The Effects: Game for Climate Change

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Abstract— **It is vital to create a virtual survival simulation that depicts life after the climatic catastrophe since society ignores the effects of climate change. In this paper, we will create a gaming model that illustrates the difficulties of surviving in three various environments, including glaciers, islands, and massive expanses of farm land. We have discussed various approaches to creating a model and making it available to all participants by utilizing them. We may draw conclusions about our findings and establish that our model performs better than the other models by comparing it to other models.**

Keywords—Role-playing game, Game-based learning, Climate change, Sustainability, Diverse landscapes

I. INTRODUCTION

Climate change has emerged as one of the most pressing issues confronting humanity in recent years [1]. The Intergovernmental Panel on Climate Change (IPCC) of the United Nations has reported that the Earth's climate is constantly changing, such as the temperature rising and the current rate of change is unprecedented which also has severe consequences for both the environment and human society. In addition to the obvious effects of climate change, severe storms, and droughts, there are additional grave ramifications including higher extinction rates of species, health hazards, as well as poverty, and displaced populations. Public education on climate change is becoming more important in motivating people to take action.

Higher education has increasingly incorporated serious games across various subject areas, from economics and intercultural communication to civil engineering and building services[2]. Serious games have a huge potential to improve student enjoyment of learning[1]. These are fully functional games that go beyond simple entertainment and offer enjoyable, beneficial experiences while achieving significant goals (such as education or behaviour modification)[3]. Also, they could seek to favourably impact people's decisions and habits in actual situations[4].

Climate change games have become a viable method for educating about their effects in recent years. The majority of prior studies have found a connection between playing serious games and motivating effects. In educational settings, the study is further supported by favourable behaviour outcomes[3]. Games may be able to engage people in a manner that more conventional instructional methods may not be able to.

Games about climate change can also foster empathy and emotional connection to the problem, which can be a strong incentive for action. For instance, Ro et al.[7] discovered that engaging in a game-based sustainability intervention led to a long-term shift in sustainability-related behaviours, such as considerably lower home power use six months later.

In further sections, we introduce our game: "The Effect", a cutting-edge serious game that aims to educate players on the severity of the climate problem. Our game's premise is to inform players about the gravitas of the climate change problem through the use of dynamic landscapes that show the effects of climate change. By combining a realistic graphical environment with exploration contents, players visualize the highlights of the severity of climate catastrophe, and in doing so, boost the player's pro-environmental views and sustainable conduct in the real world.

II. METHODOLOGIES

Several game engines enable creators to develop their own exclusive games. Unity and Unreal Engine are two well-known popular game engines. These engines are user-friendly and accessible due to their numerous features, plug-ins, and tools. The Unity-created games were playable, user-friendly (in comparison to the lags and bugs in Unreal Engine), and available for both multi-platforms (Windows, Mac, and even Linux) and for older computer versions. The interfaces of Unreal and Unity are quite similar. Nevertheless, as compared to Unreal, Unity provides stronger tools for creating objects, models, and animation that are easier to use [6]. Moreover, it supports C# programming, that supports drag-and-drop (better than scripting in Unreal Engine), and offers several rendering pipelines [7, 10]. It includes physics libraries and facilities for dealing with enormous volumes of geographical data, which contributes to the game's realism [10]. As a result, we will be building our model in Unity.

To improve the visualization content, Unity provides tools for creating static and dynamic virtual objects. Their asset store includes an enormous variety of external tools and items that are compatible with Unity. Terrain tools are one of the most significant tools for creating environments. We would get a realistic output for the total topography if we used real-world coordinates and applied them to terrain coordinates. Coordinates like latitude and longitude can aid in producing a more detailed environment. To get precise elevations, we may also use satellite pictures and overlay them on top of the terrain surface. Using readily accessible 3d assets from SketchUp and other sources helps to cut down on development time even further [5]. Autodesk Maya is frequently used by artists because of its spectacular modeling, animation, and rendering tools. The models can only be used together if they were developed using the same version. Varieties of UV layouts are available in Maya that can be used to improve the resolution of an asset. Depending on the file format, texture templates are easily accessible online and may be utilized for a range of 3D models in Unity. Animations have a cinematic impression, especially when the camera moves. Using keyframes in the Animation tab, a character's skeletal construction helps create a movement that seems natural. Unity gives artists the ability to adjust lighting preferences and "bake" those changes right into the scene tab [9].

Satellite images can define the density and the temperature within each region [8]. To achieve realism, the geospatial data obtained from such images are used [11]. Our landscape will be classified into three terrains: glaciers, islands, and farmland. The interface includes terrain brushes for creating sharper or more subtle glaciers. We can also add snow effects to the environment by using the "Global Snow" in-build script and applying icy-glass sprite textures directly to the glacier objects. The built-in script "Shape Gerstner batch" allows us to generate waves, enhance the material's reflectivity, and create wavy meshes for the ocean. By changing the inspector settings, we can produce higher waves. After shaping the island landscape, we may paint it to mimic existing textures (such as sand texture near the ocean and a green grassy texture in the Midlands). Moreover, there are options for bringing details like wind, shadows, music, and animations into our landscape, as well as trees, grass, and even animals (animals walking, hunting, attacking, etc.). Using Maya, we can give our creatures' lifelike movement. The interface includes an animation panel, which we can utilize to make little modifications within each keyframe to produce an overall smooth animation. We can build the structure of an animal using poly modeling tools with photos as references. Lastly, farmland similar to that of the island terrain can be built. Structures such as factories and underwater bases can be constructed with Unity Probuilder, which allows us to design both the interior as well as the exterior. Lastly, particle systems in Unity would be utilized to generate smoke effects.

III. SYSTEM ARCHITECTURE

In this section, the system architecture is explained using the game's designed flow. This section gives players more information about the game's flow by thoroughly outlining each step. This part serves as a reference for comprehending the game and aids in knowing the numerous rules and regulations.
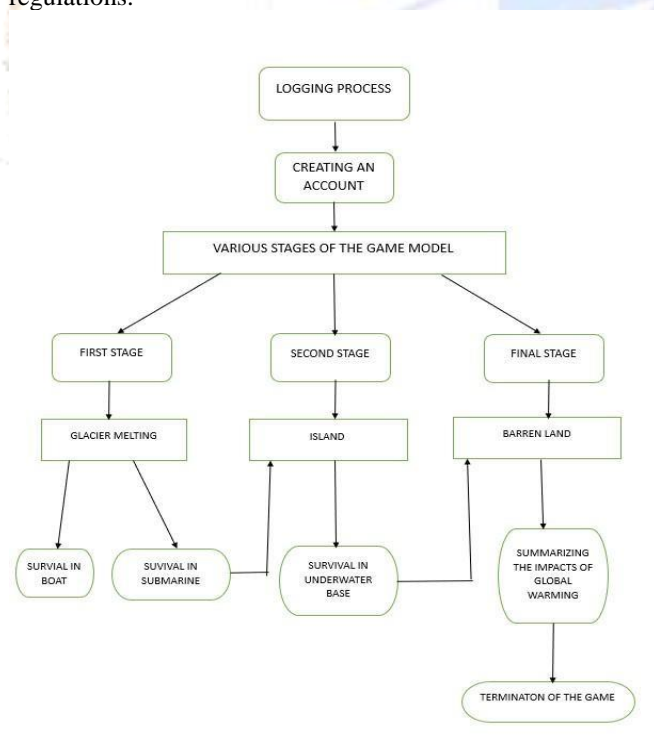

Fig. 4. Game design flowchart

"Fig. 4" portrays how the game is designed to flow. The player may choose to experience at any stage in the menu. Based upon their choices, the player would stay in the scene (they may choose to exit after viewing) or they would be automatically loaded in the next scene. During the transitions between scenes, various cinematic animations would be played to highlight how they are going to the next level. On conclusion of the final level, cut scene would be played. It would give players the summary of what they experienced, how close to reality this application is and what knowledge they gained. Finally, an info scene must be displayed to help players understand how they can prevent such effects from worsening.

A. Logging into the Model

By establishing a secure gaming environment and confirming that the game is still active, this login process will assist the user. The end user must create an account so that detailed information about the user will be saved. If the user creates the account, then the user may take part in various game interactions. Additionally, it adds various links that could enable them to build a large environment and contribute a quicker resolution towards the challenges.

B. Structure

The model is represented in a 3D virtual environment. It has a variety of realistic- environments, highly graphic avatars, and a limited number of escape mechanisms for the difficult effects. The end-user will also benefit from the interactions and get some ideas on how to resolve the problem. In order to get the most out of each setting, the end user will have to complete specific tasks and stages. In order to make the game more engaging, the model will primarily consist of three main stages where the player must fulfill the tasks.

C. First Stage

The end user will be placed in an environment where the glacier is melting after the login process is complete. "Fig. 1" is a graphical drawing of the glacier terrain. They will be assigned duties such as studying the situation around them to determine if there is any kind of escape strategy to increase their survival chances. The model will offer a few built-in solutions, which are available when tasks are completed. The options are being able to survive in a boat or a submarine. The players will be able to picture the glaciers melting away if they select the survival option boat. If the player opts to survive in the submarine, they may be able to observe the hurdles faced by aquatic life. Depending on how quickly the user resolves the issue, the higher their survival chances.

D. Second Stage

After stage one is complete, the next level is loaded into the game scene. The following stage is presented in a polluted island setting in which the rise in water level is clearly visible. The polluted island is represented in "Fig. 2". In these circumstances, they might have trouble surviving. Similar to the previous stage, survival options would be given (such as choosing to stay on the island or transporting themselves to a safer mainland). To extend the life duration on that island, benefits similar to how to survive in a built-in underwater base. The base may offer a setting that is akin to the actual

world. This foundation will provide defense against water pressure and waves, and it will not interfere with aquatic life.

E. Final Stage

Upon completion of the second stage, the third stage consists of a barren landscape without abundant nutrient-rich vegetation. This topography has difficulties, such as a lack of cultivable land and drinkable water. The challenges of survival are therefore thought to be insurmountable. This phase aims to improve user comprehension of the numerous implications of global warming. Enabling players to recognise the effects portrayed in these three stages can lead them to prevent global warming as much as possible. The user may now understand why it is important to take the implications of global warming seriously.
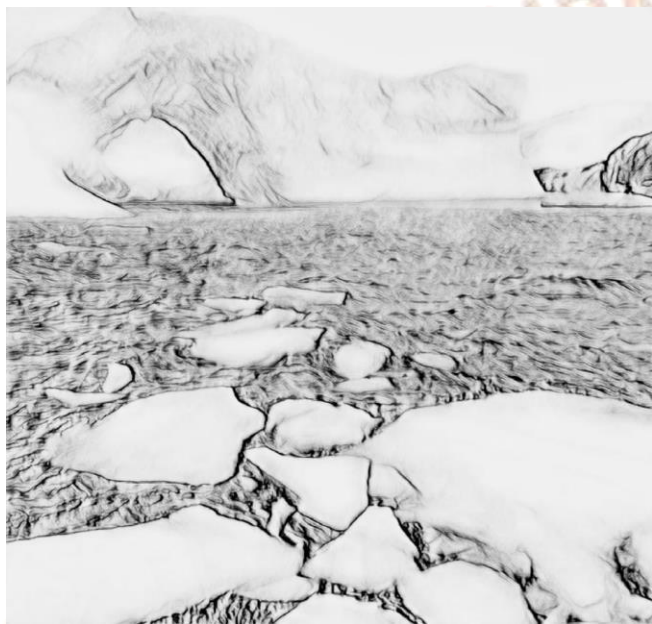

Fig. 1. Stage one contains glacier terrain. (*Melting Glacier*)

"Fig. 1" is a perfect diagram to showcase the type of 3D virtual world that players would experience at stage one. Player would spawn in a stable glacier and it would also melt off along with player experiencing such phenomena.

Fig. 2. Stage two has polluted and soon-to-be submerged island (*Island in verge of destruction*)

"Fig. 2" displays the island that the player travels to through the submarine. It is at the verge of submerging due

to the drastic increase in sea levels. The melted glaciers directly influence the water level.

Fig. 3. Final stage represent agricultural lands with factories (*Farmland with factories*)

"Fig. 3" depicts how farmlands can no longer be used to cultivate crops due to the effects of climate change. The climate change is increased due to the air pollution by the factories. This affects other attributes in the farmland terrain such as water, soil and even variability in temperature.

IV. PURPOSE

In a 3D virtual realm, our model attempts to raise public awareness about the impacts of post-global warming. It mostly consists of different remarkable changes such as ice sheet melting, temperature fluctuation, and sea level rise. Users would not only be confined to observing such events, but they would also be provided particular interactions to improve their odds of surviving. Missions would be an important component of our paradigm for this goal. The tasks allowed users to pick how they wished to survive. As a result, extending their lifeline should be the primary focus. We chose to include a plot into our game in order to develop an effective awareness model.

Our objective throughout this simulation is to illustrate how difficult survival may be in a climatic catastrophe. The application's direct message is to raise awareness about the impacts of global warming and why it should be avoided.

This model can run on a variety of platforms, making it available to practically everyone with access to the internet. These applications might be beneficial to academic institutions, museums, and even research labs. The gameplay allows students to learn. The app is also available to all visitors to the museum. It may also be used by researchers to test the application for future studies on climate change and how far it has already influenced our globe. This may also aid in the study of psychology, since researchers may examine how people react to such situations and why they choose specific survival decisions. Additional research might help us understand if people are capable of living in these settings and what they need to do so.

V. MODEL COMPARISON

There are several gaming models whose main focus is to depict climate change. They were able to achieve their core emphasis despite being depicted in numerous forms such as 2D and VR. They are also available to the general public via different channels such as websites or video gaming platforms. These games were primarily aimed at students, politicians, and the general public. Its primary mission is to engage the public in environmental learning and to support groups trying to reduce global warming [15].

A. Climate Adaptation Game

SHMI created the Climate Adaptation Game (Swedish Meteorological and Hydrological Institute). Their goal was to equip high school students and government leaders with a game to complement their recent work on climate adaptation. Furthermore, their goal was to provide adaptation practice through gaming content in order to improve student understanding. They were also attempting to persuade ordinary people to contribute to the achievement of sustainable development goals. The game is designed for usage on websites, while its equivalent is developed by a Minecraft mod. The one on the internet is the original and has been published. Although being static, it offers a variety of qualities and clickable features for players to actively engage with. Players can select numerous alternatives and their effects to demonstrate the advantages and drawbacks of such acts [15].

B. Heated Escape

The VR game Heated Escape is one of the climate change games with a similar idea to escape rooms. They provide a variety of interactive puzzles for users to complete in exchange for knowledge about climate change. They offer a variety of narrative and auditory elements that enhance the overall experience. Additional elements such as time ticking have also provided a sense of urgency to their puzzle game, driving players to finish within the time limit. These puzzles are designed to educate players based on specific environmental information. Their major purpose is to influence player behavior towards climate change and deliver a good conclusion at the end of the game in which the players in the dystopian society were able to save the planet due to their effective solution of the climate change problems. Not only is the finale inspiring, but it also encourages individuals to engage in environmentally responsible activities in real life [1].

C. The Effect

Our game offers the users a number of benefits that are promising when it comes to raising awareness about climate change. First, one of the biggest advantages is that the player may make their own decisions in a disastrous environment. Second, based on the decision they have made, the player may be able to observe how that choice will impact the subsequent scenario in the setting. They are able to witness the way their choices will play out in the future. Also some of the built-in options are provided by the model. Then ultimately, when they go to the next terrain, they may be able to witness the significant impact of climate change in that terrain.

D. The Effect vs Heated Escape

To gain perspective on certain features and identify the gaps for future study, it is helpful to compare existing frameworks and models with one another. "Heated Escape" is a scenario based role-playing game that centers on climate change, but by contrasting it to "The Effect", we can say that it lacks customization. This is because the scenarios are predetermined, which means that the players may not have as much freedom to make decisions that have a big impact on the gameplay or outcome. On the contrary "The Effect" allows the players to make their own decisions. One of the key goals of playing a climate change ought to include information about the player's decision and the disaster that results from it. The "Heated Escape" lacks this functionality since it offers no further feedback on the player's choice. In contrast, our game "The Effect" shows the repercussions and the results of the player's choice as mentioned earlier. From the aforementioned, we can conclude that "The Effect" can transcend these downsides of "Heated Escape", providing many players with an engaging and educational experience.

E. The Effect vs Climate Adaptation

The "climate adaptation game" created by the SMHI is another game that will be compared. The lack of complexity in "The climate Adaptation game" oversimplifies the intricacies of climate change impacts and adaptation strategies, which may restrict the players' understanding of the challenges and solutions. "The Effect" provides a solution to this by allowing the players to experience and observe the effects of climate change. The fact that the "Climate Adaptation game" is a 2D game limits the players ability to experience how climate change impacts other environments and does not offer a rich graphical experience. It also does not allow the player to experience a different landscape because it takes place only in one environment. Hence, our game enables users to comprehend how climate affects diverse environments.

VI. GAME METRICS

The criteria under which the games are determined to be more effective and accessible are explained in this section. Game metrics are a way to better understand games by evaluating and visualizing data collected from players during playtests [12]. Game data may be used to estimate players' emotional or conceptual states, which might be used to modify training programs to enhance motivation and performance [13]. Within our gaming model, the key performance indicator is based on many elements that make players feel more at ease in the game and foster collaborative effort among players.

Metrics	Games distinguished by game metrics		
	THE EFFECT: CLIMATE CHANGE	THE HEATED ESCAPE	CLIMATE ADAPTATION GAME
Storyline	It has a story line that guides players through the game	The storyline is similar to escape rooms.	There is little to no plot that holds the audience's attention.
Scenario	It presents the situation visually in authentic surroundings.	It presents the situation in only one graphical representation	It describes a condition in which the player has complete control over all changes made to the environment.
Stimulation	It allows the user to participate and interact with the game.	It is not very engaging and interactive.	There isn't much simulation other than clicking on different icons to select which activities to perform (using in-game money)
Player's Interaction	The user can communicate with other players and use their interactions to get through obstacles	The player is made to solve puzzles to achieve solution to finish the challenge	Because it is an individual game, participants are unable to speak withone another.
Target Audience	The target audience is the younger generations, so as to raise awareness among the upcoming generations.	It targets the player for improvements in problem solving skills and decision-making.	Students and government leaders striving to adapt to climate change are the intend edaudience.
Role Play	The player's job is to overcome challenges more quickly in order to prolong their time in the game.	The main role of the player is to solve the puzzles based on climate change.	The characters only role is to govern the city and make decisions based on situations
Game Play	It offers the analysis and perspective to tackle the climatic changes brought on by the effects of global warming.	The gameplay is interactive by providing the user with solutions for completion of the given task.	Interactive by clicking the icons, spending in game coins and usingclock buttons to time-lapse. Exploration is not very possible
Game Type	It is a 3D game.	It is a 3D game.	It is a 2D game.

Fig. 5. Comparison based on Game Metrics (*Comparison table*)

"Fig. 5" depicts a table that compares different models to our current model. It helps in distinguishing the overall quality and feature of the above games using certain standard metrics [16].

VII. CONCLUSION

The educational value of our serious game has not yet been explored because this is a work in progress. We may conclude from the comparative analysis study indicated above that our game, "The Effect," is better than other games in comparison to them as well as some of their detractors. A user research study will eventually be conducted to see whether playing our game may have an impact on players' attitudes towards climate change, their goals, and their participation in sustainable activities in the real world. The game might later be simply expanded including an interactive VR component. Thus, it helps the users to gain more knowledge by enabling VR experience. Future landscape

additions might include catastrophe caused by climate change as well their collaboration with VR. Aiming to warn the player and emphasize the seriousness of the climate situation, we make a different approach that depicts the worst-case scenario of climate change.

To conclude, "The Effect" is a serious game with a defined goal, but it also offers a fun-gaming experience because of its immersion, interaction, and intriguing environment. Lastly it provides a platform for gaining more knowledge and bringing awareness among the public about the drastic effects of changing climate across our globe.

REFERENCES

[1] Barth, Lisa L., et al. "Heated Escape: A Virtual Reality Serious Game on the Urgency of the Climate Crisis." *2022 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct)*. IEEE, 2022.B. Rieder, *Engines of Order: A Mechanology of Algorithmic Techniques*. Amsterdam, Netherlands: Amsterdam Univ. Press, 2020.

[2] Wyrwa, Artur. "Climate change mitigation game." *2018 IEEE Global Engineering Education Conference (EDUCON)*. IEEE, 2018

[3] Krath, Jeanine, Linda Schürmann, and Harald FO Von Korflesch. "Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning." *Computers in Human Behavior* 125 (2021): 106963.

[4] Leal Filho, Walter, ed. *Encyclopedia of sustainability in higher education*. Cham: Springer International Publishing, 2019.

[5] Shin, Il-Sik, et al. "Development of 3D terrain visualization for navigation simulation using a Unity 3D development tool." *Journal of Advanced Marine Engineering and Technology* 39.5 (2015): 570-576.

[6] Dickson, Paul E., et al. "An experience-based comparison of unity and unreal for a stand-alone 3D game development course." *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education*. 2017.

[7] Ro, Michael, et al. "Making Cool Choices for sustainability: Testing the effectiveness of a game-based approach to promoting pro-environmental behaviors." *Journal of Environmental Psychology* 53 (2017): 20-30.

[8] Power, Sarah N., et al. "Estimating microbial mat biomass in the McMurdo Dry Valleys, Antarctica using satellite imagery and ground surveys." *Polar Biology* 43.11 (2020): 1753-1767.

[9] Labschütz, Matthias, et al. "Content creation for a 3D game with Maya and Unity 3D." *Institute of Computer Graphics and Algorithms, Vienna University of Technology* 6 (2011): 124.

[10] Craighead, Jeff, Jennifer Burke, and Robin Murphy. "Using the unity game engine to develop sarge: a case study." *Proceedings of the 2008 Simulation Workshop at the International Conference on Intelligent Robots and Systems (IROS 2008)*. Vol. 4552. 2008.

[11] Keil, Julian, et al. "Creating immersive virtual environments based on open geospatial data and game engines." *KN-Journal of Cartography and Geographic Information* 71.1 (2021): 53-65.

[12] Nelson, Mark. "Game metrics without players: Strategies for understanding game artifacts." *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*. Vol. 7. No. 3. 2011.

[13] Sevcenko, Natalia, et al. "Measuring cognitive load using in-game metrics of a serious simulation game." *Frontiers in Psychology* 12 (2021): 572437.

[14] Christopoulou, Eleftheria, and Stelios Xinogalos. "Overview and comparative analysis of game engines for desktop and mobile devices." (2017).

[15] Neset, Tina-Simone, et al. "Serious gaming for climate adaptation—Assessing the potential and challenges of a digital serious game for urban climate adaptation." *Sustainability* 12.5 (2020): 1789.

[16] Gerber, Andreas, et al. "Games on climate change: Identifying development potentials through advanced classification and game characteristics mapping." *Sustainability* 13.4 (2021): 1997.