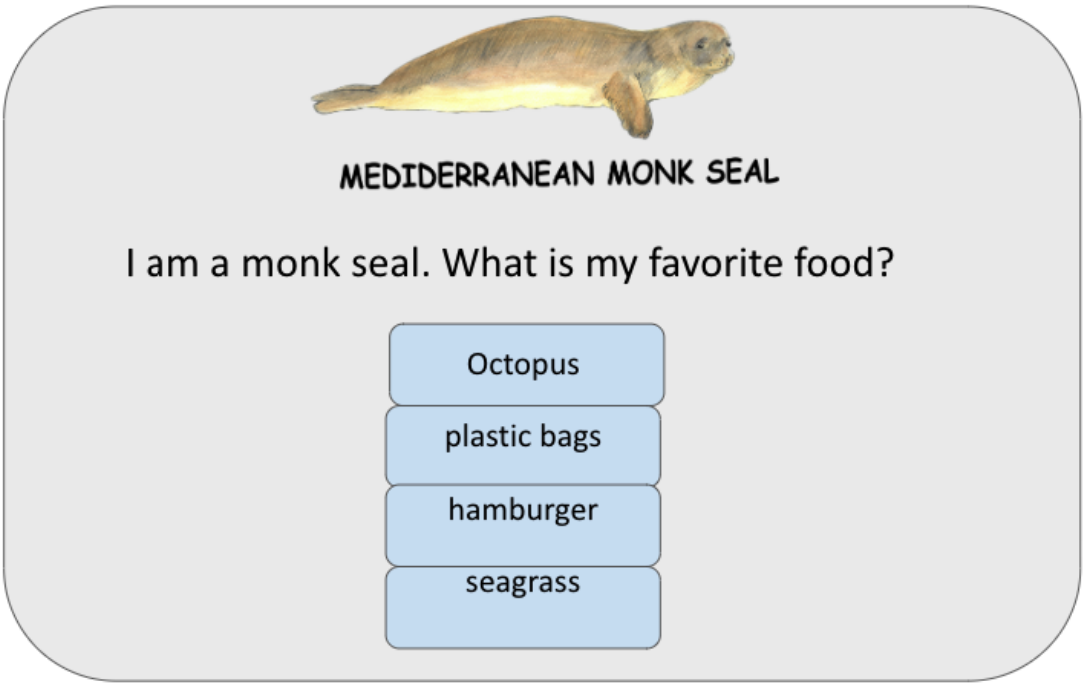


Figure 5.1.6. Quiz mockup

The mock-ups are a dynamic and evolving component of the system's development process, aligning closely with the planned use cases and contributing to the overall success of the project. They play a crucial role in transforming the application's concept into a tangible and user-friendly interface that fosters both education and enjoyment.

5.1.4. Stranded Animals

In an updated version of the main screen of "Marine Mammals" we've added a new button labeled "Unfortunately." This button provides information about a concerning issue related to stranded marine mammals. The main screen still features the "Learn" and "Play" buttons and the language selection options. However, now there's an additional button that is prominently displayed to draw attention to this important issue.

Stranded Marine Mammals Information: When you tap on the "Unfortunately" button, you'll be directed to a new screen [Figure 5.1.7] that contains detailed information about the situation of stranded marine mammals, specifically dead dolphins, found along the coastal areas of Greece over the past three years.

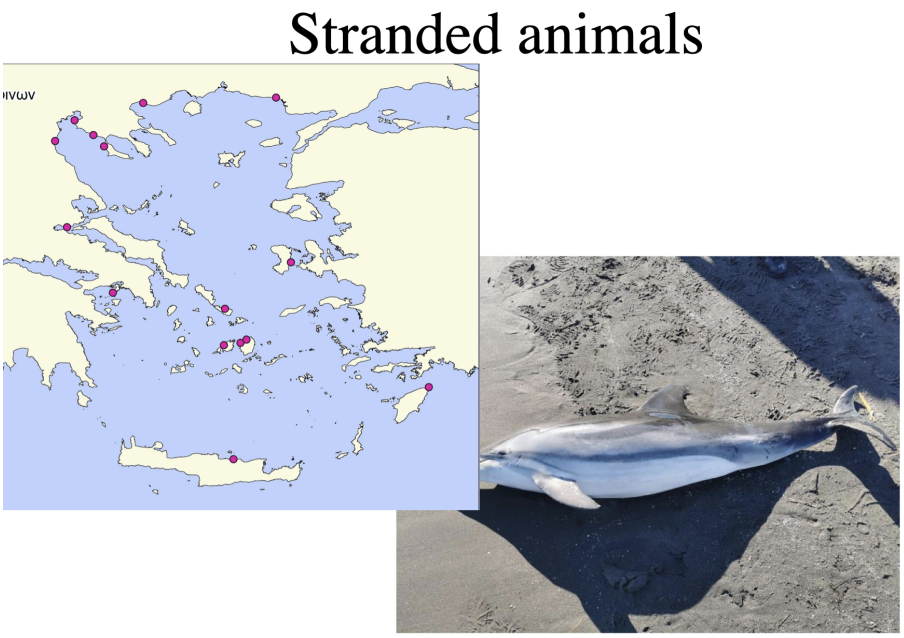


Figure 5.1.7. Stranded Animals mockup

This addition is like a wake-up call about a pressing concern. It allows users to learn about the challenges faced by marine mammals in the Mediterranean Sea and the need for conservation efforts. It's an important reminder that while we're having fun exploring and playing games, there are real issues that require our attention and action. This button provides valuable information and raises awareness about the importance of protecting these magnificent creatures and their habitats.

5.2 Application / Game activities

Creating multiple scenes in Unity in different languages is a common and effective approach. This allows you to provide content and user interface elements in various languages while keeping your project organized. Here's a simple overview of how this structure works.

5.2.1 Main menu

The logo for the "Marine Mammals" [Figure 5.2.1] educational application is an inviting visual element that serves as a central navigation point and a unifying symbol across all screens. The logo is designed in the form of a circular button, resembling the shape of a pool or a circular window into the world of marine mammals. Beyond its aesthetic appeal, the logo serves as an essential navigation element. Regardless of the screen or page within the application, users can easily locate the logo and click on it to return to the main page.The logo is a constant presence throughout the application, reinforcing its role as a central hub for navigation. The logo symbolizes the gateway to a world of marine knowledge and conservation.

Figure 5.2.1. Logo of Marine Mammals Application

The main page of the Marine Mammals educational application [Figure 5.2.2] serves as a captivating gateway to the diverse world of Mediterranean marine life. Positioned at the upper left of the design is a circular logo, resembling a button, adorned with vibrant illustrations of marine mammals that entice users to embark on an immersive learning journey. A central element of this page is the 'Let's Meet Them' button, acting as a portal to a comprehensive collection of marine mammal profiles. This section provides rich insights into their habits, habitats, and significance to marine ecosystems. Educational games, including Memory, Quiz, and Puzzle, are strategically presented for interactive learning experiences.

The page also includes a poignant 'Unfortunately' section, shedding light on the challenges faced by stranded marine animals—a stark reminder of the environmental threats affecting these creatures. Furthermore, a multilingual feature enhances accessibility, allowing

users to explore the application in different languages. Lastly, logos from involved organizations that provided data and resources, such as HCMR, MAVA, CRETAquarium, WWF, and HMU, are proudly displayed at the right area of the page. This serves as an acknowledgment of their valuable contributions and support in making this educational endeavor possible.

Figure 5.2.2. Main page of Marine Mammals Application

Unity structure

Unity is an example of a component-based game engine. Its classical structure can be seen in [Figure 5.2.3] Every object in the game is inherited from the main class called GameObject. It contains a lot of base components, such as: camera, collider, renderer, rigidbody, transform, tag, etc. GameObject class provides a common interface to access properties of an object.In the project the GameObject classes are renamed to each object we use (e.g. logo, map, quiz, bg, etc).

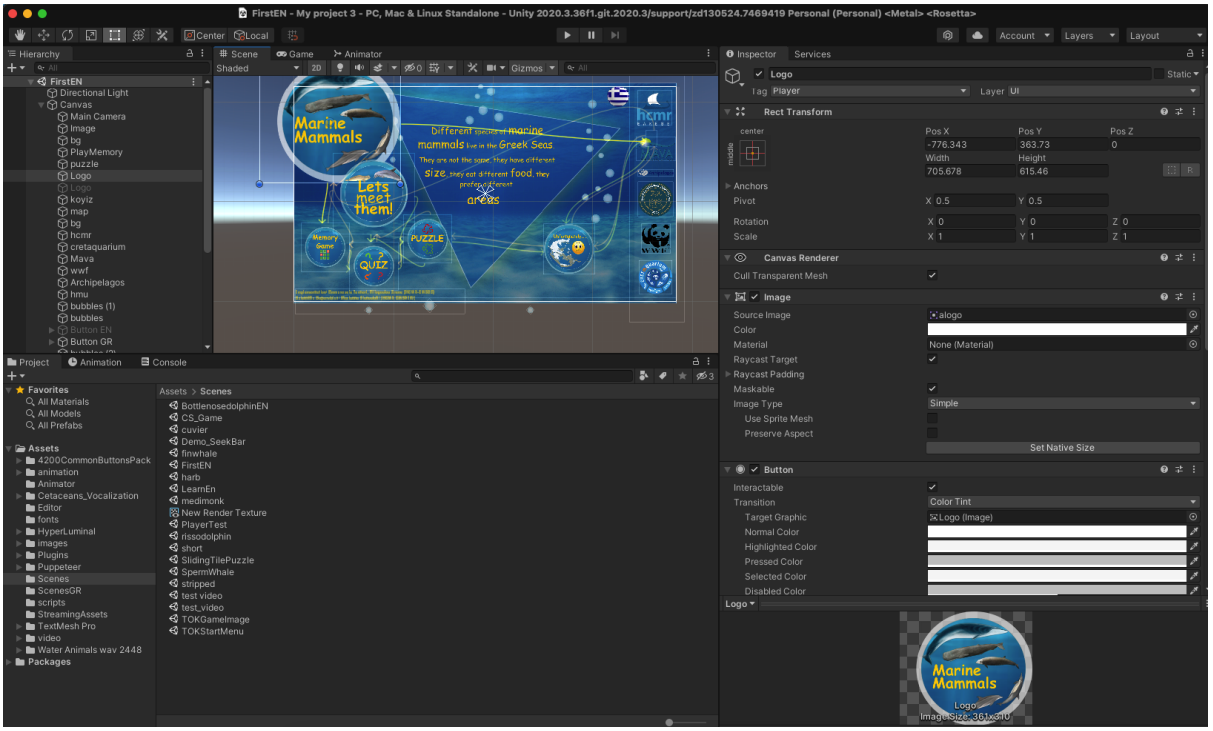


Figure 5.2.3. First Page Scene in Unity

There are also several Scenes [Figure 5.2.4] each one for a page represented in the application (main page, a game, a species page etc). For every scene there is it's identical in Greek language for the greek version of the application.

Main page is the scene "FirstEN" (for english). It contains the following buttons: The Logo, the info button "Let's Meet them" (Learn,LearnGR scenes), 3 games (Memory Game, Quiz, and Puzzle), the button "Unfortunately" (with info for stranded animals) and finally the buttons to change the language (GR/EN)

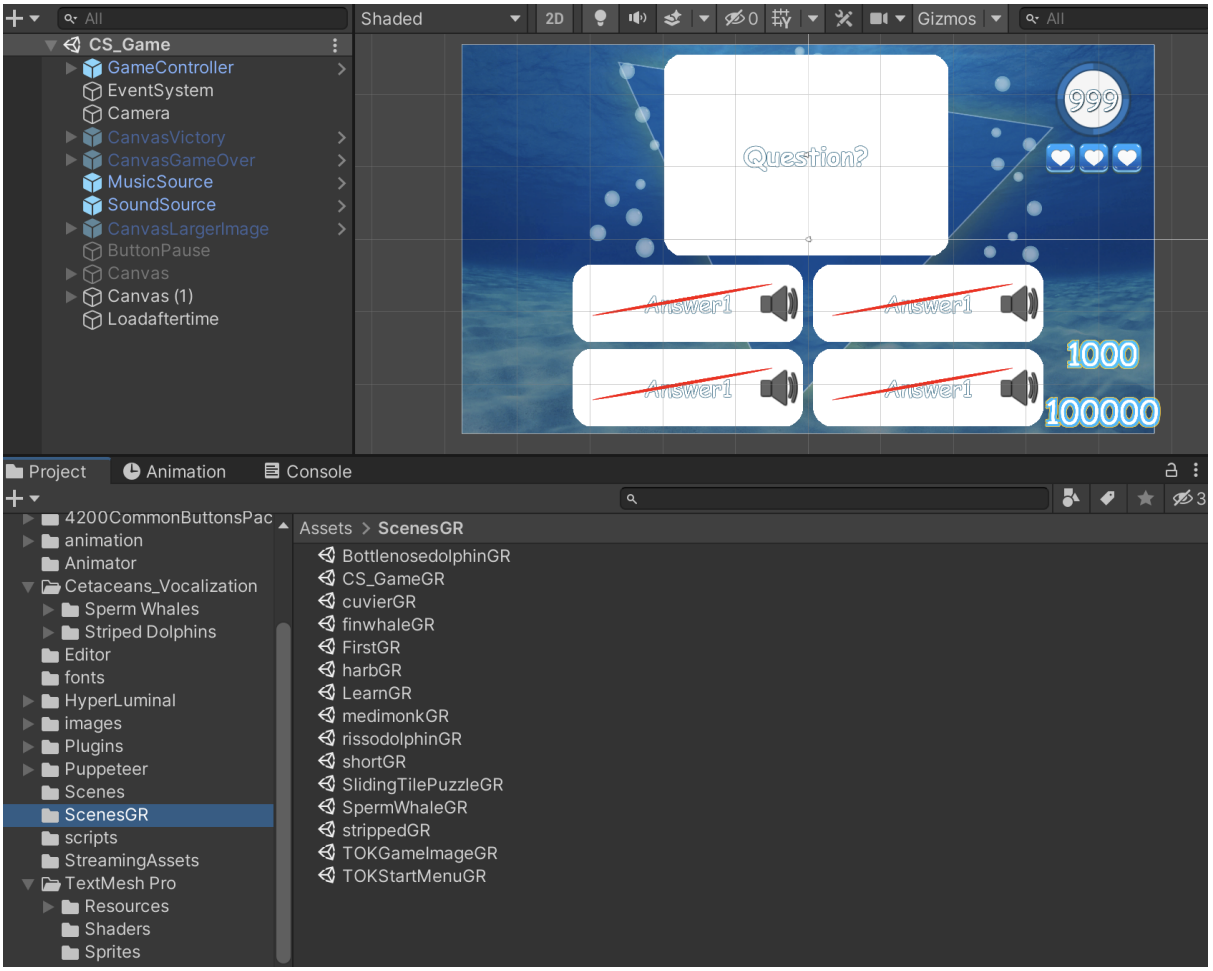


Figure 5.2.4. Quiz game and game scenes

In the process of creating the games using Unity, we leveraged assets from the Unity Store, tapping into a rich repository of resources that expedited our development. These assets, originally designed for diverse applications, were carefully selected and, when necessary, adapted to fit the specific requirements of our educational games. This approach not only saved valuable time but also ensured a visually appealing and cohesive experience for users.

To breathe life into the interactive elements of the games, we integrated pieces of code tailored to our educational objectives. This coding aspect was crucial in creating dynamic and engaging gameplay, ensuring that each game served its intended purpose in fostering learning and awareness about Mediterranean marine mammals. The coding work involved a meticulous process of adaptation and customization to align with the unique features of our educational games.

Additionally, a diverse range of assets, including images and sounds [Figure 5.2.5], was employed to enhance the overall user experience. These assets were carefully chosen to complement the educational content and make the games more immersive and enjoyable. By utilizing pre-existing assets for certain visual and auditory elements, we streamlined the development process, allowing us to focus on the educational aspects of the games while maintaining high-quality aesthetics.

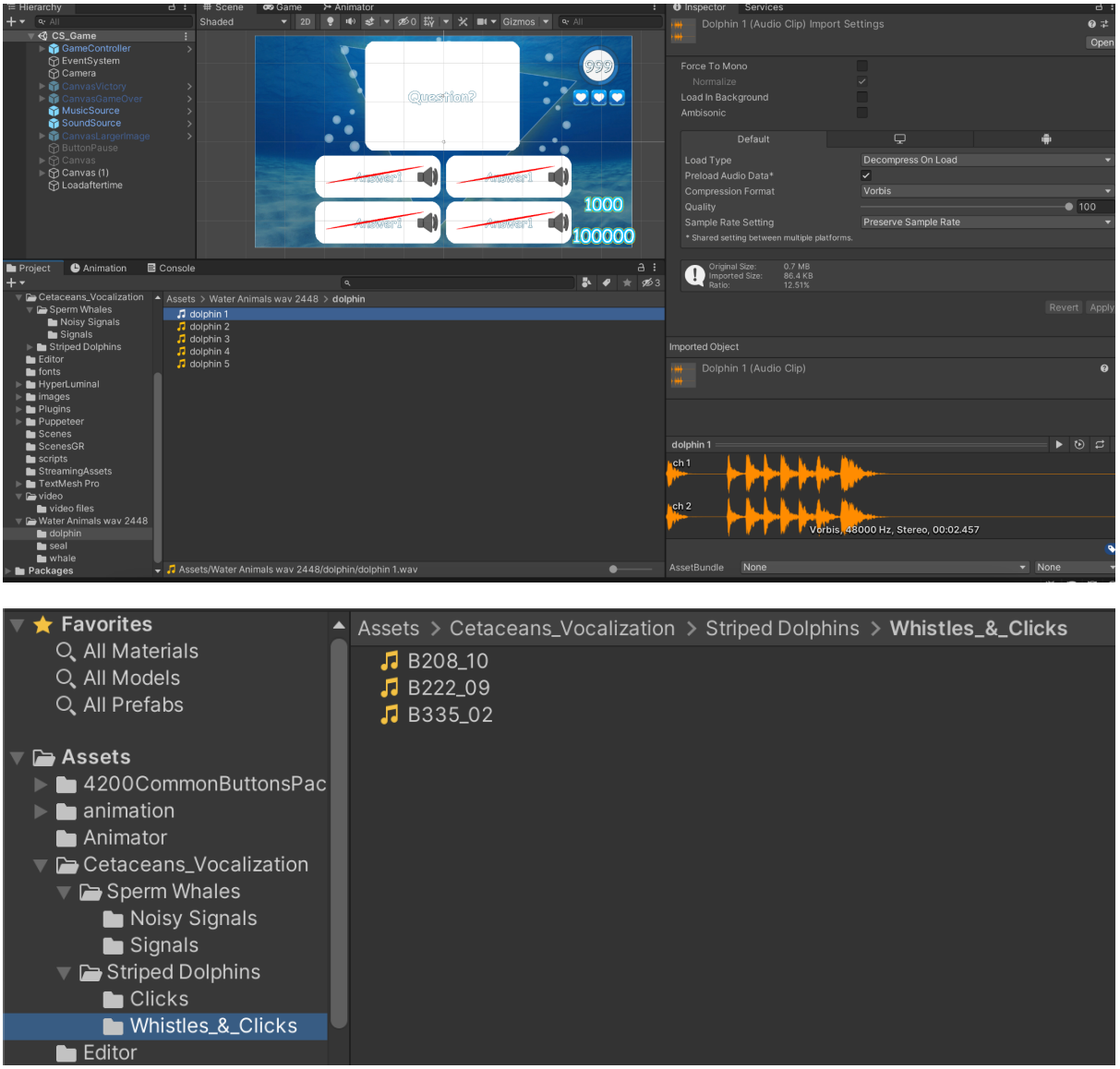


Figure 5.2.5. Using mammals sound effects in Unity project

In essence, the creation of the games in Unity was a collaborative effort, combining readily available assets with custom coding to deliver an interactive and educational experience that aligns with our objectives. This approach reflects a pragmatic blend of creativity and technology, optimizing the development process for the benefit of our users.

During the testing phase of the application, a notable observation surfaced — the application retained the specific page that the preceding user had navigated to. This unintentional persistence proved to be potentially confusing for the subsequent user approaching the kiosk. To address this usability concern, we implemented a solution within Unity to ensure a seamless experience for each new user. In response to this challenge, a modification was introduced to every scene in Unity. This adjustment involved incorporating a script that automatically redirected the application to the first page after a period of inactivity. Specifically, after 300 seconds [Figure 5.2.6] of user inactivity, the application was programmed to revert to the initial page. This deliberate design choice was made to enhance the user experience and provide a clear starting point for individuals approaching the kiosk.

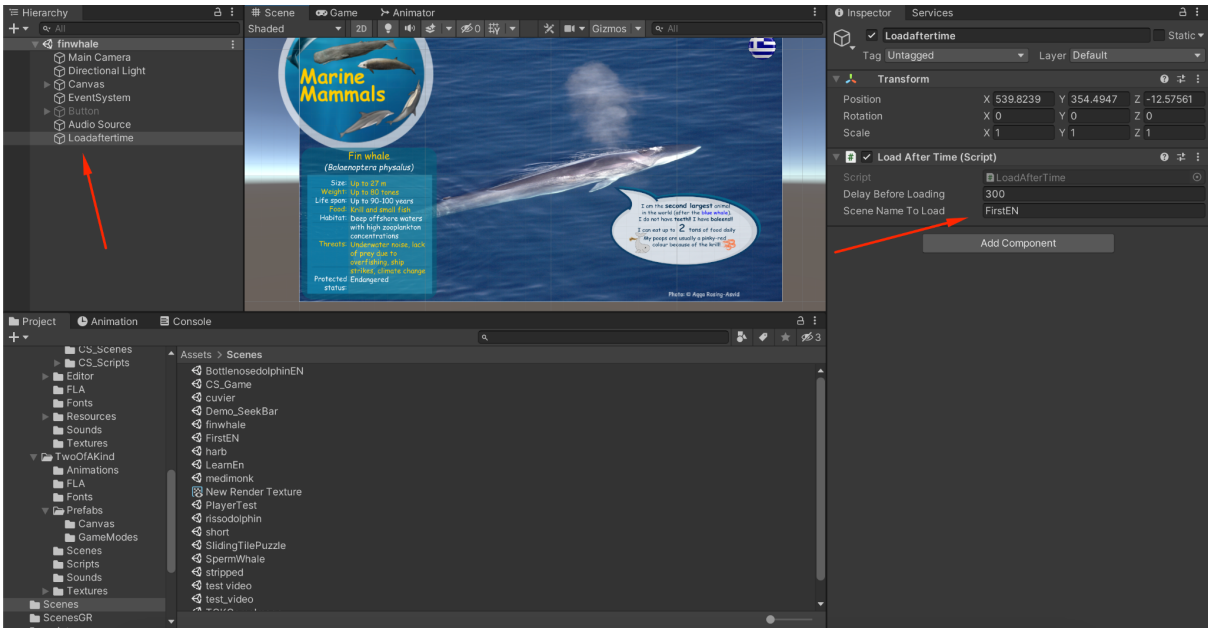


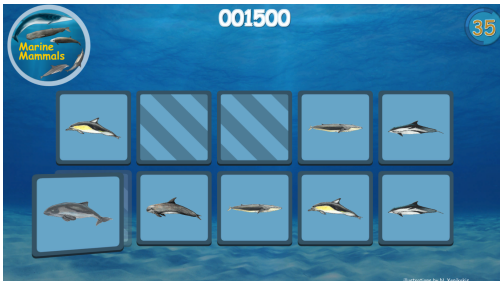
Figure 5.2.6. Return to first page after 300 seconds addition in every scene

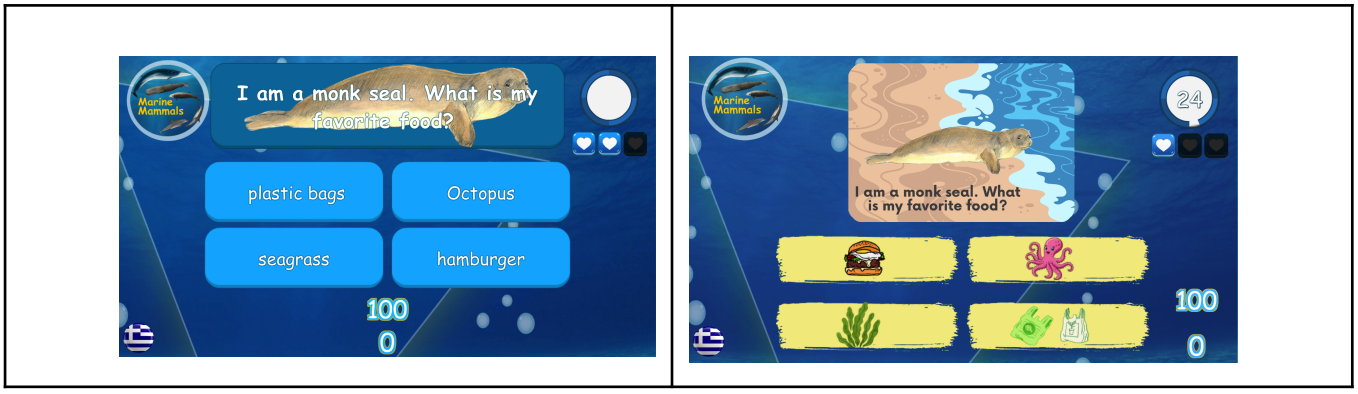
This proactive measure not only mitigated potential confusion but also ensured that the application maintained a user-friendly and intuitive interface. By incorporating this automatic redirection feature, we aimed to optimize the accessibility and ease of use for individuals engaging with the educational application, promoting a seamless transition for every new user.

In the Following table [Table 5.2.2] we can observe the evolution of the application from its inception, with its structure undergoing multiple revisions following extensive testing and trials aimed at enhancing the user experience(UX) and user interface (UI).

We initially placed the games section on a secondary screen, but later relocated the buttons to the main page due to user accessibility concerns. We also opted for a more playful graphic style for the games, making them visually engaging and enjoyable for users.

Table 5.2.2. How the application has evolved from the beginning until now

Before	After
	
	



5.2.2 Info Page (Let's meet them)

"Let's meet them" info page [Figure 5.2.7] includes nine selected species from the Mediterranean Sea to choose from and see more info for each one. There is also the name underneath each one and for those interested in the scientific aspect, the Latin name of the species is also provided. Users can tap on the image or name of a species to access more information about that particular marine mammal.

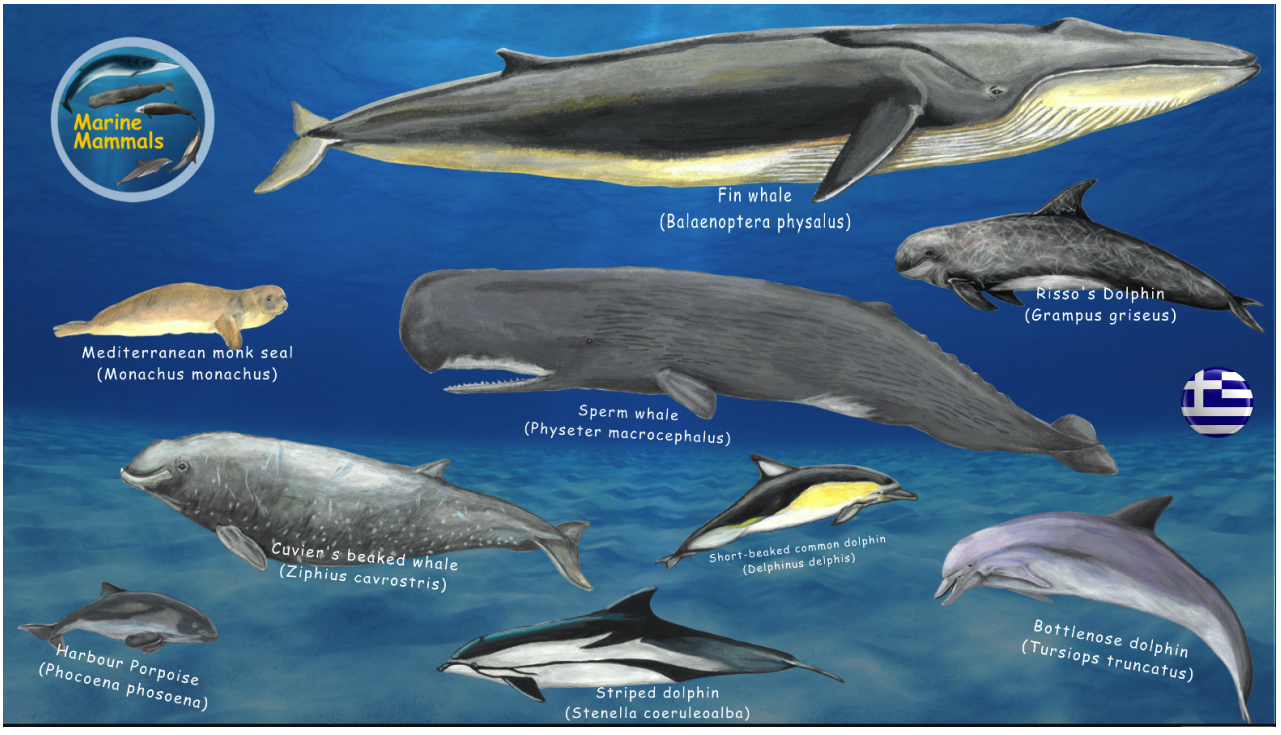


Figure 5.2.7. Marine mammals Info Page

Upon selecting a species, users are taken to a dedicated page that provides in-depth information about that species. This information may include details about the species' physical characteristics, habitat, diet, behavior, and conservation status. Visual content, such as photographs and videos [Figure 5.2.8] and sounds [Figure 5.2.9], may be incorporated to help users visualize and connect with the marine mammal species.

Figure 5.2.8. A specific dolphin(*Tursiops Truncatus*) with a video page

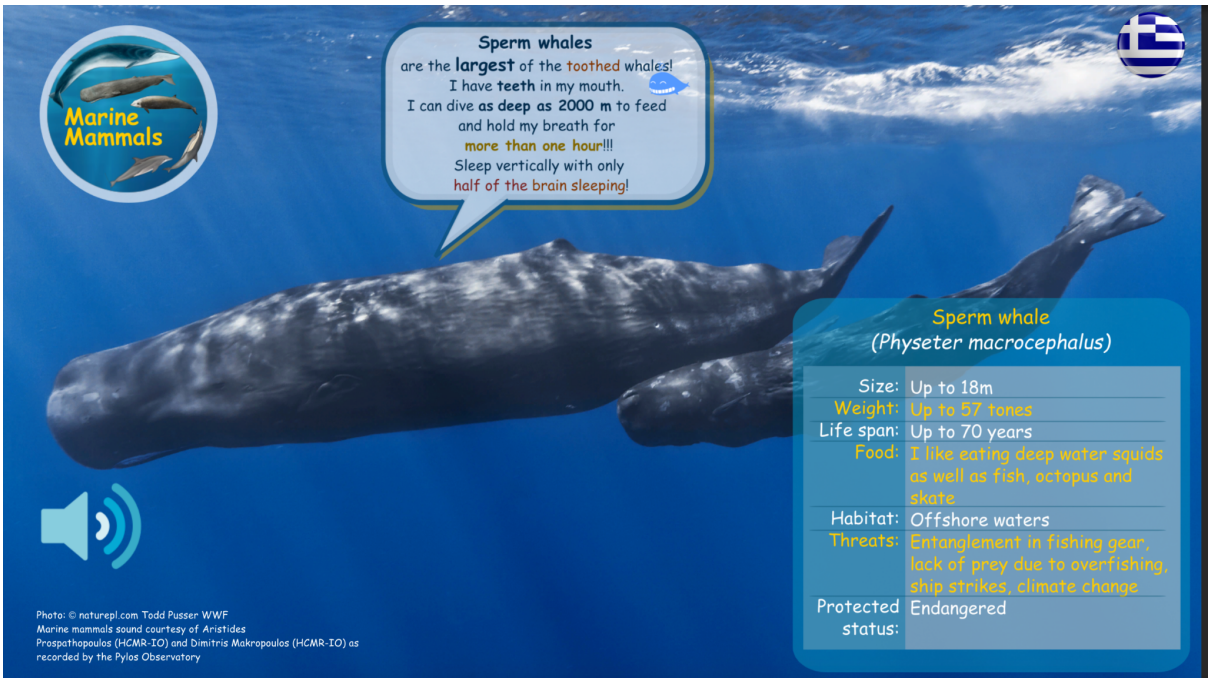


Figure 5.2.9. A Sperm whale(*Physeter macrocephalus*) with a sound

For video output, a frame [Figure 5.2.10] is overlaid on the scene, featuring various control buttons. These include options to start or stop the video playback, a scroll bar enabling users to navigate to specific points in the video, and a close button for shutting the frame.

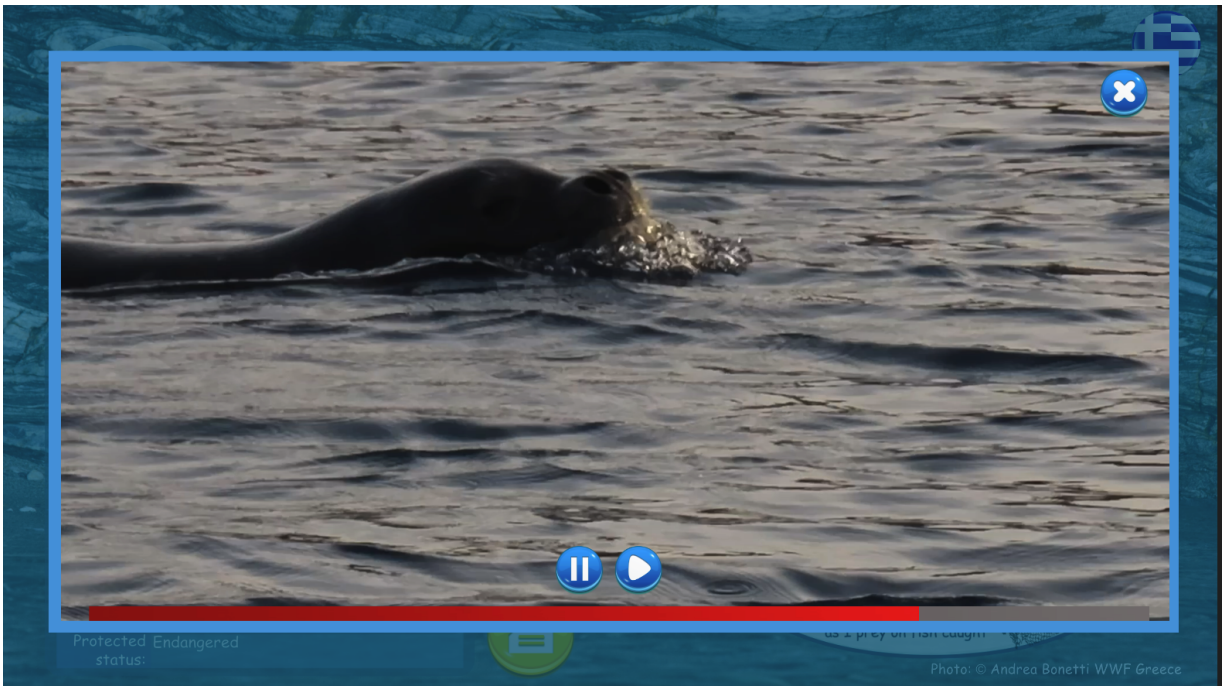


Figure 5.2.10. A video page popup

5.2.2 Memory game

The primary objective of the Memory Game [Figure 5.2.11] is to match pairs of marine mammal images. By flipping over two cards at a time, the player aims to find identical pairs hidden among the cards. The game features a collection of randomized species cards, each displaying images of different Mediterranean marine mammals. Players interact with the cards by tapping on them, revealing the images beneath.

Figure 5.2.11. Memory Game

The game utilizes smooth animations, with cards flipping over to display the marine mammal illustrations. Users can hear cheerful sounds (dolphins) when making a successful match. Similarly, when an incorrect pair is chosen, the game offers feedback through sound effects, encouraging players to keep trying. At the top right corner, there is also a countdown timer. If the user successfully completes the task before the timer reaches zero, a victory screen [Figure 5.2.12] appears. This screen displays the user's current score and the overall high score for the specific game. After completing the game, users are presented with the option to either play again or return to the homepage of the application.

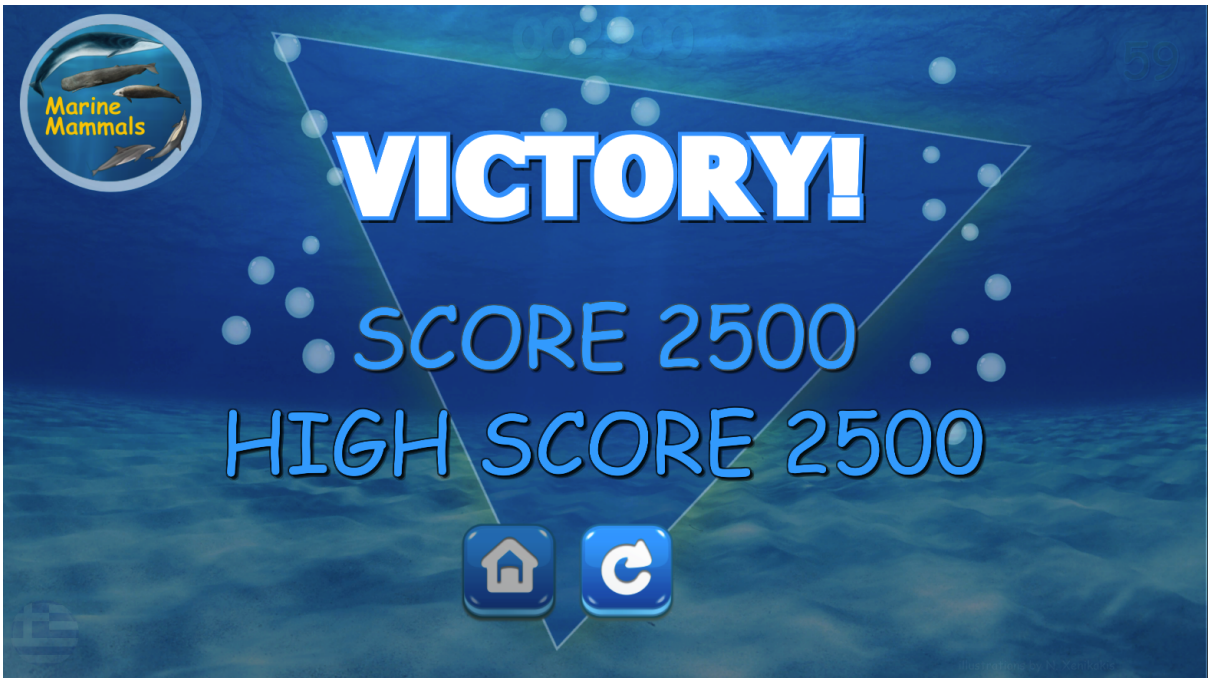


Figure 5.2.12. Memory Game winning screen

5.2.3 Quiz

The primary goal of the Quiz Game [Figure 5.2.13][Figure 5.2.14] is to answer a series of randomized questions about marine mammals. Players must choose the correct answer from a set of four possible options. The game offers a wide variety of questions related to Mediterranean marine mammals. These questions are randomly selected. Users are presented with multiple-choice questions, each with four colorful answer options. The graphics and vibrant design make the learning process engaging and visually appealing. Each question comes with a time limit for answering and also includes audio feedback and animations. Points are awarded for each correct answer. The score is updated in real-time, allowing users to track their performance and compete with themselves or others. Once the game is completed, users have the choice to either play again to improve their score or return to the home page of the application. This flexibility allows players to continue learning or explore other sections of the app.

Figure 5.2.13. Quiz Game

Figure 5.2.14. Quiz Game

At the top right corner, there is a countdown timer and three badges, which count failed answers. If the user successfully completes the task before the timer reaches zero and without losing any badges, a victory screen [Figure 5.2.15] appears. Throughout the game, the screen displays the user's current score and the overall high score for the specific game.

After completing the game, users are presented with the option to either play again or return to the homepage of the application.

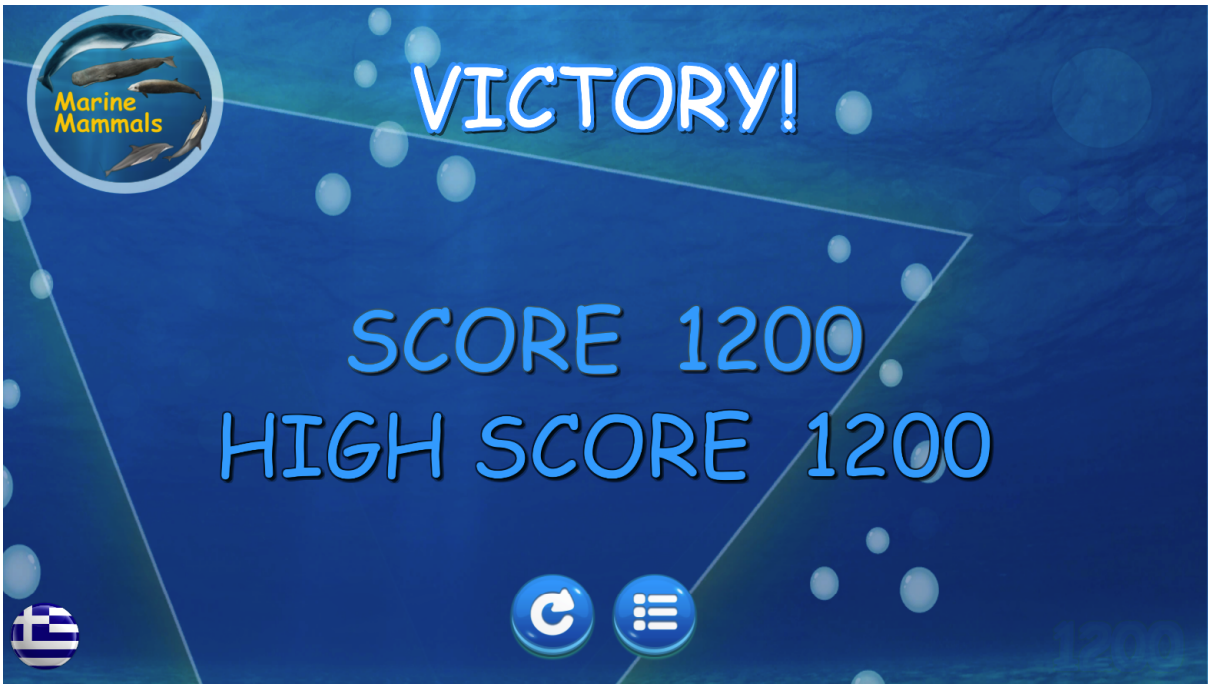


Figure 5.2.15. Quiz Game winning page

5.2.4 Sliding Puzzle

The primary aim of the Sliding Puzzle Game [Figure 5.2.16] is to rearrange shuffled segments of an image, to reconstruct the complete picture. Players need to slide the puzzle pieces into the correct order. The game draws from a selection of 2-3 random photos, each showcasing different Mediterranean marine mammal species. Each selected image is divided into either 6 or 9 puzzle pieces. The pieces are initially shuffled randomly, creating an engaging challenge. Players can interact with the puzzle pieces by sliding them horizontally or vertically. Before the game begins, users are presented with the full image on one side, providing a visual reference for the completed puzzle. This serves as a goal and reference point for players. The game algorithm shuffles the puzzle pieces at the start of each game.

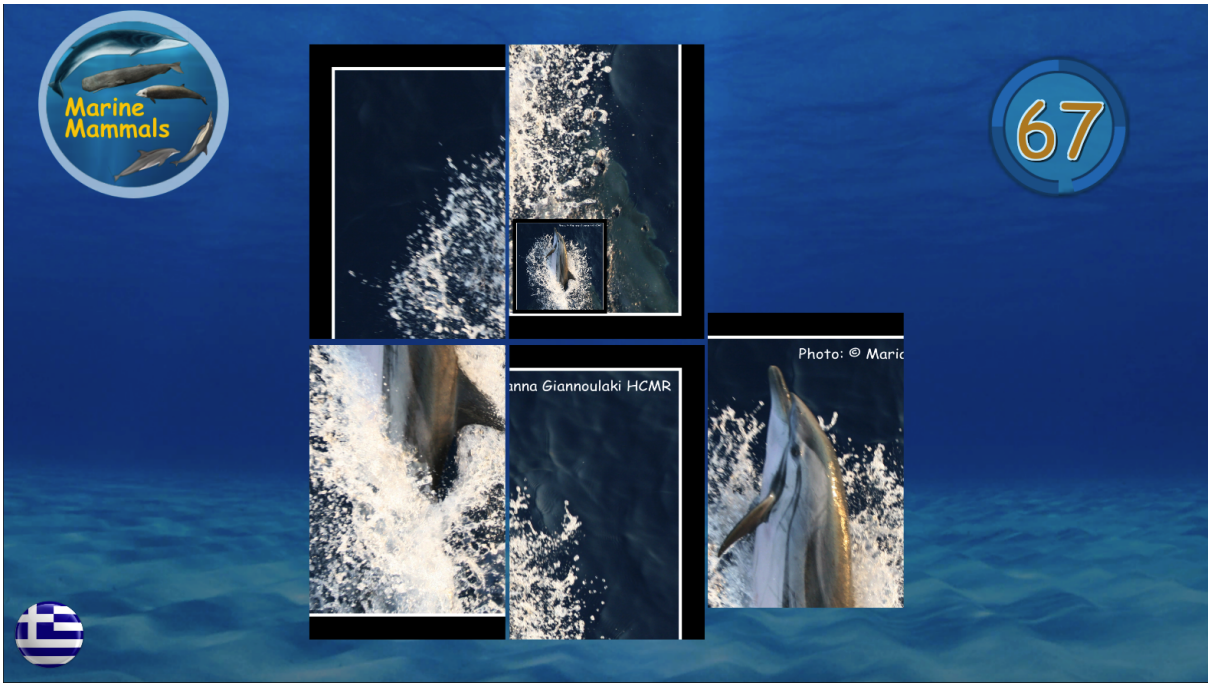


Figure 5.2.16. Sliding Puzzle

At the top right corner, there is also a countdown timer. If the user successfully completes the task before the timer reaches zero, a victory screen [Figure 5.2.17] appears. This screen displays the user's current score and the overall high score for the specific game. After completing the game, users are presented with the option to either play again or return to the homepage of the application.

Figure 5.2.17. Sliding Puzzle winning page

5.3 Implementation: Adapting to Diverse Platforms

Throughout the development process, the application underwent various iterations to ensure compatibility with a wide range of platforms. Initial testing primarily occurred on Windows and Linux environments, refining the application's performance and functionality across these operating systems. This cross-platform adaptability was critical to guarantee accessibility to a broad user base.

In later stages, efforts were extended to include a version optimized for Mac users. This expansion broadened the application's reach, accommodating users across different computing environments. However, recognizing the increasing prevalence of mobile devices, particularly tablets, in educational settings, additional versions were created for Android platforms. These mobile versions were specifically tailored for tablets and proved instrumental during school visits and educational festivals. The portability of tablets facilitated a more interactive and engaging experience for users, allowing them to explore the marine mammal world on a device that aligns with contemporary educational practices.

The continual evolution of the application across diverse platforms reflects a commitment to inclusivity, ensuring that the educational content remains accessible to users regardless of their preferred operating system or device.

5.3.1 Navigating Platform Challenges

The choice of the Windows platform for the initial development phase was deliberate, driven by its widespread use in educational institutions, schools, and aquariums. This decision aimed to ensure that the application could be readily deployed on personal computers across various settings, reaching a broad audience of potential users.

However, as the application evolved, we encountered a challenge regarding the security and integrity of the interactive kiosks, particularly in environments where touchscreen functionality was crucial. The ease with which users could navigate out of the application to access other Windows functionalities, potentially compromising the system's security, prompted a reassessment of the chosen platform.

In response to this challenge, we explored alternative operating systems, specifically experimenting with the Ubuntu distribution within the Linux environment. The objective was to assess the feasibility of deploying the application in a Linux setup, aiming to create a more secure and controlled environment for touchscreen interactions. This exploration was motivated by the need to prevent users from inadvertently exiting the application or accessing unauthorized functionalities, ensuring a more seamless and secure user experience.

The transition to Linux distributions, while presenting its own set of challenges, marked a strategic move toward enhancing the application's resilience and usability in touchscreen-enabled environments. This adaptive approach reflects a commitment to addressing real-world issues and optimizing the application for diverse educational settings.

5.3.2 Dual-Platform Maintenance and Tablet Deployment

Maintaining compatibility with both Windows and Linux platforms has proven essential in ensuring the versatility of the educational application. Unity's flexibility played a pivotal role in facilitating this dual-platform approach, allowing us to cater to diverse educational environments without compromising on functionality or user experience.

The journey didn't stop there. Recognizing the changing landscape of educational technology and the need for more portable solutions, we ventured into the realm of tablets [Figure 5.2.18] and mobile devices [Figure 5.2.19] . Unity's adaptability allowed us to seamlessly export versions of the application tailored for these platforms. Tablets emerged as a particularly valuable tool for reaching young learners in remote areas, such as islands where access to traditional educational resources might be limited. To address the unique challenges of these environments, robust tablets encased in durable covers were employed, ensuring resilience against the rigors of children's interactions. This strategic deployment extended the reach of the application to locations where conventional educational outreach might be challenging.

Figure 5.2.18. Installation in Android Tablet with hard case, specially for kids

This expansion into tablet deployment showcases the application's commitment to inclusivity, reaching learners beyond traditional educational institutions. The adaptability of the application across platforms underscores its dynamic nature, continually evolving to meet the diverse needs of its user base.

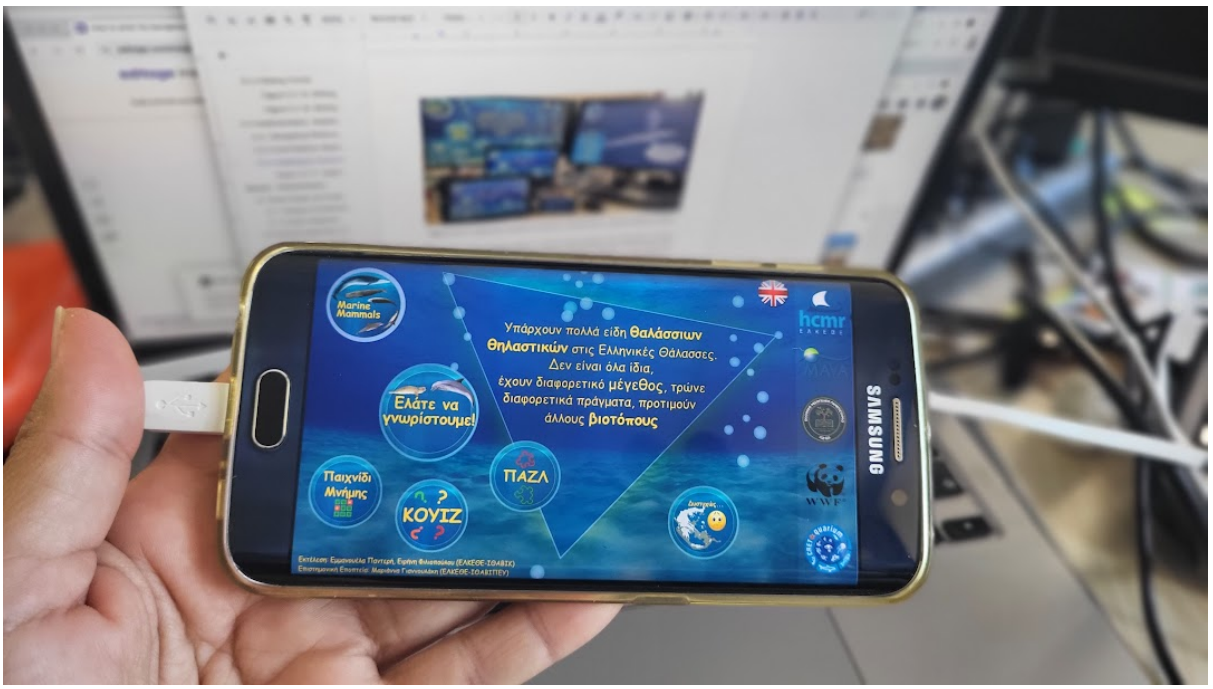


Figure 5.2.19. Installation in Android Mobile

5.3.4 Adapting to Varied Screen Resolutions

Navigating the diverse landscape of screen sizes presented an additional challenge in ensuring a seamless user experience across different platforms. The stability of a 1920x1080p resolution was well-suited for the kiosk setups, providing a consistent visual experience in those environments.

However, when extending the application to mobile devices with varying screen sizes, a more adaptive approach became necessary. Tablets, especially those procured by the Hellenic Centre for Marine Research and designed with strong, durable cases suitable for kids, were identified as a targeted platform. To optimize the application for these tablets, a stable resolution was carefully selected to maintain visual clarity and consistency across the designated devices.

This strategic decision reflects a nuanced understanding of the importance of screen resolution in delivering an engaging and cohesive educational experience. It also underscores the application's commitment to tailoring its interface to meet the specific requirements of each platform, ensuring that users, whether on large kiosk displays or handheld tablets [Figure 5.2.20], encounter an immersive and visually satisfying journey into the marine mammal world.

Figure 5.2.20. Application Installed in Windows, MacOS, Ubuntu(Linux), Android mobile and tablet

Chapter 6 - Results - Dissemination

In this section, we present the results of our research and the outcomes of the educational application development process. This section is structured to provide a comprehensive overview of the project's achievements, findings, and the impact of the application.

6.1 Kiosk Design and Implementation

The integration of interactive kiosks played a pivotal role in the presentation and accessibility of the educational application. This section provides an insight into the thought process and considerations behind the creation of these kiosks. As the need for an engaging and user-friendly interface became apparent, the development of wooden kiosks became imperative. This subsection outlines the rationale behind incorporating touchscreens, the careful selection of small/mini PCs, and the strategic design of a custom drawer to house essential components like the PC, mouse, and keyboard. Additionally, attention is given to security measures, including a robust locking mechanism, ensuring the protection of equipment and cables from unauthorized access. The section sets the stage for a detailed exploration of the design principles and considerations that guided the creation of these integral elements in presenting the educational application.

6.1.1 Design Considerations

In this part, we look closely at how we designed the interactive kiosks. We discuss the size and materials chosen for the wooden structures, focusing on making them strong and looking good with the educational theme. We also explain how we combined touchscreens with the design, making technology blend seamlessly with the physical appearance. The part goes into detail about choosing small/mini computers that fit well into a specially made drawer, considering space and making it easy to use. We also talk about keeping the kiosks secure, explaining how the locking mechanism works to protect the equipment and cables. This section helps you understand the careful choices we made in designing the kiosks to make them effective and easy for users, ensuring they are enjoyable entrances to the educational application.

We had different approaches in designing the kiosks depending on the area created like the kiosks crafted for Cretaquarium and Rhodes Aquarium. The distinct environments of these two locations prompted tailored designs to harmonize with their unique atmospheres.

Figure 6.1.1. Kiosks arrived at Cretaquarium to host the Marine Mammals application

At Cretaquarium, the design palette is inspired by the deep blue hues of the marine environment. The kiosks seamlessly integrate with their surroundings through a color scheme that mirrors the ocean depths. In contrast, the kiosks at Rhodes Aquarium are designed to complement the warm and wooden-toned ambiance of the surroundings. The choice of colors

here aims to harmonize with the natural elements of the environment, offering a distinctive yet integrated appearance.

Figure 6.1.2. Kiosk at Rhodes Aquarium to host the Marine Mammals application

These divergent design approaches showcase adaptability and responsiveness to the unique characteristics of each location, ensuring that the kiosks not only serve as functional interfaces but also contribute aesthetically to the overall visitor experience.

Figure 6.1.3. Kiosk at the entrance of the Cretaquarium hosting the Marine Mammals application for a special event

6.1.2 Audio Integration

The placement of the speaker was initially outside the kiosk, but this posed a significant challenge. The kiosks were often in high-traffic areas where many people, including children, passed through. Unfortunately, having the speaker outside made it

susceptible to interference—people could easily tamper with the volume, turn it on or off, or even damage the speakers. Recognizing this safety concern, we undertook a pivotal evolution in the audio integration within the interactive kiosks. This evolution involved relocating the speaker from the external position to inside a custom-made drawer. The decision to move the speaker inside was driven by a need for enhanced security and durability. This modification is detailed, emphasizing the strategic placement of two small holes in the drawer to allow the pristine projection of sound while ensuring the speaker remains protected. This change in how we approach audio doesn't just enhance the user experience by immersing them in a more encompassing auditory environment. It also reflects the adaptability of the kiosk design to address real-world challenges, improving both visual and auditory elements. These adjustments underscore our commitment to refining the kiosks for a safer, more enjoyable, and balanced educational experience.

6.2 Practical Application and Impact

In line with our commitment to practical application, the educational application was installed in several interactive kiosks at Cretaquarium [Figure 6.1.1] and the Rhodes Aquarium [Figure 6.1.2], enhancing the learning experiences of visitors and learners in these prominent marine institutions. Furthermore, the application traveled to various educational festivals, including the Thessaloniki International Fair [Figure 6.2.4.], where it engaged with a wider audience and showcased its educational value.

The kiosk featuring the Marine Mammals application was also showcased at the International Exhibition Center of Crete (ΔΕΚΚ - Διεθνές Εκθεσιακό Κέντρο Κρήτης) during the InnoDays 2023 event hosted by the Region of Crete in November 2023. The exhibition attracted hundreds of attendees, including families and children. A dedicated section named the 'Kids Creativity' corner featured various installations designed for children, and among them was the engaging Marine Mammals application. [Figure 6.2.6.][Figure 6.2.7.][Figure 6.2.8.]

Figure 6.2.1. Marine Mammals Application installed in two kiosks at Cretaquarium "Cetaceans of the Mediterranean" area

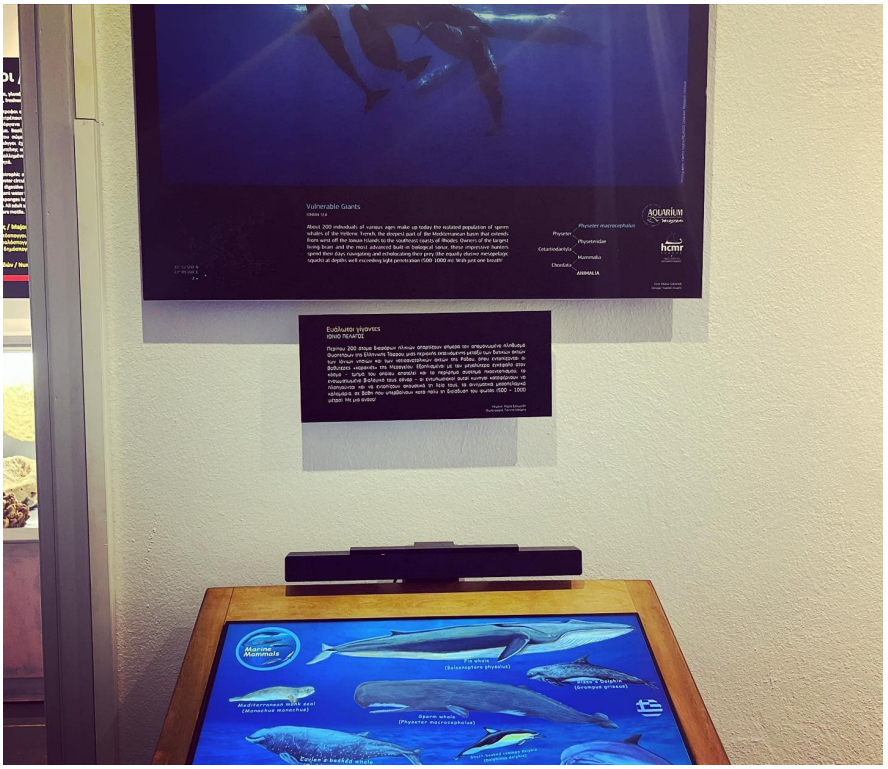


Figure 6.2.2. Marine Mammals Application installed in Rhodes Aquarium

Additionally, the application was integrated into school visits, offering students interactive learning experiences on tablets. This on-site engagement further extended the reach and impact of the educational content, reinforcing our dedication to marine conservation education.

As part of the practical implementation, social media channels [Figure 6.2.3] [Figure 6.2.4] were employed to promote the educational application at major events, allowing for widespread exposure and engagement with potential users.

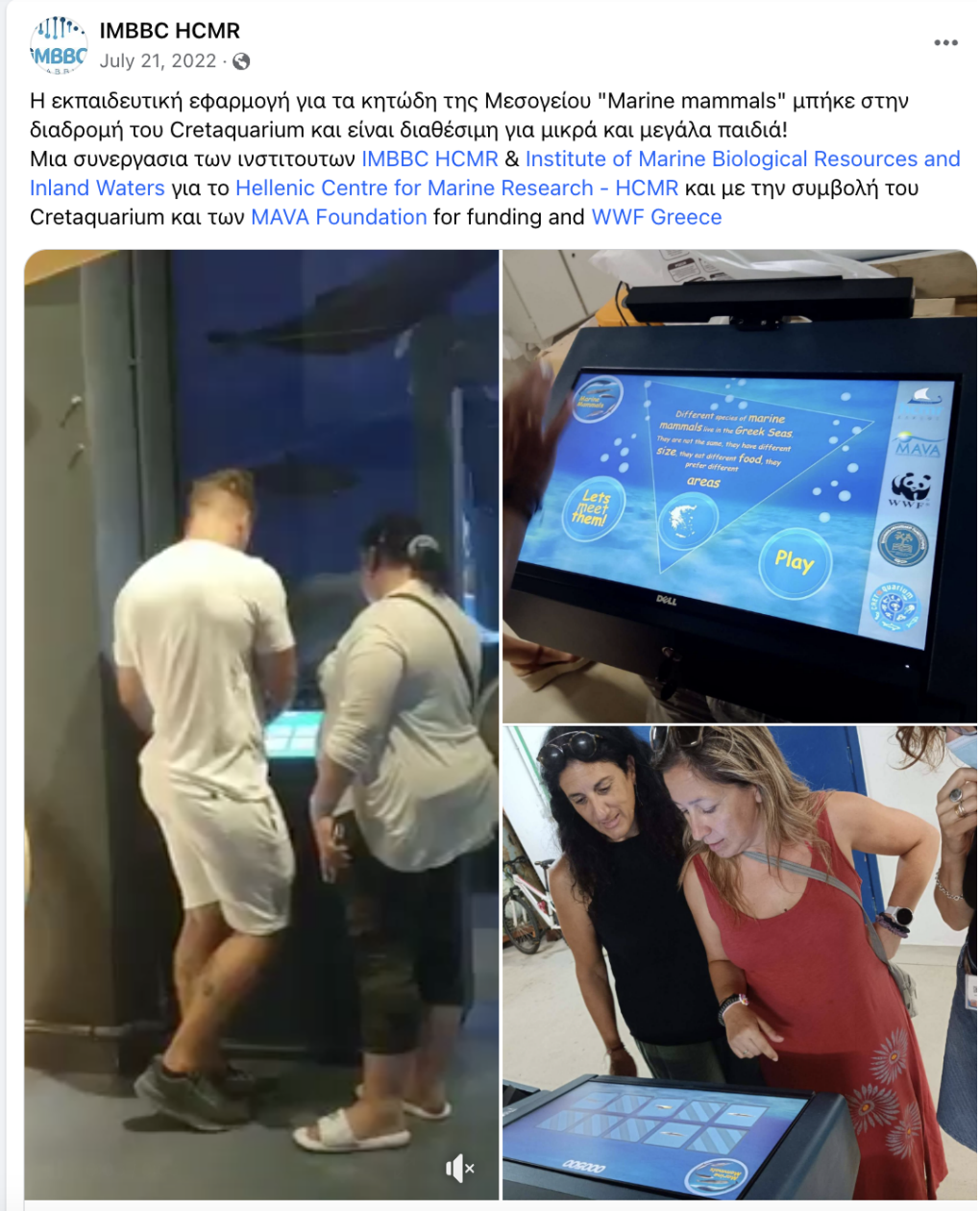


Figure 6.2.3. Marine Mammals Application introduced in social media from the Institute of Marine Biology, Biotechnology and Aquaculture at the Hellenic Centre for marine research (IMBBC - HCMR)

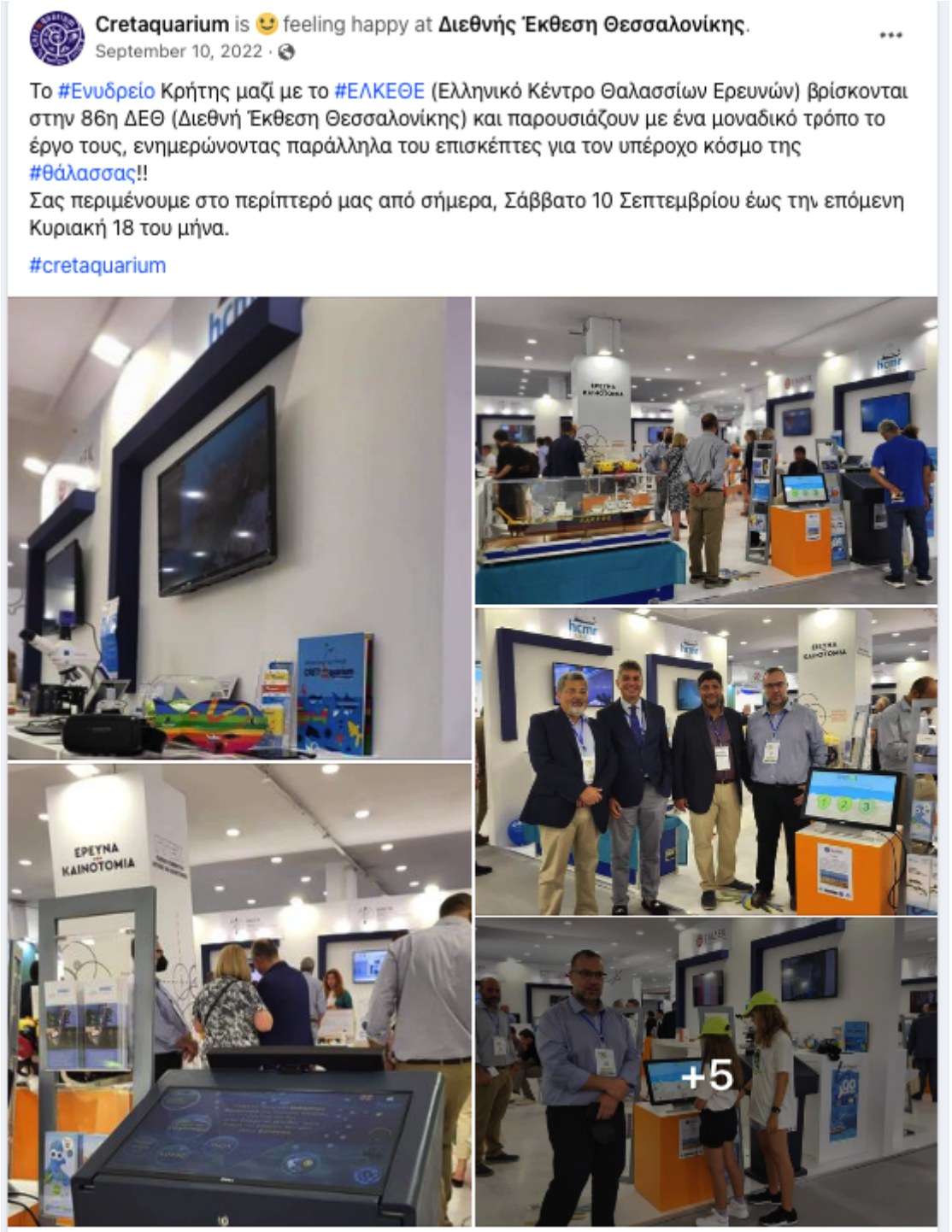


Figure 6.2.4. Marine Mammals Application introduced in social media from Cretaquarium

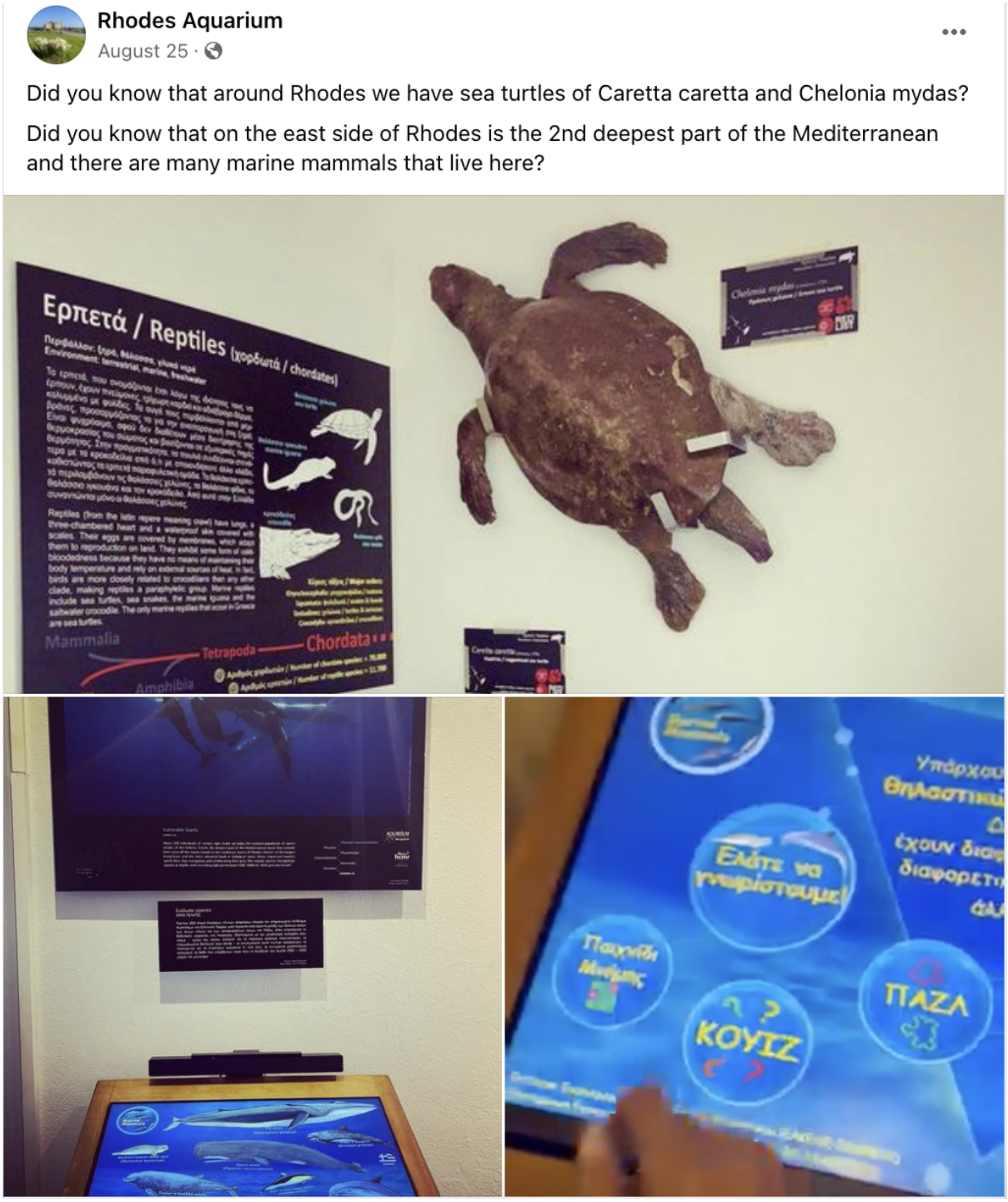


Figure 6.2.5. Marine Mammals Application introduced in social media from Rhodes Aquarium

Figure 6.2.6. Marine Mammals Application introduced in InnoDays 2023 an event from the Region of Crete

Figure 6.2.7. Kids playing Marine Mammals Application InnoDays 2023 event

Figure 6.2.8. Kids playing Marine Mammals Application InnoDays 2023 event

Chapter 7 - Conclusions

We have successfully integrated state-of-the-art technologies, such as the Unity 2D/3D game engine and touch screen functionality, into the educational application. These technologies have significantly enhanced user engagement and interactivity, making the learning experience more immersive and enjoyable. The chosen technologies have proven to be pivotal in achieving our goal of educating young learners about marine conservation.

The educational content and design of the application have been meticulously crafted to provide rich, interactive learning experiences. Users have engaged with the species cards, interactive mini-games, and diverse learning content, indicating the effectiveness of the application's design. The educational content and design contribute to the development of essential skills and a deeper understanding of marine conservation.

The application has been successfully deployed in various settings, including aquariums, educational festivals, and school visits. The practical implementation of the application has showcased its adaptability and accessibility, with users engaging with the content in diverse environments. These practical implementations reinforce the application's role in engaging and educating young learners and promoting marine conservation awareness.

In summary, our research has not only achieved its objectives but has also exceeded expectations in engaging and educating young learners about marine conservation. The application's reach, adaptability, and positive impact on users underscore its potential as a valuable educational tool for fostering environmental awareness. These conclusions pave the way for a comprehensive analysis and discussion of our findings in the subsequent section.

This project was a collaborative effort between the Institute of Marine Biology, Biotechnology, and Aquaculture (IMBBC) at the Hellenic Centre for Marine Research (HCMR) and the Institute of Marine Biological Resources and Inland Waters (IMBRIW). The project was made possible through the generous contributions of CRETAquarium, the MAVA Foundation, the support of WWF Greece, and the dedicated efforts of several scientists who contributed to data gathering, as well as artists who created the stunning illustrations of marine mammals.

Looking forward, the success of our educational tool opens doors to further research and application in the realm of marine conservation education. As we celebrate the achievements of this project, we also recognize the potential for ongoing enhancements and

expansions. Our commitment to making a positive impact on environmental awareness remains steadfast, and we are excited about the possibilities that lie ahead.

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