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Empowering Disaster Education with Gamified Simulations

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Abstract–Disaster preparedness education faces challenges in engaging learners effectively. This research explores gamification, particularly utilising Unity3D, to transform disaster awareness training through an application called *Train To Survive*. Integrating gamified elements into simulations aims to create immersive experiences surpassing conventional methods. Design and development prioritise user feedback, emphasising user-centric design. Leveraging Unity3D's capabilities, simulations offer realistic scenarios fostering knowledge retention. Comparative analysis evaluates Unity3D's effectiveness in engaging users and enhancing disaster awareness. Findings underscore gamified simulations' potential to revolutionise disaster education, promoting proactive community resilience. This research contributes insights into gamification's role in disaster preparedness, advocating for Unity3D's use in creating impactful learning experiences.

Keywords—disaster awareness, gamified simulations, *Train To Survive*, Unity3D capabilities

I. INTRODUCTION

Disaster preparedness education stands as a paramount endeavour, serving as the backbone for communities to effectively mitigate the multifaceted impact of both natural and human-made calamities[1]. However, established within traditional instructional methodologies lies a notable deficiency, one that manifests in the inability to holistically engage learners and instil the breadth of knowledge requisite in this critical domain. Conventional approaches, provided by the delivery of lectures and dissemination of informational pamphlets, falter in their capacity to authentically replicate the urgency and nuanced complexity present in real-life disaster situations. Consequently, their ability in facilitating comprehensive training and fostering heightened awareness among individuals and communities alike is significantly cut down.

To address these widespread challenges head-on, this research embarks on an ambitious exploration into the transformative potential of gamification, a pioneering approach that holds promise in reshaping the landscape of disaster awareness training. Central to this endeavour is the leveraging of the Unity3D platform, an innovative tool that offers unparalleled capabilities in immersive simulation development[2]. By skillfully integrating gamified elements into carefully crafted simulations, the extensive goal is to create a new boundary in educational experiences, one that exceeds the limitations of conventional methods.

Within the body of this paper, it dives deeply into the details of designing, developing, and evaluating these groundbreaking gamified simulations[3]. The approach is underscored by an unwavering commitment to user-centric design principles, ensuring that the resulting learning experiences resonate deeply with learners of diverse backgrounds and skill levels. Leveraging the advanced features and functionalities afforded by Unity3D[4], the simulation meticulously emulates realistic disaster scenarios, meticulously recreating the difficult environments and high-stakes decision-making situations that characterise real-world crises.

Through an exhaustive process of rigorous comparative analysis, this research paper endeavours to unravel the efficacy of Unity3D-based gamification in not only captivating

II. DESIGN AND METHODOLOGY

Softwares Used

This section gives an in-depth overview of the softwares used in the design and implementation of this disaster awareness simulation. Unity3D and Blender provide the backbone for this educational project.

Unity 3D

With its intuitive interface, extensive asset store, and robust physics and animation systems, Unity3D enables developers to bring their creative visions to life[5]. Its cross-platform compatibility allows for seamless deployment on desktop, mobile, web, and emerging technologies like VR and AR. Supported by a vibrant community and continuous updates from Unity Technologies[6], Unity3D remains a top choice for both indie developers and established studios seeking to build engaging and visually stunning games and applications.

Cross-Platform Compatibility: Unity3D allows developers to create games and applications that can run seamlessly across multiple platforms, including desktop, mobile, consoles, and web browsers.

User-Friendly Interface: Unity3D features an intuitive and user-friendly interface, making it accessible to developers of varying skill levels. It offers a visual editor for designing scenes, users' attention but also in significantly enhancing disaster awareness relative to traditional training methodologies[7]. By properly scrutinising the engagement levels, knowledge retention rates, and overall efficacy of gamified simulations, the simulation seeks to offer invaluable insights into the pivotal role of gamification[8] in disaster preparedness education. Moreover, it advocates for the widespread adoption of Unity3D as an indispensable tool for crafting impactful learning experiences that empower communities to proactively build resilience[9] against the unpredictability of potential disasters.

scripting support using C#, JavaScript, or Boo, and a vast library of assets and resources.

Graphics and Rendering: Unity3D boasts powerful graphics capabilities, including advanced rendering features such as real-time global illumination, dynamic lighting, and post-processing effects. It supports high-definition graphics and enables developers to create visually stunning environments.

Blender

Blender is a powerful open-source 3D creation software widely used for modelling, animation, rendering, and more. With its comprehensive set of tools and features, Blender empowers artists, designers, and developers to bring their creative visions to life in stunning detail. Whether creating intricate 3D models, animating characters and objects, or rendering photorealistic scenes, Blender offers a versatile and flexible platform for a wide range of projects. Additionally, Blender's free and open-source nature ensures that it remains a cost-effective and accessible option for creators around the world.

Open-Source Software: Blender is a free and open-source 3D creation suite, meaning it's freely available to download, use, and modify. This open nature fosters a vibrant community of users and developers contributing to its ongoing development and improvement.

Comprehensive 3D Toolset: Blender provides a wide range of tools and features for 3D modelling, sculpting, texturing, rigging, animation, rendering, compositing, and more. It offers everything you need to create complex 3D scenes and animations within a single software package.

Cross-Platform Compatibility: Blender is available for Windows, macOS, and Linux, ensuring compatibility across various operating systems. This allows users to work seamlessly regardless of their preferred platform.

User-Friendly Interface: Blender features a customizable and intuitive interface designed to streamline workflows and maximise productivity. Users can customise the layout, hotkeys, and toolsets to suit their individual preferences and workflow requirements.

3D Modeling and Sculpting: Blender offers powerful 3D modelling and sculpting tools for creating a wide variety of objects, characters, and environments. From simple geometric shapes to intricate organic forms, Blender's modelling and sculpting tools provide the flexibility and precision needed for creative expression.

Selection of Unity3D and Blender

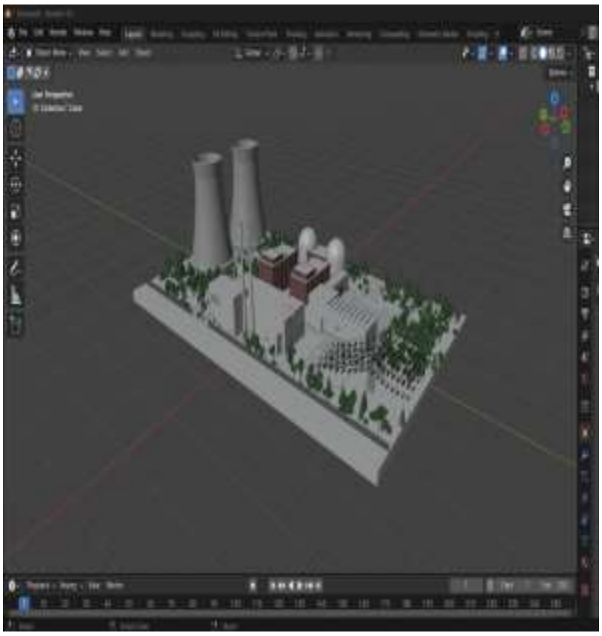


Figure 1: Complete Blender design of nuclear power plant.

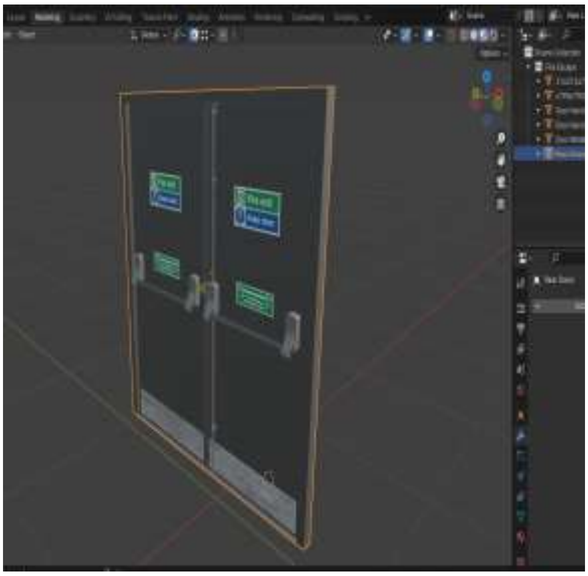


Figure 2: Blender design of emergency exit.

The integration of Unity3D and Blender is a common practice in various stages of game development and animation production. Artists and designers often use Blender to create 3D models, animations, and visual effects, which can then be imported into Unity3D for use in game development[10]. Similarly, Unity3D projects may require custom assets or animations created in Blender, which can be seamlessly integrated into the final application.

Design of simulation

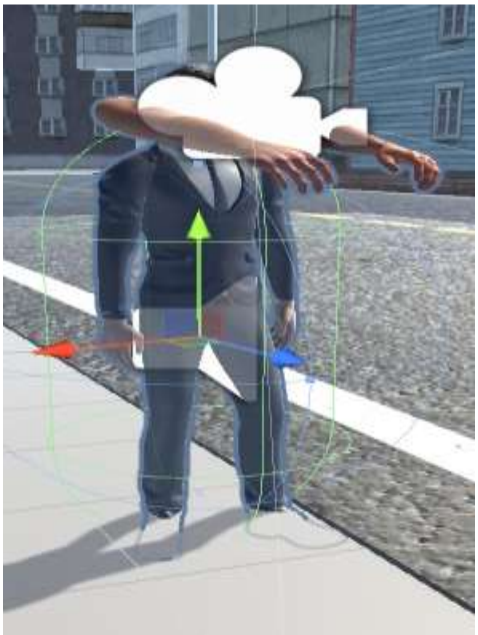


Figure 3: Design of First-Person character which shows hand animations.

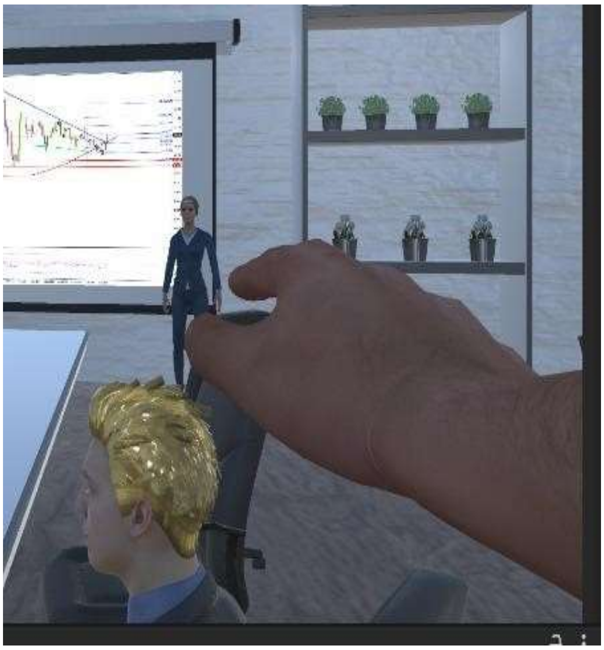


Figure 4: First Person hand animation.

Figure 5: Design of Non-Playable-Characters (NPCs).

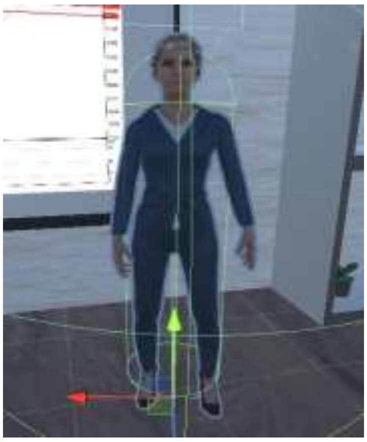


Figure 6: The design of a single Non-Playable-Character.

The design on the simulation *Train To Survive* makes the use of Unity's robust toolset as well as the intricacies of Blender's animations. The idea is to design and create the simulations of certain scenarios posed by natural and man-made disasters like earthquakes and tsunamis to highlight[11] the difficulties faced by individuals from all walks of life and how to react in said scenarios. The application consists of simulations of certain environments[12] such as that in an office, an open setting, and a village, and what is generally bound to take place in those environments during a disaster. The use of blender is extensive in the creation of all the constituents of the environment. These constituents are then integrated in the Unity3D software and the situation is then programmed using the C# programming language.

The user is given a set of choices devised from real-life scenarios out of which he or she makes a choice[13] based on prior knowledge. Depending on the choice made, the simulation progresses further. If the choice made is incorrect, a cutscene designed using Blender plays which indicates what will happen if the said choice is made in real life. Real world government advisories have been used to guide and implement the choices. The application includes a personalised feedback system[14] at the end of each scenario which is the backbone of this research. The feedback consists of a questionnaire that tests the knowledge that is gained by the user throughout the simulation. The answers of this questionnaire are stored in a database[15] which is used to obtain data sets that can be used to segregate the answers given by users based on age groups[16] as well as occupations.

Some key ideologies behind the methodology of the simulation are as follows:

Scenario 1: Earthquake in an office environment.

Figure 7: The environment design of the first scenario.

Figure 8: Design of gameplay in the Scenario I.

Conceptualization and Objective Definition:

Definition of specific learning objectives and educational goals for the earthquake and tsunami[17] simulation scenario, focusing on disaster preparedness, response strategies, and decision-making skills.

Establishment of the conceptual framework for the simulation, outlining the scenario, environment, interactive elements, including an earthquake alarm, NPC interactions, office furniture, electricity supply management, door animations, and voice dialogues using AI.

Identification of the target audience, including demographics and educational backgrounds, to tailor the simulation effectively.

Design and Development:

Development involves creating a detailed storyline and script for the simulation, specifying events, interactions, and decision points. Blender is utilised to design and model the office environment with realistic details. The user interface (UI) is designed for intuitive navigation. 3D models of player characters and NPCs are created with animations. Unity3D integrates environment, characters, animations, and interactive elements. Logic is programmed in C# for interactions, including earthquake triggers and decision prompts, based on player choices.

Scenario 2: Earthquake in an open environment.

Figure 9: Design of a playable part of the environment in Scenario II.

Figure 10: Design of the environment in Scenario II.

Conceptualization and Objective Definition:
Conceptualising an earthquake scenario using Unity3D and Blender, the objective is to create an immersive experience that educates users on earthquake preparedness. This involves designing a park environment with character and NPC interactions, voice lines, animations, and choice boxes. The scenario aims to simulate realistic earthquake effects, prompting users to make decisions and learn effective response strategies.

Design and Development:
Design and development for an earthquake scenario in an open environment using Unity3D and Blender involves crafting park layouts, character and NPC designs, environmental details, voice lines, cutscene animations, choice boxes, and picnic table dynamics. This entails creating realistic park elements, visually appealing characters, immersive environmental details, scripted voice guidance, dynamic cutscene animations, interactive decision points, and physics-based picnic table interactions. The goal is to provide users with an engaging and educational simulation focused on earthquake preparedness and response.

Scenario 3: Nuclear gas disaster in a village

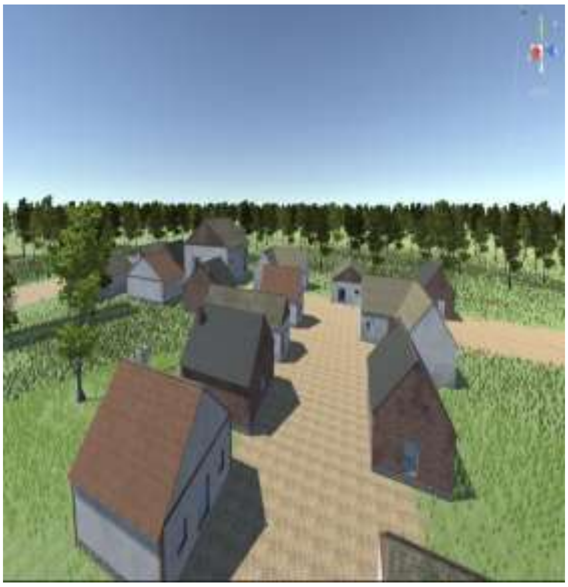


Figure 11: The environment design of the third scenario.

Figure 12: In-game design of power plant in Scenario III..

Conceptualization and Objective Definition:
Conceptualization and objective definition for a simulation scenario of a nuclear gas disaster in a village, developed using Unity3D and Blender, involves creating a detailed virtual environment. This includes designing the village layout, nuclear power plant[18], and character models, while incorporating interactive elements such as choice boxes. The objective is to simulate the challenges and complexities of a nuclear gas disaster, providing users with an immersive experience to learn and practice evacuation procedures, decision-making, and resource coordination in such scenarios.

Design and Development:
Design and development for a research paper on a simulation scenario of a nuclear gas disaster in a village, using Unity3D and Blender, involves crafting detailed designs for the village layout, nuclear power plant, character models, and various interactive elements like choice boxes. This aims to create an immersive and educational experience, enabling researchers to explore disaster preparedness and response strategies.

Content Creation and Integration:

Development of educational content, including informative texts, videos, and dialogues, to convey essential information and concepts related to earthquake and tsunami preparedness and response.
Integration of educational content seamlessly into the simulation, ensuring coherence and relevance to the learning objectives and scenario progression.

User Testing and Evaluation:

Conduction of user testing sessions with representative participants to evaluate the usability, engagement, and effectiveness of the simulation.
Collection of qualitative and quantitative feedback through a questionnaire to assess user experience, learning outcomes, decision-making skills, and the effectiveness of AI-driven voice dialogues.
Analysis of user performance, engagement metrics, decision pathways, and sound effects' impact on immersion to identify strengths, weaknesses, and areas for improvement.

III. COST EFFECTIVENESS

The earthquake, tsunami, and nuclear disaster simulation project, leveraging Unity3D and Blender, is highly cost-effective[19] due to several factors:

Free Software: Both Unity3D and Blender are open-source software tools available for free, eliminating the need for costly licensing fees. This significantly reduces the upfront costs associated with software acquisition and allows for the development of the simulation at no additional expense.

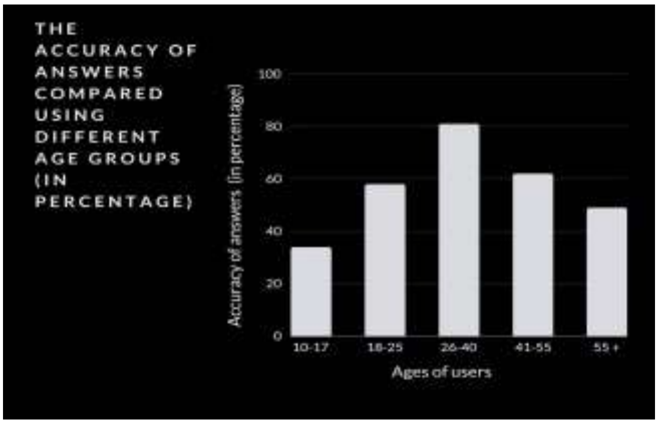
Minimal Hardware Requirements: Unity3D and Blender have modest hardware requirements, allowing developers to work with standard desktop or laptop computers without the need for expensive hardware upgrades. This ensures that hardware costs are kept to a minimum, making the project accessible to researchers and developers with limited resources.

No Additional Software Dependencies: The simulation can be developed and executed using only Unity3D and Blender, eliminating the need for additional software dependencies or third-party tools. This reduces software procurement costs and streamlines the development process.

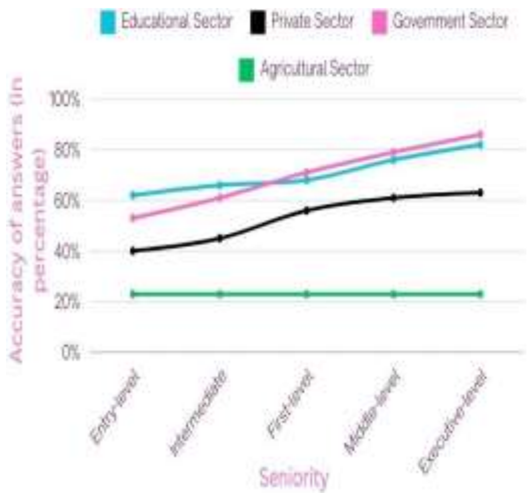
Scalability and Reusability: Once developed, the earthquake, tsunami, and nuclear disaster simulations can be easily replicated and deployed across multiple platforms and educational settings without incurring additional expenses. This scalability and reusability maximise the cost-effectiveness of the project, as the simulation can continue to benefit various stakeholders in disaster education and preparedness over time.

IV. RESULT

User Engagement: User feedback indicated high levels of engagement with the simulation, attributed to its immersive environment, interactive elements, and gamified features[20].



Graph 1: It displays the comparison of results taken from the accuracy of answers to the questionnaire within different age groups.



Graph 2: The above graph displays the comparison of results taken from the accuracy of answers from different occupational sectors. Positional seniority is used to differentiate the results. It is seen that executives of almost all sectors except agriculture possess the experience and knowledge to overcome stress-inducing situations caused by natural and man-made disasters.

V. REFERENCES

1. Chittaro, L., Sioni, R., "Serious Games For Emergency Preparedness: Evaluation Of An Interactive vs A Non-Interactive Simulation Of A Terror Attack", Computers In Human Behaviour, 50, pp 508-519, 2015.
2. Prensky, M., "Simulations: Are They Games?", Digital Game Based Learning(McGraw-Hill), 9(5), pp 1-6, 2001.
3. Khasawneh, Y. J. A., Khasawneh, N., Khasawneh, M. A. S., "Exploring the long-term effects: Retention and transfer of skills in gamified learning environment", International Journal of Data and Network Science, 8(1), pp 195-200, 2024.
4. Padilla, J. J., Lynch, C. J., Diallo, S. Y., Gore, R. J., Barraco, A., Kavak, H., Jenkins, B., "Using Simulation Games For Teaching And Learning Discrete-Event Simulation", Winter Simulation Conference, 2016.
5. Hussain, A., Shakeel, H., Hussain, F., Uddin, N., Ghouri, T. L., "Unity Game Development Engine: A Technical Survey", University Of Sindh Journal Of Information And Communication Technology, 4(2), 2020.
6. Ahamed, S., "Study Of An Application Development Environment Based On Unity Game Engine", International Journal Of Computer Science And Technology, 2020.
7. Planchon, J., Vacher, A., Comblet, J., Rabatel, E., Darses, F., Mignon, A., Pasquier, P., "Serious Game Training Improves Performance In Combat Life-Saving Interventions", Injury, 49(1), 2018.
8. Haryanto, H., Rosyidah, U., Kardianawati, A., Sutojo, T., Mulyanto, E., Lakoro, R., "Activity Design based on Appreciative Learning in Disaster Mitigation Serious Game", 2023 14th International Conference on Information and Communication Technology and System, pp 52-56, 2023.
9. Drumhiller, N. K., Srba, K. V., Wilkin, T. L., "Simulation and game-based learning in emergency and disaster management", Simulation and Game-Based Learning in Emergency and Disaster Management, pp 1-290, 2021.
10. Megha, P., Nachammai, L., Ganesan, T. M. S., "3D Game Development Using Unity Game Engine", International Journal Of Scientific And Engineering Research, 9(3), 2018.

11. Simões-Marques, M., Moreno, D., Correia, A., "Developing a Serious Game to Support Disaster Management Preparedness - A Design Thinking Approach", Advances in Intelligent Systems and Computing, 1207 AISC, pp 108-115, 2020.
12. Mitsuhara, H., Tanimura, C., Nemoto, J., Shishiburi, M., "Location-Based Game for Thought-Provoking Evacuation Training", Multimodal Technologies and Interaction, 7(6), 2023.
13. Meng, Y., "Serious Game For Training to Escape from Disasters and Deal with Accidents", Proceedings of the 17th European Conference on Games-based Learning, pp 847-851, 2023.
14. Li, L., Fang, Z., "Earthquake Escape Simulator: A System for Disaster Knowledge Popularization", Journal of Physics: Conference Series, 2333(1), 2022.
15. Ning, H., Pi, Z., Wang, W., Farha, F., Yang, S., "A Review on Serious Games for Disaster Relief", Proceedings - 2022 4th International Conference on Data Intelligence and Security, pp 408-414, 2022.
16. Salman, O. K., Khasawneh, Y. A. J., Alqudah, H., Alwaely, S. A. K., "Tailoring gamification to individual learners: A study on personalization variables for skill enhancement", International Journal of Data and Network Science, 8(2), pp 789-796, 2024.
17. Hawthorn, S., Jesus, R., Baptista, M. A., "A review of digital serious games for tsunami risk communication", International Journal of Serious Games, 8(2), pp 21-47, 2021.
18. Rufino, R., de Classe, T. M., Siqueira, S. W. M., " Games With Training Purpose for Hazard Situations in the Industry - Systematic Mapping of the Literature", ACM International Conference Proceeding Series, pp 181-188, 2023.
19. Whitfill, T., Auerbach, M., Diaz, M. C. G., Walsh, B., Scherzer, D. J., Gross, I. T., Cicero, M. X., “Cost-Effectiveness Of A Video Game Versus Live Simulation For Disaster Training”, BMJ Simulation & Technology Enhanced Learning, 6(5), pp 268,2020.
20. Aldunate, R., Navarro, C., Martin, D. S., "Video game-based platform to improve decision making during response to large scale natural disasters", International Journal of Scientific and Technology Research, 8(10), pp 3179-3188, 2019.