

A Digital Game-based Science Activity for Children: Stop Climate Change

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Introduction

In recent years, we see that technology and technological applications have been used effectively in many fields of education. Especially, during the novel coronavirus (Covid-19) process, students and teachers could not continue their education in an area close to the whole of the world for a long time. It has been determined that approximately 1.5 billion students cannot continue face-to-face education due to the Covid-19 (UNESCO, 2020). In this process, education and training activities had to be continued remotely. It has been greatly affected by our perspective on education and training activities during the pandemic process (Bozkurt and Sharma, 2020). The teaching of the lessons had to be moved from the concrete environment (face to face) to the abstract environment (online). For this reason, synchronous (Henriksen, Creely & Henderson, 2020) and asynchronous (Lowenthal, Borup, West & Archambault,



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2020) content presentation has been used extensively in online environments during the pandemic process. Ministry of National Education (MoNE) has tried to carry out the lessons prepared within the framework of distance education activities for around 18 million students in our country through EBA TV, EBA live lessons and EBA academic support applications (Sözen, 2020). MoNE has been working on the use of digital technologies in education for a long time. In this context, the Movement to Increase Opportunities and Improve Technology (FATİH) Project started to be implemented in pilot schools in 2012. For this purpose, studies such as making internet access available to all schools and dissemination of information technology classes have been carried out for the use and dissemination of new technologies in education (Işık and Bahat, 2021).

Digital Games and Education

In this study, a digital game was developed to teach the subject of Climate Change using Unity, one of the digital game development platforms. Anastasiadis, Lampropoulos and Siakas (2018) new generation of students has been significantly influenced by the digital age and constantly uses Information and Communication Technologies (ICT) in their daily lives. Digital game-based learning provides further benefits for enhancing students' learning experience and improving learning and teaching procedures, while promoting active interaction and communication between students and educators. Greenfield (1996) reached four basic conclusions in his research with students aged 12-16 playing adventure games with students aged 12-16: a) Video games help develop strategies for reading three-dimensional images. b) They help improve learning through observation and hypothesis testing. c) They expand the understanding of scientific simulations. d) They increase parallel attention strategies. Gros (2007), video games are useful tools for learning and gaining knowledge of certain strategies. They also enhance the learning that is characteristic of the culture of the information society, and this learning is likely to have long-term consequences. Although entertainment is the first factor that attracts people to spend long hours playing games, effective principles and/or approaches in game design facilitate and

engage positive learning outcomes (Gee, 2007; Li and Tsai, 2013). Digital games provide engaging experiences, interactive learning environments and collaborative learning activities; therefore, they have greatly increased in popularity in recent years (Squire, 2002; Squire, Giovanetto, Devane, and Durga, 2005). As it can be understood from the literature, in recent years, more and more technology and its elements have been allocated in education. Digital games will play an important role in the teaching processes of the course of science in order to teach students the subject and its content that are difficult to learn and to have fun while learning.

Scope of the Study

Within the scope of this study, a digital game about climate change, which has become increasingly important in recent years, has been developed by utilizing Unity, one of the digital game development platforms. Unity, like other "game engines", is a "software framework", or set of tools for developers that simplifies rendering, physics, and input, and frees them from creating sandboxes from scratch.

Many studies have been published so far on the creation of games in computer classes, literature. Most of these studies are concerned with how games can be highly motivating to teach computer science subjects, particularly in software engineering, virtual reality, and computer languages (Ward, 2008). The Unity Game Development Environment, a popular game development platform, is rarely used in computer classes. Although Unity is used in education after high school, it has been determined that it is rarely used for students aged 14-16 (Comber, Mayer, Motschnig, & Haselberger, 2019). With this research, it is aimed to teach climate change and related concepts with a digital game developed using Unity platform for primary school students. When the literature is examined, the content within the scope of this research that may be directly related to climate change at primary school level has not been found.

Game Content: Stop Climate Change

Login page

This page is the one that appears when we first open the game. As seen in Figure 1, there are three choices on this page. The main song of the game plays here, as well. On this page, we can start the game, adjust the volume of the music, and exit the game.

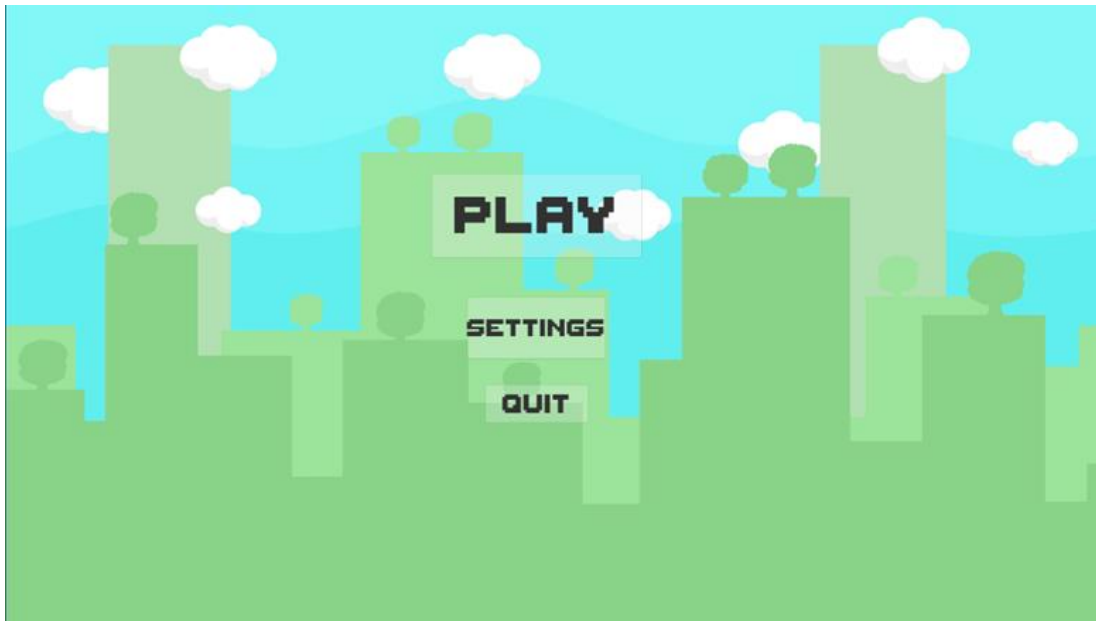


Figure 1. Main screen of the game (login page)

As seen in figure 1, selecting “Quit” allows us to close the game. When “Settings” is selected, we see the screen displayed in figure 2. We can adjust the volume of the music of the game or turn the music on and off. Pulling the bar to the right increases the volume, while pulling it to the left decreases the volume. We can return to the home screen by selecting “Main Menu.”

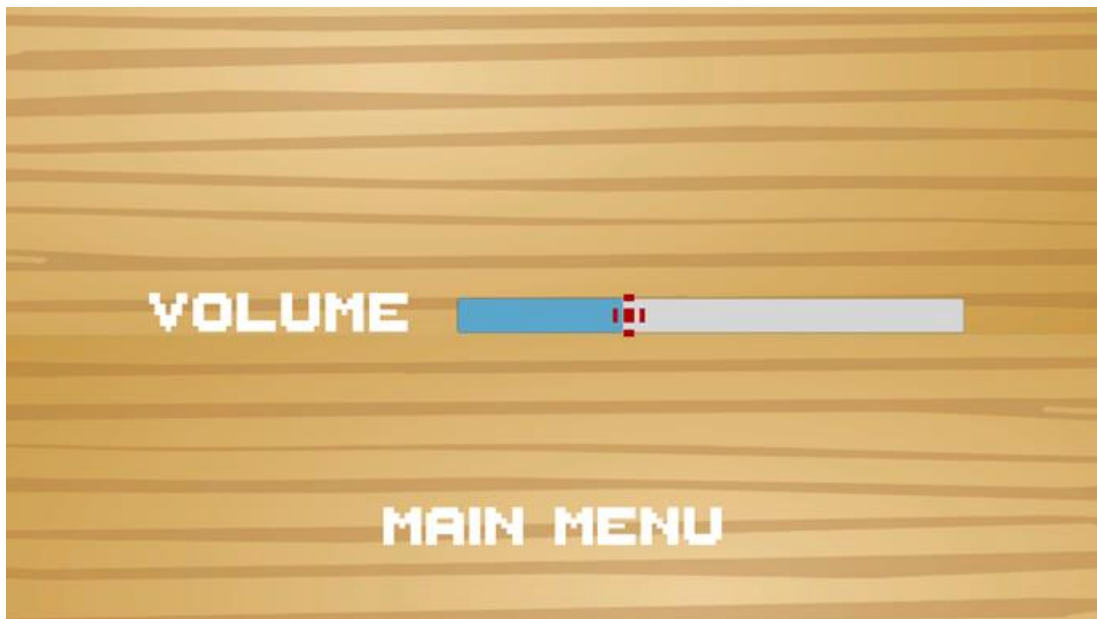


Figure 2. The settings screen

As seen in figure 3, when “Play” is selected, three different questions and an additional level are displayed. The questions lead to the relevant levels. On this screen, there are visuals that will help in understanding what global warming is, including CO₂, Earth and a thermometer, the Sun, and a tree.



Figure 3. The level selection screen

The player can go to the desired level of the game by clicking on the relevant question on this screen. The order of the questions and the related levels is chronological. The first question is “Why is climate change happening?” In this level, the player is informed about the causes of climate change. The second question is “What happens in the process of climate change?” In this level, the player is informed about what happens during the process of climate change and the results through visuals and gameplay. The third question is “What can we do to prevent global warming?” In this level, there is information about how we can prevent global warming and the wasting of energy sources with visuals and platform elements. In the Green World level, a green and beautiful world, which we could obtain if we prevent global warming, is depicted for the player. The player does not need to pass a previous level to move on to the next one. As levels are finished, the player is directed back to the level selection screen. It will be more beneficial for the player to proceed in chronological order, but the level selection screen nevertheless allows players to choose levels in any preferred order.

Process of the Game

In a game, game elements form the infrastructure of the game. This infrastructure affects the playing of the game and provides communication with the player. While playing the game, the player plays according to the existing game mechanics. These mechanics are different for Windows, Android, and iOS platforms. Gameplay mechanics include features such as the character’s movements, jumping, and interactions with other elements.

Non-touch Devices

In Windows, we use the mouse cursor to press buttons in the game. After placing the mouse cursor on the button that we want to press, we select it by pressing the left mouse button. For example, when we open the game, we move the mouse cursor over

the word “Play” on the screen and left-click, and then the level selection screen appears. We can move our character to the left by pressing the A key on the keyboard and to the right with the D key. With the space key, we can make our character jump.

Touch Devices

To press buttons on mobile devices, clicking is enough. For example, when we open the game and click on “Play” on the screen that appears, the level selection screen then appears.

Joystick usage will be helpful at this point, as mobile devices do not have a keyboard for making the character move. We can control the character with the joystick in the lower left corner as seen in figure 4. When the joystick is moved to the left, we move the character to the left, and the character moves to the right when the joystick is moved to the right. When we pull the joystick up, the character makes a jumping movement.

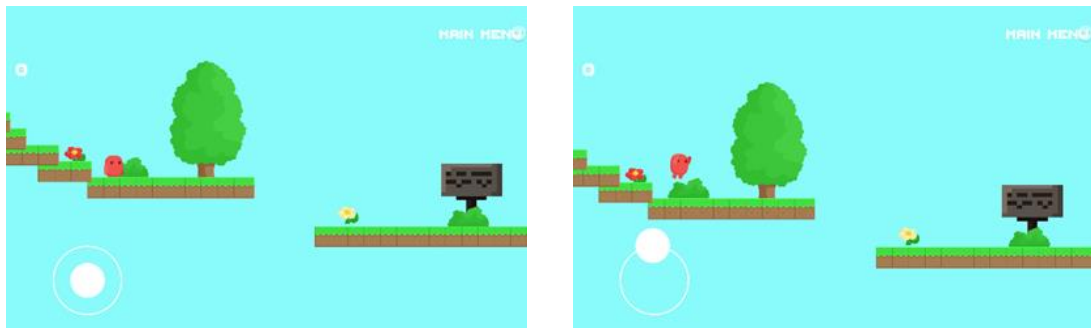


Figure 4. The joystick is visible in the bottom left of the screen. In the figure on the right, the character is jumping

Game Items and Features

There are four different levels in the game. Figure 4 presents an image from the “Green World” level. We can return to the main screen with the “Main Menu” button, which appears in the upper right in figure 5. We can exit the game from that screen or we can

adjust the volume from the settings section of the game. To change the level, we can choose a new level after selecting “Play” from the main menu.

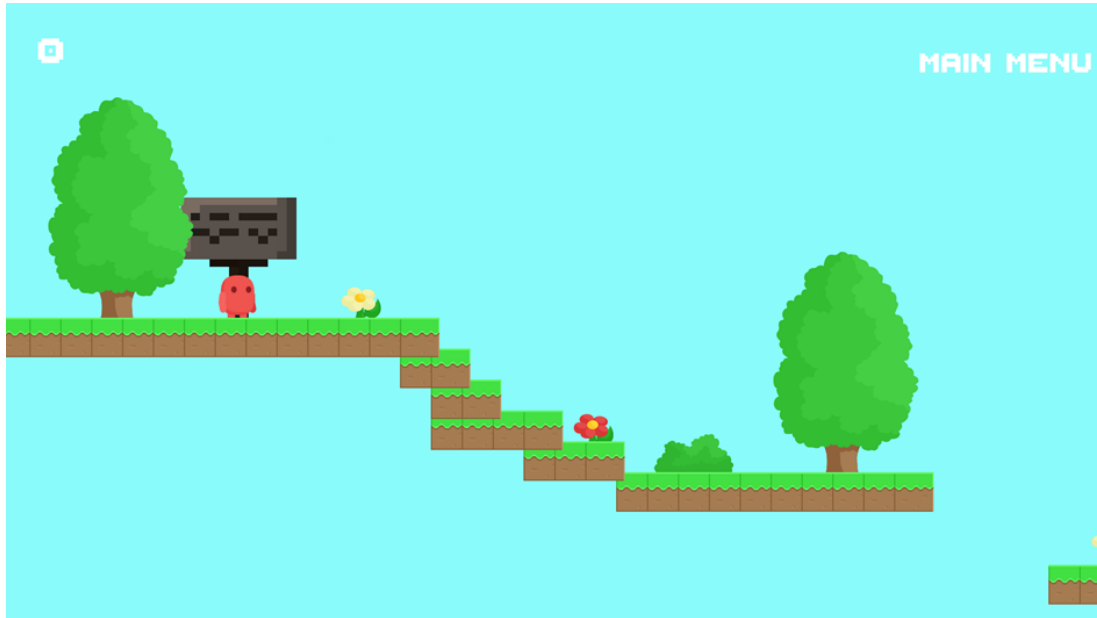


Figure 5. Game items

Character

The red object in figure 5 standing next to the tree and in front of the sign is the main character of the game. The player brings life to this character by directing him. The player passes through the selected level by moving the character left and right and making him jump. If the main character does not move, the game cannot be played. Therefore, the most important character of the game is the main character. His name is Emre and he represents the player. The target audience for the game comprises children aged 6-12 years.

Scoring System

The number “0” initially appears on the scoreboard in the upper left of the screen. In the game, there are trees for acquiring a score in each level. As trees are collected, 5 points are added to the scoreboard. The reason for using this scoring system is to offer

a competitive element for players. In the game, tree numbers vary from level to level. In the first level there are 5 trees, so for the first level, the total possible maximum score is 25 points. For the second level, there are 6 trees, so the total possible maximum score is 30 points. For the third level, there are 4 trees, so the total possible maximum score is 20 points. Players can compete with each other using this scoring system.

In figure 6, there is a tree that the character will get, and in figure 7, in the upper left the scoreboard total is seen to have increased. More than one of these objects can be found in each level. Since there is more than one, players can compare scores among themselves.

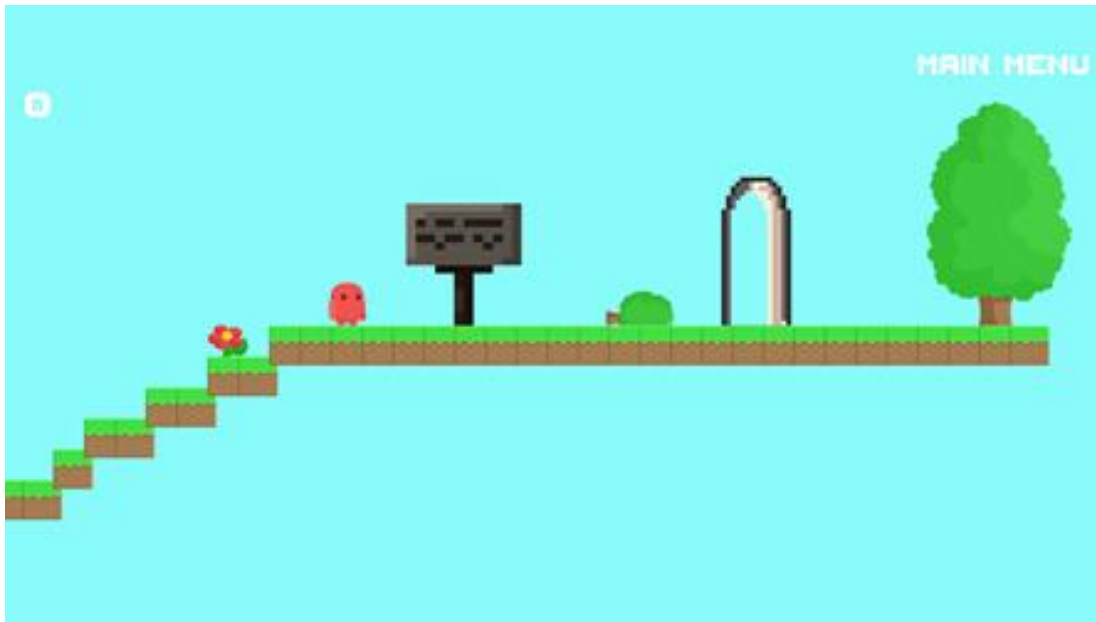


Figure 6. Before getting tree for points

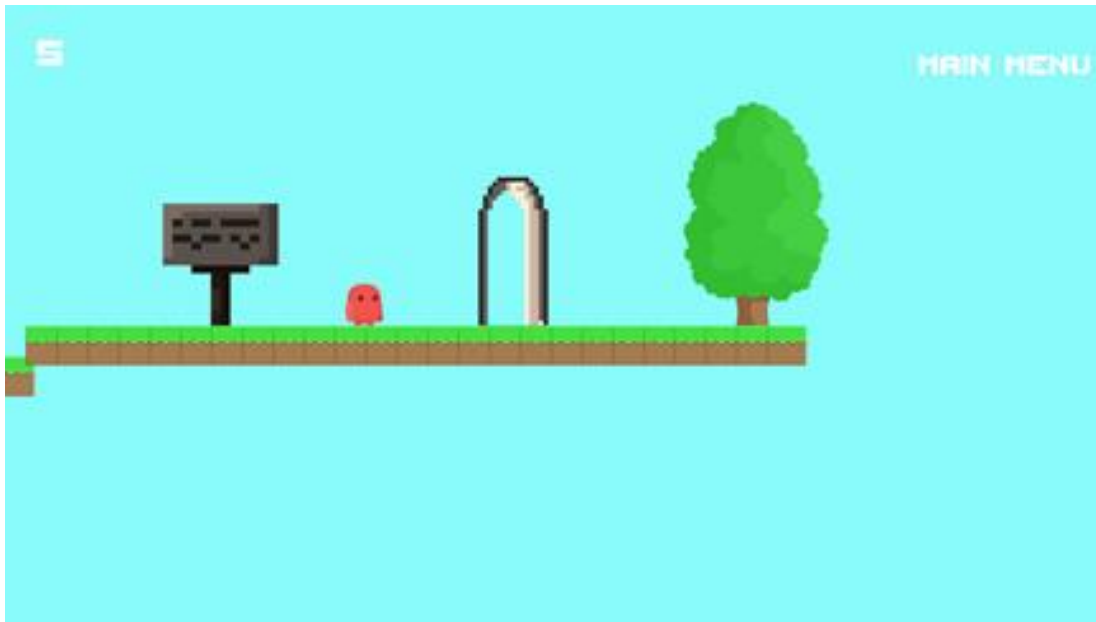


Figure 7. After getting tree for points

Portal

The portal seen in figure 6 and figure 7 is visible at the end of each level. This portal functions as a door and is located at the end of the level. The player must pass through the portal to finish the level. The level cannot be completed without going through the portal. The character returns to the level selection screen after passing through the portal and can then move on to the next desired level. The aim of the game is to reach all four portals by completing the four levels.

Elimination and Restarting

When we touch certain objects in the game, we get burned. When we are burned, we encounter the screen shown in figure 8. These objects vary from level to level. When the main character (Emre) touches these objects, he is eliminated. The game restarts when the green “Restart” button is pressed under the text that appears on the screen after the character is burned by one of these objects. Pressing “Restart” resets the scoreboard and the character returns to the first part of the game. The game is entered

again from the level selection screen and the player tries again from the beginning to score points and reach the portal at the end of the level.

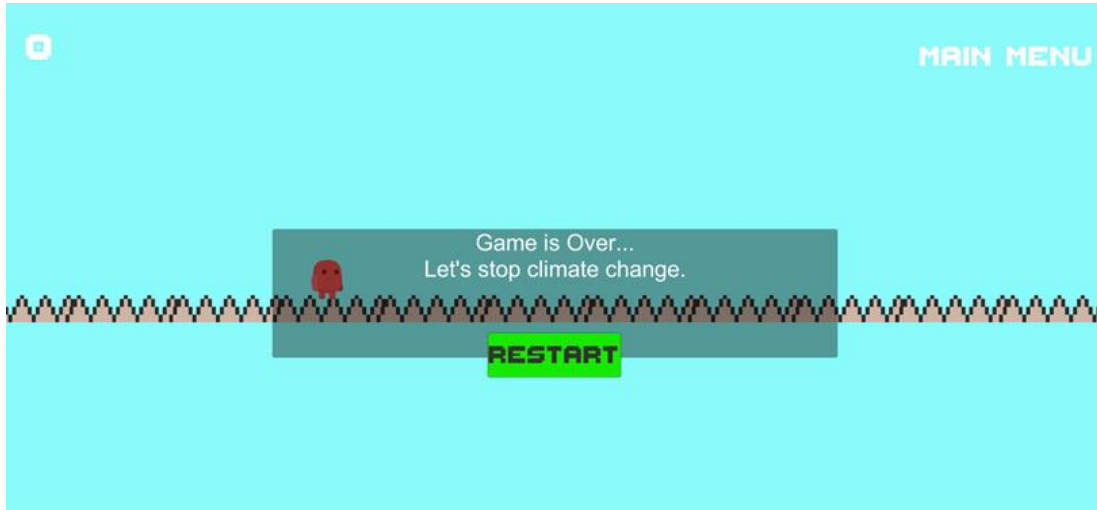


Figure 8. When the main character eliminated

Sign System

The sign system in the game is the game's most important element after the main character. The signs contain the educational aspects of the game and convey information to the students. When Emre comes in front of a sign, the text written on the sign can be seen in a bubble that appears below it on the screen. These texts vary from level to level and they provide answers to the questions asked for each level. For example, one level asks "Why is climate change happening?" In this level, information about the causes of climate change is accordingly given on the signs. As seen in the example in figure 9, when the character stands in front of a sign, the informative text opens in a bubble at the bottom of the screen. It is important for players to read the contents of these signs and be informed about the concept of climate change.

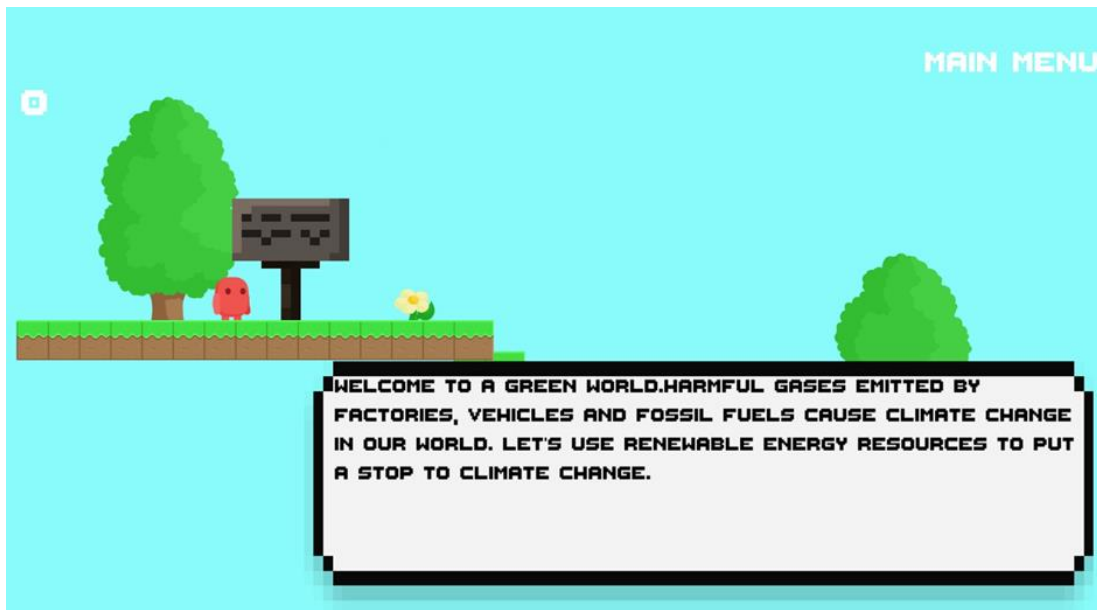


Figure 9. When the main character is in front of a sign

Game Levels

“Why is Climate Change Happening?”

The theme of this level, which is the first level of the game, is as follows: People are increasing Earth’s climate change and temperature by using fossil fuels. This adds to the large amounts of greenhouse gases in the atmosphere, increasing the greenhouse effect and causing global warming. To explain these factors that cause climate change, background images and a gray theme are used in this level to emphasize air pollution and the release of toxic gases into the atmosphere. In addition, the platform elements in this level are gray. In figure 10, toxic CO₂ and CO gases are seen in the cloud in the background, and the construction of factories can be seen at the rear. Later in this level, the player will encounter items more closely related to real life. In figure 11, the character is seen interacting with vehicles waiting to buy gas at a gas station and he must make his way through these vehicles. City elements are seen in the background, placed there to help build this feeling of pollution. The player earns points by finding trees in this section. The scores earned here do not change the course of the game but will allow the player to compare points in conversations with other players. The level

continues until the character enters the portal. The player will gain information from the signs in this level. The name of the level on the signs is “Why is climate change happening?” This question is answered by the signs. The player gets information on this subject in the bubbles that appear at the bottom of the screen whenever the character comes in front of a sign.

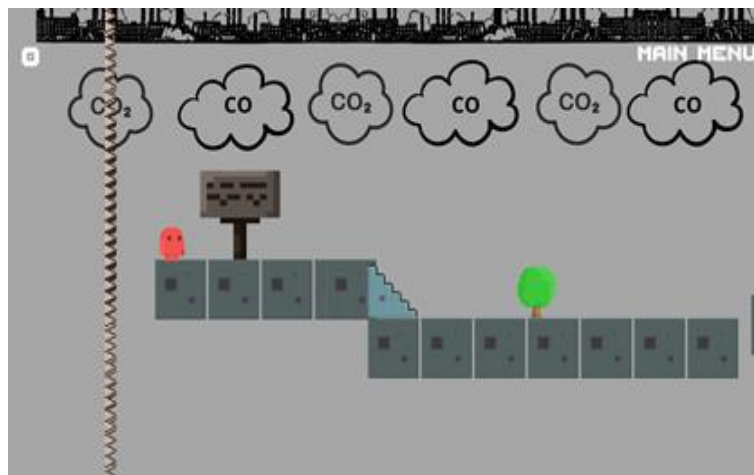


Figure 10. Starting point for this level



Figure 11. The character interacts with objects

“What Happens in the Process of Climate Change?”

When we move on to the second level, we deal with the increase in the greenhouse effect due to the presence of water vapor, carbon dioxide, methane, nitrogen oxides, and other greenhouse gases in the lower atmosphere of the Earth in the process known as global warming. Students will begin to learn about the factors that cause global warming and concepts related to climate change as a result of global warming. This level contains two parts. In the first part, the increasing temperatures in the world are mentioned together with the greenhouse effect, urban development, and resulting desertification. In the second part, the melting of glaciers due to increasing temperatures and the negative situations caused by this melting are addressed.

In the first part, a background reminiscent of desert dust, which may arise due to desertification, is used. A platform with brown tones is used to match the background. At the same time, if the character touches a white box, the character will be eliminated. The “Restart” message will then appear. These white boxes are seen in the upper part of figure 12; the character is standing on the platform there.

In the second part, the melting glaciers turn into water in the background due to the increase in temperatures, and a snowy environment and a cold blue more suitable for this theme are used in the background. If the character falls into the water, he will be eliminated. In figure 13, the water and the snowy environment are seen. The player earns points by finding trees in the first and second parts. The scores earned in this way do not change the course of the game but will allow the player to compare points with other players. The score in the first part is carried over into the second part, and this level continues until the character enters the portal. The player receives information from the signs, as in the previous level. The name of the level on the signs is “What’s going on in the global warming process?” This question is answered as the player accesses information on the subject in the bubbles that appear at the bottom of the screen whenever Emre stands in front of the signs. In the first part, information about desertification and the excessive use of concrete is given on the signs together with information on the efficient use of water. In the second part, the signs address the melting of glaciers and the resultant dangers that the world will face.

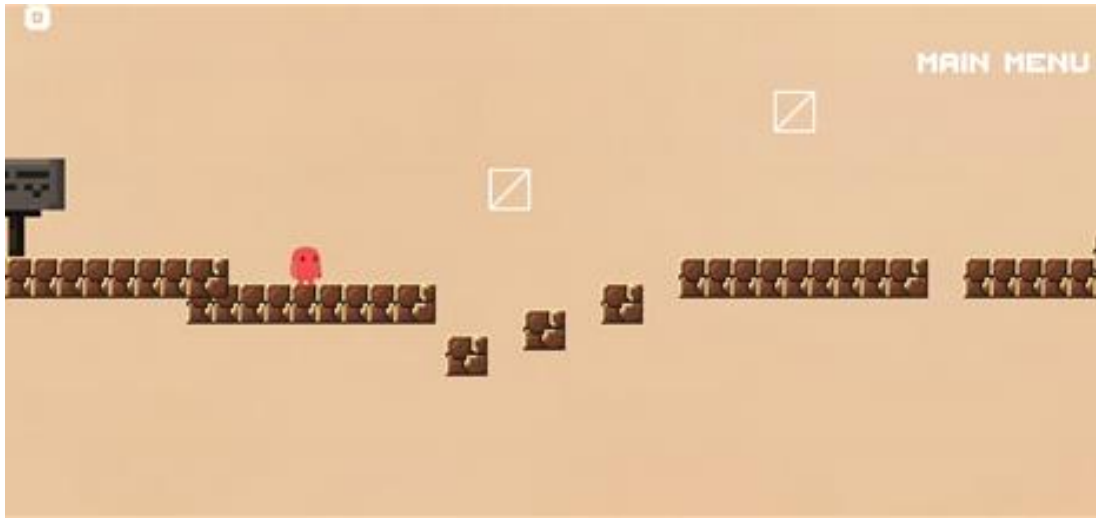


Figure 12. Image from the first part and the starting point of the level

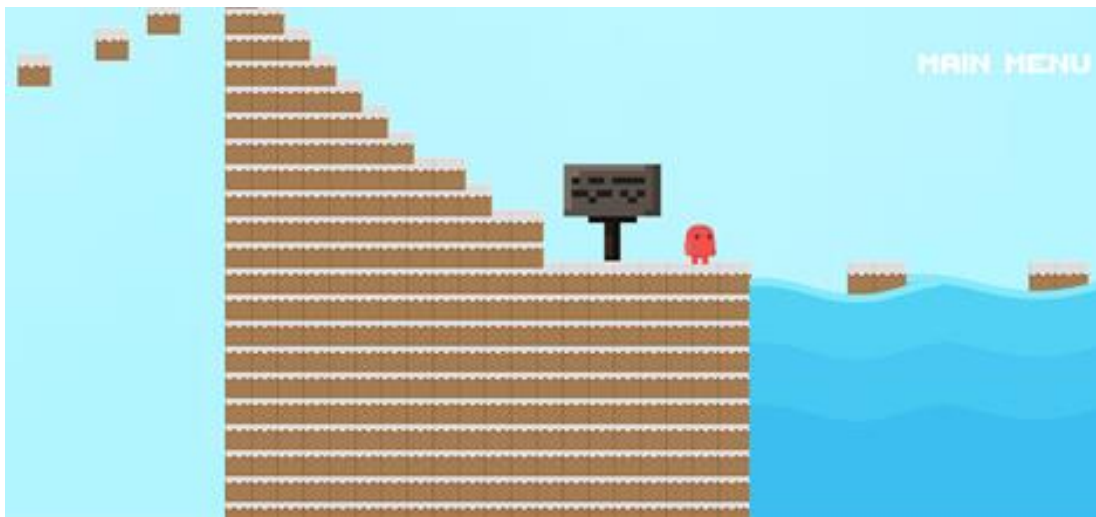


Figure 13. Image from the second part

“What Can We Do to Prevent Global Warming?”

As we move on to the third level of the game, attention is drawn to elements that are solutions to the problem of global warming caused by the emergence of greenhouse gases. In this way, students will understand that if the factors causing global warming are eliminated and/or reduced, the negative effects of climate change will also be decreased. Looking at the game’s theme, we see solutions suggested to solve this

problem. For example, rather than using fossil fuels that produce harmful gases, the importance of finding solutions with renewable energy sources depicted in the background of the game is shown in this level. We have many natural energy sources such as wind, water, and solar power that we can use without harming nature. Reducing the use of fossil fuels and preferring renewable energy sources will reduce harmful gas emissions into the air. This will be extremely beneficial for us in preventing global warming.

To show the importance of renewable energy sources, wind turbines, water energy, and solar panels appear in the background in this level. In this level, we can first pass over the wind turbines; if we fall, there is a possibility of passing them from below. Afterwards, we pass through the part where water energy is produced. In this part, the character is eliminated if he falls into the water. Next come the solar panels. In these parts, as players interact with these objects, they will learn more detailed information about renewable energy sources. The water energy part is shown in figure 14.

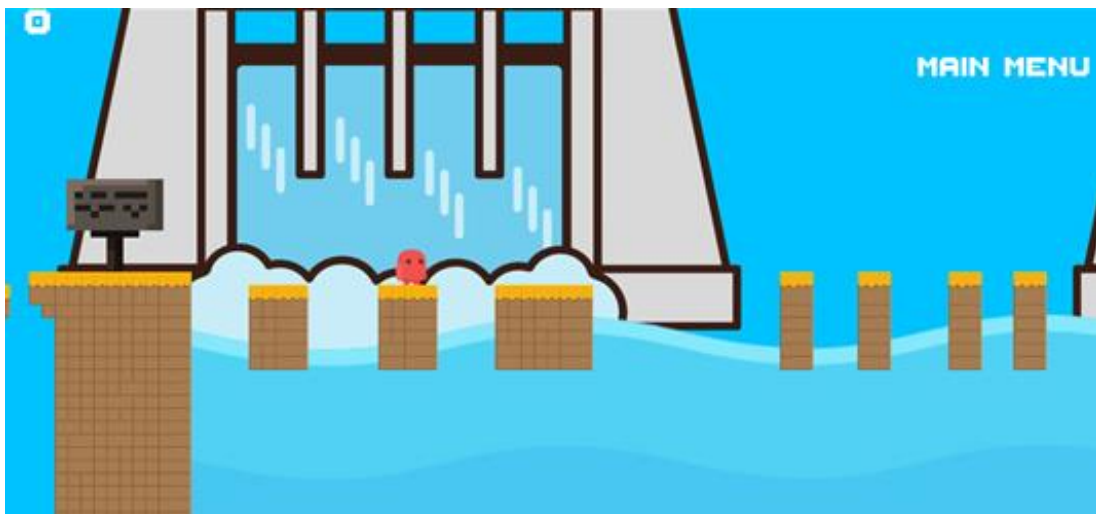


Figure 14. Main character in the part of this level addressing water energy

The player earns points by finding trees in this level. Again, the score will not change the course of the game, but players can compare their scores among themselves. The level continues until the character enters the portal.

The player gains information from the signs in this level, which are titled “How can we prevent global warming?” This question is answered when the character accesses information from bubbles that appear at the bottom of the screen upon standing in front of the signs. The signs contain information about renewable energy sources. Each time the player comes to a new renewable energy source in this level, information about that source is provided.

“A Green World”

The aim of this level, the final level of the game, is to present students with a depiction of a world where climate change has been prevented. Through this comparison, an effort is made to create environmental awareness among the players by prioritizing the beauty and naturalness of a world without global warming. In this level, the player encounters easier gameplay compared to other sections. This level is intentionally easier and shorter to make the player feel that a world without global warming will be comfortable and simpler. The trees, flowers, and greenery in the design of this level facilitate that feeling.

The player gains points by finding a tree in this section. A deal is offered to the player in the text written on a sign before the player claims the tree. A better future is offered in this deal. The level continues until the character enters the portal.

The player will obtain information from the signs in this level. While making reference to the previous levels on the signs, the concept of a green world is presented. The character can access information on this subject from the bubbles that appear at the bottom of the screen upon standing in front of the signs.

Conclusion

In recent years, when distance education activities have increased rapidly with the Covid-19 pandemic, we see that technology and technological applications have found

more place in the teaching processes. In this context, applications such as Zoom, Teamlink, Google Meet, Adobe Connect and Webex have been frequently used as teaching-learning tools in distance education. In the distance education processes, various video tools such as Udemty and Khan Academy, which have educational content, were also used during the period when students were away from school. In these applications and in science teaching with the help of tools, a more synchronized distance education activity was carried out. This digital game about climate change, which aims to teach climate change to students by endearing it to students, can be considered more as an asynchronous distance education activity. Thus, it is aimed that students can both play the game and have fun in the process while they are learning climate change and related concepts, independently of each other, at any time and with the help of a smart device they want. The aspect of this digital content developed using the Unity platform, which distinguishes it from other applications, is that students are active while learning the subject and concepts related to the subject.

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