Save the Ocean: A Game for Environmental Awareness

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Abstract—**Environmental issues have become the subject of strong discussions nowadays and games have become great allies in the teaching and awareness of environmental problems, especially when applied in children's education. This paper presents a 2D serious game for the PC platform to raise awareness about the environment, focusing on water pollution. Players take in the role of mechanic-sharks and compete with each other to collect different types of waste in the ocean. The goal is to indirectly teach players about selective waste collection and which types of materials are more harmful to the environment.**

Keywords-**Game Development, Unity, Environmental Awareness, Serious Games;**

I. Introduction

To raise awareness about environmental problems, environmental education plays an essential part, as it seeks to communicate to the population the role that every individual has in protecting the environment [1]. It is a process that provides a critical and global understanding of such issues, allowing a conscious position regarding preservation and adequate usage of natural resources [2]

Santos and Santos [3] emphasize that environmental education is a learning process that aims to form and develop responsible actions in order to create a relationship model between man and the environment. From this perspective, serious games may present themselves as ally, since they present powerful characteristics that can be used in the learning process of this theme. According to Malaquias et al. [4], the ludic features present in games, provide a more pleasurable learning experience and lead to new knowledge regarding to environmental issues. Games can improve skills such as meta-communication, comprehensibility, thinking process and learning languages. Furthermore, it gives the opportunity to students to become active and get involved in the learning process [5].

Examples such as [6, 7, 8] have obtained results demonstrating that this approach, using games, made players more aware and conscious of environmental issues. However, the work of [9] shows there is still a lot of ground to cover and there is a lack of games exploring this subject, focusing on real environmental issues.

Aiming to contribute to raising awareness about environmental issues and protection in a more ludic fashion, this paper presents a game entitled Save The Ocean. In this 2D serious game for PC, two players control mechanic-sharks able to execute selective waste collection in the ocean. They will compete with each other, and the one that collects more waste will be victorious. The goal is to have players learn and better understand the importance of disposing waste correctly, to avoid the degradation of not only the marine environment, but the whole planet. To evaluate the game we performed a small experiment with 10 participants, and showed that after playing the game they became more aware about environmental issues.

The remainder of this paper is organized as follows. Section II presents related work that also aimed to raise environmental awareness through the development of digital games. Section III describes the game mechanics and how it is being used to reach our main goal, i.e., raise awareness about environmental issues. Section IV presents preliminary results about the game effectiveness, and in Section V the authors conclude the paper and also gives light into future ideas.

II. Related Work

In this section we present similar work performed by other researches who also developed video games as means to raise the issue of environmental awareness.

Braga and Oliveira [6] propose a 2D serious mobile game as a tool to teach and raise awareness about water pollution. It is entitled "Save Fish" and it is an endless runner with a side scrolling gameplay. The environment and background are underwater. The goal is to capture as many fish as possible that have been mutated due to the

presence of chemical waste in the water. The main character is a submarine that moves horizontally and shoots fishing nets. As the game advances, mutated fishes as well as chemical objects spawn and move towards the submarine. The first must be captured, so it can be properly treated and medicated so they can become healthy fish once gain. The latter damages the submarine, so it must be avoided. At the beginning and end of each trial play, a message with information about water pollution is displayed as to educate the player.

The authors also applied a questionnaire, before and after the game was played, to measure if it had affected the players knowledge regarding water pollution. They concluded that after playing the game the majority of participants felt their knowledge about water pollution increased.

Nunes et al. [7] explores a 3D VLE (Virtual Learning Environment) by developing a mobile serious game entitled "Protecting the Earth". The game targets children and addresses topics such as: selective waste collection, recycling and reduction of waste production. The authors reinforces that the main cause of environmental problems is not actually a lack of public policies, but rather citizen collaboration.

The game has three phases, with the difficulty increasing as the player advances. The first phase deals with selective waste collection. The game presents a public square with several colored recycling bins and garbage spread on the ground. The player has to pick it up and place it in the correct bin (plastic, metal, paper and etc). The second phase focuses on recycling the collected garbage from phase one and creating new toys. The third phase is still experimental and focused on eco-friendly behavior. In this part, the player interacts with other characters from the game that is behaving in a wasteful way. The goal is to correct them with actions such as: turning the lights off, the tap off and etc. Given that this game is targeting children, the art and graphics reflect this choice. The gameplay is also in a slow pace, as to allow the player to observe its actions and learn from it. In the first stage, for instance, the player has no time limit to place the garbage in the correct recycle bin.

Finally, a systematic review performed by [9] analyzes a total of 43 serious games and gamified applications related to water. The goal is to study how these games can benefit real-world environmental decision analysis. They concluded that games and gamification can be used to aid environmental MCDA (multi-criteria decision analysis), but there is also some mismatches, opening opportunities for more research.

III. Save The Ocean

In this section we will describe the game we developed named Save The Ocean, a 2D serious game for the PC platform, for two players. They will be playing as sharks who compete with each other to pick up wastes from the ocean. The match lasts three minutes. Powerups and powerdowns become available as the game progresses to make it more competitive, fun, and keep the players in the flow channel. Different types of waste, with different value points, spawns in the scene and players must reach it first. At the end, the one with the highest score will be victorious. Figure 1 presents the game in progress.

Figure 1. Save the Ocean - A match in progress

A. Game Story

In this game, a recycling company found an opportunity to expand its business and help the environment with the vast amount of available ocean waste. In order to accomplish that, they allocated their best engineers to develop two cyber-sharks (robot sharks) with the ability to collect and properly separate the trash. To make it more fun and stimulate the population to collect as much waste as possible, the company has set up a competition. Each participant controls a shark that needs to collect appropriate waste to score points. The company is awarding prizes such as consoles and high-end gaming PCs to winners.

B. Game Mechanics

The core mechanic of the game is to collect waste from the ocean, as cyber-sharks that can eat it. There are four types of wastes available: plastic, metal, glass and paper. These materials take different amount of time to decompose and have different harmful effects on the environment. For instance, a plastic may take up to hundreds of years to decompose and it is very harmful on the oceans. A glass may take millions of years to decompose but it is not as harmful as plastic. To educate players, we used a scoring system based on harmful effects and decomposition time, presented on Table I. We believe it will show the players that plastic is the most harmful waste and it is degrading our oceans.

To keep players aware and create a fun and competitive environment, we implemented a mechanic where not all waste should be pick up at all times. Observing Figure 1, at the top of the screen, the UI displays the current score for each player, the time remaining to end the match, and what

TABLE I. SCORING SYSTEM FOR SAVE THE OCEAN

Material	Points	Decompose Time	Harmful Effect	Color
Plastic	4	Up to 1000 years	High	Red
Glass	3	Up 1000000 years	Low	Green
Metal	2	Up to 200 years	Medium	Yellow
Paper	1	Up to six weeks	Low	Blue

type of waste is currently awarding points (center). In this example the color is red, which represents plastic. Players will only score points if they collect plastic. If other types of waste are collected, they will be punished by losing points. Punishments in games are important to avoid boredom, and to increase the feeling of accomplishment when the objective is completed [10]. Using this system we also teach player about selective waste collection, since these are standard colors in recycling bins.

Before the match begins, the game displays a simple guide with the types of waste, their color and also controller information, as seen on Figure 2. Every 30 seconds the game changes the type of waste that should be picked up, and the UI reflects this by changing the color and creating a small visual effect to let players know about this change.
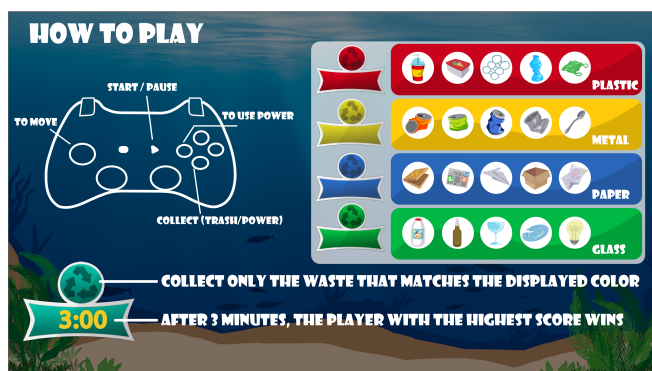

Figure 2. Save the Ocean - How to Play

On one hand, the side effect of this mechanic is that, during the plastic phase, a player might be able to accumulate enough points to compensate mistakes in other phases and still win the game. On the other hand, we are using this to emphasize the damage that plastics bring to the environment, specially living species in the ocean. However, players should not enter a rush mode and collect every waste that spawns without carefully analyzing it. Players will lose points if incorrect waste type is collected. We believe this balances this situation, maintaining a cautious gameplay.

To add more fun and competition, the game also has powerups and powerdowns that spawn randomly through the match. The player may pick it up, and use it in a time he considers more adequate. There are three types of items: Freeze, Inversion and Speed. The first one allows the player to freeze the opponent for six seconds. The second one inverts the controls of the opponent, to confuse him. And

the third one buffs the player, making him move faster, so he/she can reach valuable wastes before his opponent.

When the match finishes, a victory screen is displayed, as shown in Figure 3. It has the total points obtained by the winner, and it details the type and amount of wastes obtained in a table for each player. It also shows the number of points each type of waste is worth. To reinforce the color system used for recycling bins, the lines of the table has the color according to the respective waste type. For instance, the blue cyber-shark was the winner, and it collected seven plastics, each awarding four points, and the line color is red.

Figure 3. The victory screen of the game Save the Ocean

IV. PRELIMINARY RESULTS

To evaluate our solution for raising environmental awareness, we conducted a simple experiment where participants were asked to play the game Save The Ocean. A total of 10 engineering undergraduate students, ranging from 18 to 25 years of age participated in the experiment. The goal was to measure if, after playing the game, they became more aware about environmental issues.

Participants were asked about (Q1) Their familiarity with the color system used in recycling bins and (Q2) Their knowledge about what type of wastes are more harmful to the environment. They were asked these questions before and after playing the game. Figures 4 and 5 presents the results in a pie chart.

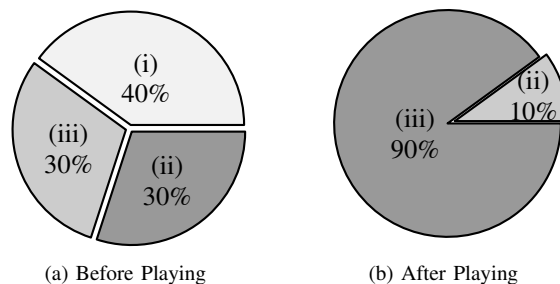(a) Before Playing   (b) After Playing

Figure 4. Percentage of players who were unaware (i), partially aware (ii), or totally aware (iii) of the colors used in the recycling process.
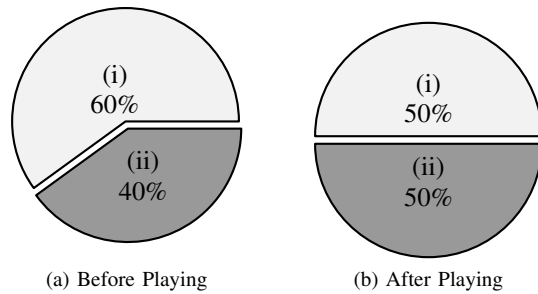
Figure 5. Percentage of players who were partially (i), or totally aware (ii) of harmfulness level of specific wastes to the environment

As shown in Figure 4, before playing the game, 40% of players were unaware of the color system used in recycling bin, and 30% were totally familiar with the system. After playing the game, 90% of players became totally aware of the colors used in the recycling bins. As for harmfulness level, according to Figure 5, 40% of the participants were aware of how different types wastes affected the environment. For example, they knew that plastic was the most harmful waste in the ocean. After playing the game, this number raised to 50% of participants.

This results shows that the game was very effective in teaching the colors used in the recycling bins, but did not perform as well when educating about how different types of wastes affect the oceans differently. It did increase the awareness, but only slightly. As such, the scoring system used in the game requires some tuning, along with the UI.

V. CONCLUSION

In this paper we presented the development of a 2D serious game for PC that aims to raise environmental awareness and protection, focused on water pollution. The game features cyber-sharks that are able to collect wastes from the oceans. We proposed a scoring system where wastes there are more harmful to the environment are worth more points. To teach players about selective waste collection we introduced the colors system adopted in recycle bins, as to guide players which waste they can collect in the respective time slot. To evaluate the game, we performed an experiment to measure how the game affected players knowledge about environmental issues. We noticed the game was very effective in presenting the color system used in recycling bins. However, it was not as much effective when presenting which types of wastes were more harmful. In future works we intend to improve this part of the game, and also perform more experiments.

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