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SU: A Serious Game for Water Management - Based on Istanbul

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Abstract. With the increasing population growth of human beings, the world is being threatened by the water scarcity problem, causing insecurity in water accessibility. Therefore, a deliberated water management gains fatal importance. In addition, the awareness of the issue through education, specifically in the early ages, plays a crucial role in this path. This research considers the water issue of Istanbul in its content. However, regarding the target audience, which is the kids, it uses a novel approach to tackle the problem. The paper proposes a visually enriched and nonlinear, serious game for the children to teach them about the importance of water and its impact on the planet, specific to Istanbul. The game is inspired by National Geographic Turkey's documentary named 25 Liters: In Pursuit of Water, asking the players to survive in a drought situation in the future. It aims to change the kid's lifestyle to revive the country's in-danger future.

Keywords: Serious games, Water management, Virtual water, Drought, Decision making

1 Introduction

Lack of clean freshwater is vital for the world and its inhabitants due to its impact on their health, economy, and social well-being. However, the available water resources are under pressure due to excessive demand created by urban population growth, representing a severe threat (Rijsberman, 2006; van Leeuwen & Sjerps, 2016). This threat causes water scarcity, in which a society

becomes water insecure and cannot fulfill its essential needs over long periods (Savun-Hekimoğlu, Erbay, Hekimoğlu, & Burak, 2021; Rijsberman, 2006). Furthermore, being an arid region, scarcity intensifies the problem, putting food resources, health, and the natural ecosystem in danger (Seckler, Barker, & Amarasinghe, 1999). Hence, to tackle the issue, water management is a key need for all aspects of society to secure the next generations' economic growth and life quality (Savun-Hekimoğlu et al., 2021). However, it is important to remember that water consumption of a region includes virtual water, meaning the amount of water used for any production, in addition to the direct use of freshwater. The production of various types of products consumes different amounts of water. In this regard, Zimmer and Renault (2003) propose categories, including primary products, processed products, transformed products, by-products, multiple products, and low or non-water consumptive products. According to Hoekstra and Mekonnen (2012), grain production needs less water than livestock products. Additionally, while cheese production consumes much virtual water, beef is the product with the greatest water usage amongst edibles. The production of electronic components, however, requires even more water. The production trade between various countries leads to a virtual water flow, an alternative to importing water for arid regions to deal with scarcity (Chapagain & Hoekstra, 2004; Hoekstra & Mekonnen, 2012; Seckler et al., 1999). This study's objective is the water management of Istanbul, a fast-growing metropolitan city. This city faced water scarcity throughout its history due to its distance from water resources (Savun-Hekimoğlu et al., 2021; van Leeuwen & Sjerps, 2016). Additionally, it faced a very recent drought in 2020 when the freshwater resources in the city reservoirs fell to 20% (Yılmaz et al., 2020).

As Appel et al. (2019) assert concerning sustainable ecosystems, citizens' awareness is crucial; hence informing them of the related challenges, specifically from the early ages, is vital. Additionally, according to UNESCO (1980), contemporary literature on environmental education should endorse a promising approach, paving public awareness about the subject. In this regard, educational or 'edutainment' software, a term combining education and entertainment in the form of video games for learning, is key to serving academic ingredients by embedding entertainment and bonuses for the user via a digital medium. These educational games are also known as serious games and have attracted players since 2002 (Alvarez & Djaouti 2011; Mouaheb et al., 2012). Such a point of view towards an issue such as water scarcity, a long-term challenge for the planet which will increase in severity, brings a creative and innovative technological approach to the possible futures.

Therefore, this paper proposes a serious game to increase awareness of the next generations' water shortage issue based on the city of Istanbul. While

existing developed educational games in the literature focus on water management, this game is based explicitly on Istanbul, focusing on the water level of Istanbul's reservoirs. The game has a nonlinear decision-making theme, depicting the city's future in a drought situation, asking the player to live through water shortages and see the effects on the environment and landscape. A documentary by National Geographic Turkey named 25 Liters: In Pursuit of Water (Dilara, 2019) was the inspiration behind the game's story. The game aims to teach children about the actual and virtual value of water, its efficient use, and the effects of its use on the environment.

2 Literature Review

A considerable number of studies in the serious game's literature focus on water and its management. However, each has a different point of view towards the issue for a wide range of target audiences.

SmartH2O is a project using consumers' water usage data for use in serious games to get feedback and raise people's awareness and highlight the dangers of wasting water (Rizzoli et al., 2014). Similarly, Khoury et al. (2014) proposed a serious game about flood prevention occurring as the result of climate change in the UK's Millbrook village for public awareness and identifying novel approaches to the issue. The game, developed in the Unity engine, gives players questionnaires before and after playing it. Flipping Lakes is a game-based method, educating various types of audiences about water quality and pollution management. It aims at engaging and educating both the stakeholders and the community in global water issues (Armstrong et al., 2021).

Multiple studies considered developing a serious game framework regarding sustainability and water. Makahiki is a serious game framework provided with built-in games for organizations regarding the sustainability of various natural resources, including water (Xu et al., 2017). Another serious game framework proposed by Rottondi and Verticale (2016) focuses on the privacy aspect of energy and water usage reduction. Another framework, introduced by Teague et al. (2021), considers water-related planning and threat reduction during stakeholders' participation in a decision-making process. In another attempt, Ong and Araral (2021) developed a mobile serious game based on message framings to inform the players of their water usage level regarding the risk of drought.

AQUAGUARDIANS (AG) is a serious educational game for water management tested in two cities with drought problems, resulting in successful outcomes. The game involves the community in the issue in a virtual cultural environment, involving reading texts and written input. As another example for

water management, Van der Wal et al. (2016) used a serious game providing feedback on the consequences of users' choices. Morley et al. (2017) present a competitive online serious game for water distribution performance optimization.

While all these investigated studies are specific for adults, the only game aimed at children is described in Appel et al. (2019). This sample focused on the need to create a knowledgeable society for a healthy and sustainable ecosystem. Hence, the players are informed about the difficulties of maintaining surface waters. They proposed the Hydro Hero serious game with minigames exclusively for children, underlining the importance of education at an early age. The game is based on canal maintenance, including questionnaires tested at a science museum. Based on the discussed studies, we see a lack of serious games for raising children's awareness of water's importance and its effects on the environment. Hence, in this study, we developed a serious game in this regard based on Istanbul and its reservoirs.

3 Game Design

As a children's game, the story is essential to the Su game development to engage the players with the intended information. The game is inspired by 25 Liters: In Pursuit of Water, a documentary by National Geographic Turkey, which depicts Turkey in 2050, suffering severe water scarcity. In the video, the people of Istanbul are trying to survive on only 25 Liters of water daily. The documentary demonstrates the current condition of Istanbul's landscape due to environmental issues and the current water use level. It also explains the concept of virtual water in detail, demonstrating the effect of lifestyle and eating habits on the country's water usage.

The story of the Su game is set in Istanbul 2050 when a drought is drying up the dam's water and destroying the green spaces. Additionally, the citizens suffer from a severe lack of fresh water. The game's main character is a child going to the water museum with school-mates and the teacher. This character and the theme of the story are designed to keep the children immersed in the game. The player navigates the game's character along various corridors in the museum and learns information about water and Istanbul. After finishing the tour in the museum, the students go back to the school. The teacher asks questions about what they learned and how they can survive in the current drought condition of Istanbul. In this part, the player will be asked questions to get the final reward. The player has a reservoir with a specific amount of water at the beginning. With each wrong answer, the amount of water is reduced, and the landscape around it is destroyed, while correct answers have the opposite

effect. Hence, in this way, the player will try to remember the knowledge learned in the first part of the game, give the correct answers, and keep the water level high. The results will be shown visually to demonstrate the effect of water scarcity on the landscape by showing dry and green environments (Figure 1). Additionally, the players will not be shown the numbers but rather see the effect visually so that they will be able to visualize the conditions as much as possible. In the end, based on the reserved amount of water in the dam, the player will get rewards.

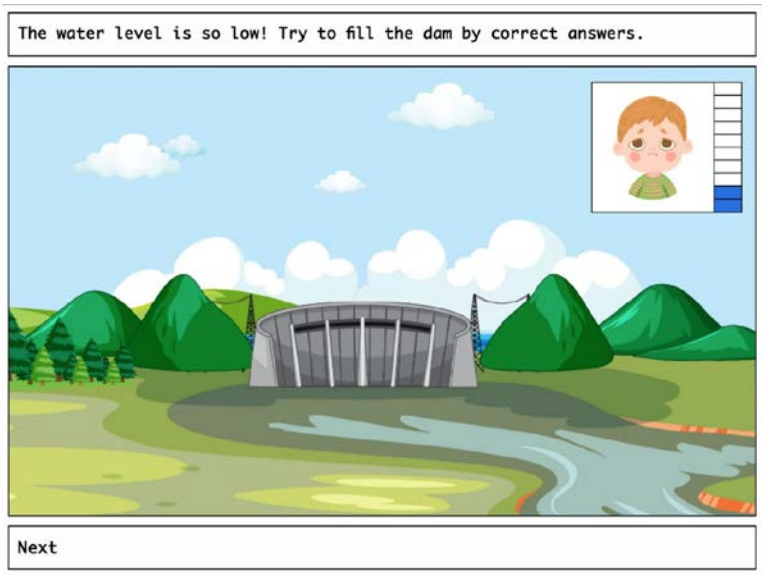

Figure 1. Effect of wrong answers on the environment in the game

We aimed to transmit a wide range of elementary-level data to the players. During the game, the player, first of all, will learn the importance of water as a necessity for human beings, animals, and plants. Next, the player learns about the impact of the water on the planet, the water cycle as a continuous process, and the consequences of any interruption of this on the world's well-being. Afterward, there is an explanation of how freshwater reaches the consumers for everyday use and how it can be polluted. In the next stage, they will encounter the meaning of the virtual water. This part explains the amount of water used to produce the edibles players consume, the clothes they wear, and the devices and the vehicles they use. This information is designed to guide them to change their lifestyle from a very early age, for both a healthy body and a green planet. Finally, as a part of the story, players will be informed that, in the 2050 drought, Istanbul's reservoirs are just 10% full.

4 Game Development Platform

For the development of the SU game, we tried Twine (2021), Scratch (2021), and Stornaway.io (Stornaway.io, 2021) platforms to find the one most suited to the game's content and its target audience. Considering that the target players are children and considering the need for a more visual outcome, we chose the Stornaway.io platform. This platform allows developing interactive, nonlinear branching video stories, which engage the audience, encouraging them to watch and replay it. Like the Twine platform, it will enable the viewer to personalize their journey, however, in a more visually appealing format. In Stornaway.io, the videos can be easily uploaded and connected without any need for coding knowledge (Figure 2). Additionally, it is easy to define buttons and periods for each video to let players select their paths (Figure 3). The platform is newly established and in the process of development, but its results can be published on the Stornaway.io web page, or the developers can get embedded links to share on their web pages. In addition, it enables sharing in PowerPoint presentations, and there are plans to publish on various other platforms in the future. Hence, at this point, we need to create educational and entertaining videos for use in a video game via the Stornaway.io platform.

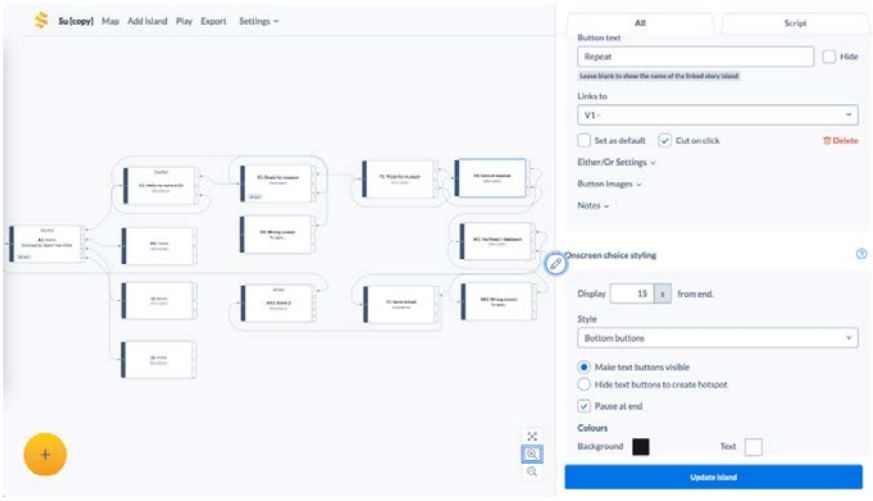

Figure 2. The development process of the game in the Stornaway.io platform. Source: www.stornaway.io

Figure 3. Game's interactive selection sample

5 Animation Making Platform

For the video creation part, we needed a platform to create entertaining videos to which speech sound could be added. For this purpose, we used Animaker software which allows non-professionals to create animations (Animaker, 2021). The software has a range of ready-to-use characters, elements, backgrounds, and music for animations, and the speech can be added to animations by simply typing the conversation and selecting the desired voice tone. Finally, the video can be published and downloaded (Figure 4). Hence, after creating each scene, all the videos can be uploaded to the Stornaway.io platform with their proper texts and choices so that the users can make their selections and also answer the relevant questions in the second part of the game.

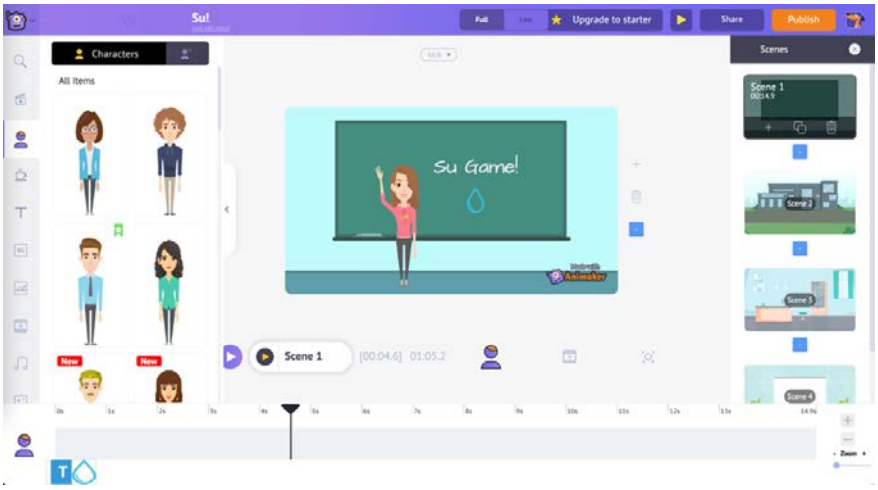

Figure 4. Animaker animation design interface. Source: www.animaker.com

6 Conclusion

To conclude, this paper aims to raise water awareness by focusing on educating children. It considers Istanbul's water scarcity problem by informing the children about the direct and virtual use of water, in addition to the effect of its excessive use on the planet and the environment. To achieve this, it takes advantage of serious educational games to provide entertaining instruction. Depicting a future drought situation in Istanbul, the game challenges the players to survive by controlling the water level of a reservoir by answering questions on information learned in the first phase of the game. Wrong answers result in a decreasing water level, demonstrating the effect of water on the landscape. The game's animation is created in the Animaker, an easy-to-use animation-making platform. The game is developed with the Stornaway.io platform, designed for the development of interactive movies and games. The visually appealing design is expected to encourage children's immersion in the game and learning about these issues. The game is still in its alpha version, not fully developed yet, and hence, has limitations. The limited time and budget and the small group of developers in this project demonstrate the possibility of developing games for various purposes using simple development means, without the need for large teams or complicated coding. Additionally, users can play the published version of the game in any browser of any device, eliminating the need for a professional gaming system and making it available to the mass public. As future work, the fully developed game can be incorporated into the curriculum in an elementary school to involve the students in environmental issues from early ages, leading to a more environmentally conscious population.

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