Developing next-generation educational mobile games in light of technological trends: a study on the "Obstacle Run" game

Şeyhmus Aslan, Buğrahan Bilir, Qusai Gazawy

Department of Computer Engineering, Faculty of Engineering, Çankırı Karatekin University, Çankırı, Turkiye

ABSTRACT

The focus of this study is directed towards the examination of the design, development, and analysis of user feedback for the hyper-casual game known as "Obstacle Run," with the aim of enhancing mathematical skills. A comprehensive analysis of the game's design, mechanics, and user experience is conducted. The primary objective of the game is to foster the improvement of mathematical skills in an enjoyable manner and to provide support for the learning process through straightforward game mechanics. An in-game mechanism, requiring players to engage in solving mathematical calculations and problems, is presented by the game titled "Obstacle Run." Increasing the character count within the game is envisioned as a means to bolster mathematical proficiency. This study meticulously focuses on the detailed examination of this unique game, where game design, mechanics, and mathematical calculations come together. Additionally, an exploration of the potential of gamification within game development and education is carried out. The results have been derived from the testing of the game prototype and the subsequent analysis of player feedback. This research is also regarded as a step towards comprehending the connection between hyper-casual games and mathematics education, with the aim of presenting a novel perspective in this domain. It is to be noted that this study is intended to serve as a valuable guide for game developers and educators alike. Its findings are poised to serve as a significant resource for future game projects and strategies in mathematics education. In conclusion, this study provides a summary of a significant endeavor aimed at elucidating the potential of hyper-casual games, such as "Obstacle Run," in facilitating the development of mathematical skills and exploring the possibilities of gamification in the realm of education.

Keywords: Mobile games, C++, unity, mathematics

INTRODUCTION

This research study focuses on the design and development of hyper-casual games. Its primary objective is to examine the game "Obstacle Run," which aims to help players improve their mathematical skills while incorporating simple mechanics. In the game, the goal is to increase the character's count and enhance mathematical abilities. This game presents mathematical calculations and problem-solving skills to players in an enjoyable manner. The article aims to provide a detailed analysis of game design, game mechanics, and mathematical calculations. Additionally, this study explores the potential of gamification in game development and education. The results are based on testing the game prototype and analyzing player feedback. This article is considered an important step in better understanding the connection between hyper-casual games and mathematics education, offering a fresh perspective in this field. It aims to serve as a useful guide for game developers and educators.

The findings of this study will be a valuable resource for future game projects and mathematics education strategies.

The aim of this study is to examine the impact of using mathematical operations in the design of my hyper-casual game, "Obstacle Run," and to make a significant contribution in this field. In line with this goal, this game, which aims to provide both an enjoyable and educational experience, enhances players' mathematical skills and equips them with the ability to solve mathematical problems. While highlighting the development and importance of hyper-casual games, we will now take a step further to delve into the evolution of this dynamic game genre in the literature in more detail.

In today's gaming industry, diversity has emerged with the advent of different game genres, and it has drawn attention to a new category of games known as hybrid-casual games.

Hybrid-casual games, based on the studies by Knezovic (2022) and Facebook Gaming (2020, 2022), are simple and intuitive games with hyper-relaxing mechanics. These games focus on mechanics such as rotation, stacking, matching, and timing while also incorporating broader meta-game elements. Meta-game elements aim to enhance participant engagement by combining various elements such as social features, in-game progression mechanics, game narratives, and competitive aspects. Hybrid-casual games offer a more intriguing gaming experience by integrating meta-game elements into the core gameplay of hyper-casual games. This allows players to enjoy both a straightforward and relaxing gaming experience while also taking advantage of the game's deeper features (Pizzo, 2023).

The origins of hyper-casual and hybrid-casual games can be traced back to video game arcades. In the late 1970s and early 1980s, video game arcades became increasingly popular. These arcades, though lacking sophisticated design and gameplay, attracted the interest of teenagers and young adults. During this time, games that competed for high scores became significant. Major video game competitions like Atari's Space Invaders Championship were organized. The emergence of home video game consoles created competition for video game arcades. In particular, the Nintendo Entertainment System (NES) played a pivotal role in popularizing home gaming experiences. With the success of the NES, the video game industry became commercialized and competitive (Scullion, 2019; Wirtz, 2022).

Hybrid-casual games offer a gaming experience by utilizing meta-game elements for long-term engagement. These meta-game elements provide players with both short and long-term goals and objectives, often associated with rankings or high scores (Brandstater, 2021). They incorporate the fundamental elements of competition into these entertainment-focused games. Additional meta-game elements may include character progression, core development, and other in-game progression features, as well as social aspects like group chats, leaderboards, and friendly competitions. Hyper-casual games have quickly become repetitive with low retention rates. While the seven-day average retention rate for mobile games is approximately 20%, it drops to 10% for hyper-casual games (Pangle, 2022). Consequently, game developers are now primarily focusing on hybrid-casual games. Hybrid-casual games bring the retention level on par with other mobile games by encouraging continuous engagement and motivation through meta features and progression elements (Brandstater, 2021; Facebook Gaming, 2022; Pangle 2022).

The "Obstacle Run" game operates within the same framework as a few popular games like "2048," "Threes!," and "Math Riddles." However, there are distinct differences among these games. "2048" and "Threes!" are puzzle games where players aim to combine numbers on the board using their mathematical skills. These games can help enhance mathematical thinking and strategic planning abilities. However, unlike "Obstacle Run," these games do not directly involve solving mathematical problems and do not offer a unique mechanism for increasing numbers. On the other hand, "Math Riddles" is a puzzle game where players progress by solving various mathematical problems. However, this game often provides a static experience and, unlike "Obstacle Run" lacks dynamic gameplay or mechanics involving

obstacles (Dorokhine & Bratt, 2022; Pocket Gamer, 2017; Taş & Taş 2021).

While most hyper-casual games are primarily focused on entertainment, "Obstacle Run" also serves as a learning tool. Additionally, the game incorporates mechanics that involve increasing the character's count and encountering obstacles based on mathematical operations. These features enable the game not only to be fun but also to enhance strategic thinking and quick decision-making skills. Detailed information about the game is provided in Chapter 2.

METHODS

If we briefly talk about the game, it revolves around an adventure where a character progresses on a flat surface, encountering doors and obstacles. As the character passes through doors, their number increases, while it decreases when they collide with obstacles. The objective of the game is to pass through as many doors as possible to increase the count and surpass the designated enemy count. If the character's count exceeds the enemy count, the player wins the game; otherwise, they lose.

The Unity game engine introduces essential concepts for developers to use when creating their games. The "Scene Management Hierarchy" allows you to organize and control transitions between game scenes, representing the sections and levels of your game. The "Prefab System" facilitates the easy creation of reusable objects, enhancing project organization and saving time. "Input Management" provides developers with the freedom to determine how in-game controls will function, compatible with both old and new systems. The camera defines how players perceive the game world, significantly influencing the player experience. "MonoBehaviors" components are used to add functionality to objects, enabling objects to listen to, process, and respond to events. Finally, "Basic Methods" are functions used in MonoBehaviors components, allowing objects to become interactive within the game world. Unity streamlines the game development process with these fundamental concepts, as illustrated in Figure 1.
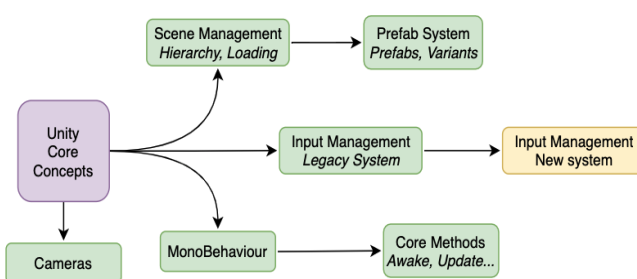

Figure 1. The core concepts of unity

3D Objects

In the game development process, various objects are used that support the game's mechanics and create the game's atmosphere. These objects include elements with which players will interact and which will shape the gaming experience. Figure 2 provides examples of a few objects. These objects serve as the fundamental building blocks of the game and enable players to immerse themselves in the game world.
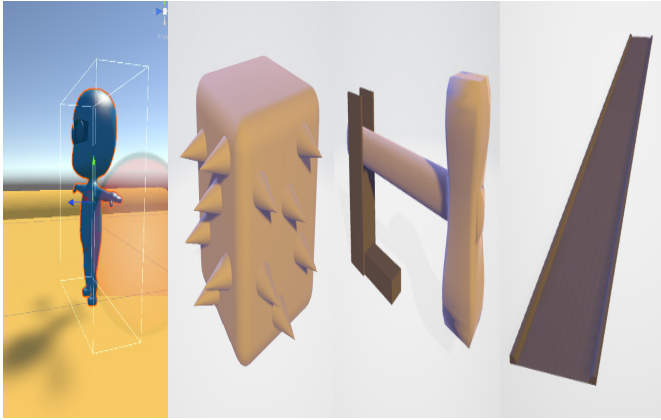
Figure 2. Three-dimensional object.

Game Menu Designs

Menu design is important from the perspectives of user interface and user experience. A game menu enables the user to perform functions such as starting the game, transitioning between levels, adjusting settings, and customization options. In this study, factors to be considered in game menu design and principles of good design have been emphasized. It is important for menu design to be user-friendly, aesthetically appealing, guide the user, and provide easy access to other sections within the game. This study focuses on essential options that should be present in the menu, user interface elements, and visual design elements. Additionally, different types of menus and menu designs suitable for various game genres have been discussed.

Using and Editing Scripts in Unity

Unity provides a user-friendly Editor for arranging and adjusting the properties of objects. Editing objects involves operations like setting their positions, modifying rotations, changing scales, adding and removing components, and more. We can see an edited version of level 1 of the game in Figure 3. Using scripts in Unity, you can control various components and objects in your game. Scripts add flexibility and power to the development process by allowing you to program the functionality and gameplay of your game. In Unity, scripts are created using the C# programming language and are written using integrated development environments like MonoDevelop, Visual Studio, or JetBrains Rider.
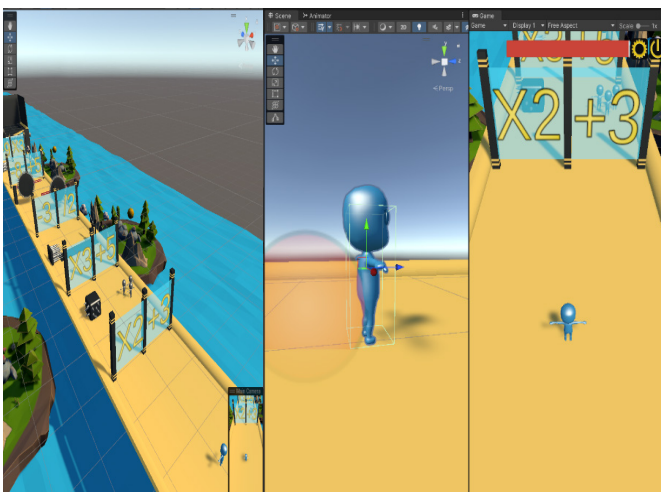

Figure 3. The layout of level 1

Script Files

The script files used in this game project are created using the C# programming language within the development environment provided by the Unity game engine. These script files are designed to control the game's functionality and regulate the behaviors of various objects. For managing a character with alternative costumes or abilities, the Alt_Character script file is utilized, while triggering and managing movements such as walking or jumping animations are handled by the Animatorich script file. Script files like these play a significant role in managing different components and interactions within the game. Each one is designed to control or customize a different aspect of the game. Effective use of these script files can significantly enhance the game's fluidity, realism, and user experience.

RESULTS AND DISCUSSION

Surveys and Reviews

We have a series of questions directed at users of the Obstacle Run game. These questions are designed to gather insights into what users think about the game, how they interact with it, and which features of the game they like or dislike. This information will assist in evaluating the current version of the game and planning for future updates and improvements. Below, you can find details about these feedback questions. Survey questions:

- In your opinion, which age group do you think this game is suitable for? (5 - 8 / 8 - 13 / 13 - 18 / 18+)
- How many hours do you play the Obstacle Run game per day? (0-1 Hour / 1-2 Hours / 2-3 Hours / 3+)
- Please rate the level of enjoyment of the game. (0-Very Bad, 1-Bad, 2-Fair, 3-Good, 4-Very Good)
- Do you think that as you play the Obstacle Run game, you have improved your hand-eye coordination and mathematical problem-solving speed, making it easier to pass levels? (Yes / No)
- Do you believe that your speed in performing mathematical calculations has increased after spending time playing the Obstacle Run game? (Yes / No)
- Do you think that the character, enemy, obstacle, and environmental designs used in the game make it more appealing? (Yes / No)
- In your opinion, was the character optimization in the game at an ideal level? (Yes / No)
- Do you think the instructions provided at the beginning of the game were sufficient for you to be able to play the game? (Yes / No)

The responses given by users to these questions can be seen in Figure 4 and Figure 5. As shown in Figure 4, many users are in the age range of 8-18 and spend their time playing this game for 0 to 2 hours a day. Furthermore, a significant majority of users find the game very enjoyable. When considering these responses, and upon examining the answers in Figure 5, it can be concluded that an educational game can provide support to a user in their education phase, helping them enhance both their mathematical skills and physical abilities. Particularly, as the level of enjoyment in the game, in-game optimization, and the design-theme-graphics coherence increase, users tend to spend more time with the game. This, in turn, can contribute more to the

user's education and development. As seen from the answers to the survey questions in Obstacle Run, approximately 80% of users believe that playing this game enhances their ability to perform mathematical calculations and improves their hand-eye coordination, among other physical motor/ reflex movements. They have even mentioned that as they spend more time playing the game, they can tackle more challenging levels proportionally, even when the character speed increases, and obstacles become more difficult in the advanced levels. Especially, since the vast majority of users agree that more challenging levels become easier to overcome, it can be presented as evidence that the game positively contributes to the user in terms of mathematical calculation abilities and personal skills.
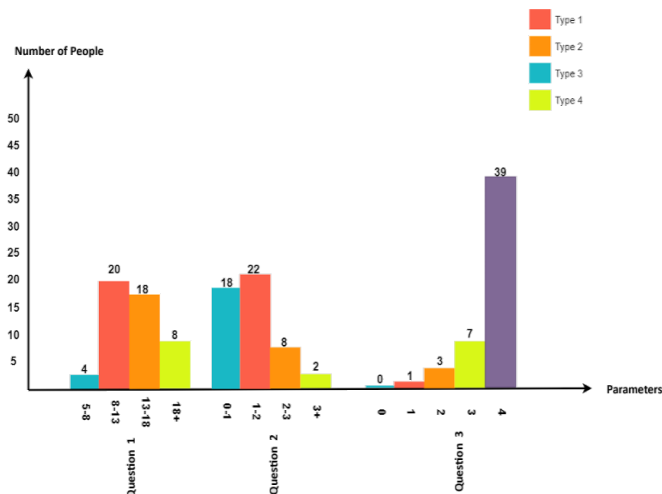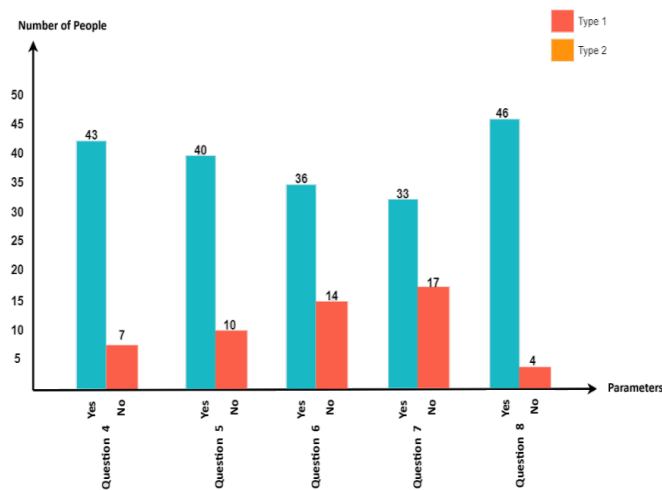

Figure 4. Survey results

Figure 5. Survey results

In conclusion, approximately 80% of respondents who answered the questions expressed that they enjoy playing Obstacle Run, and they believe the game has contributed to their personal development depending on the variables in the game. This demonstrates that in today's world, games can provide support in education and important aspects such as decision-making skills. Furthermore, by establishing a direct or inverse relationship based on the criteria found in the survey questions, a more optimized game can be designed in each aspect, considering the educational aspect, the time spent by the user playing the game, and the game's likability by the user. This way, especially individuals in the education phase can receive significant support for their education.

CONCLUSION AND FURTHER GUIDELINES

General Conclusion

As a result of this project, it has been observed that a math-focused hyper-casual game can offer a unique experience. The game provides an opportunity for players to improve their mathematical skills while also highlighting their strategic thinking abilities. However, some disadvantages, such as a limited target audience and gameplay diversity, should also be taken into account. The findings from this project demonstrate that mathematical skills can be enhanced through games. It has been proven that the world of gaming is an effective platform for teaching various subjects and developing skills. In this context, it is important to develop and diversify more math-focused games in the future.

Future Work

Within the scope of this study, the focus was on the design, development, and analysis of user feedback for the "Obstacle Run" game. The findings have helped us evaluate the overall success of the game and the user experience. However, since the gaming industry is a rapidly evolving and changing field, there are various opportunities to build upon our current work and make our game more engaging and interactive.

The rapid advancement of technology and the emergence of new and exciting opportunities like VR provide the potential to further expand our game and enhance the user experience. VR offers the potential to provide users with a more immersive and realistic gaming experience, allowing them to interact with the game world in a deeper way. In a platform game like "Obstacle Run," VR technology could offer users a realistic running and obstacle-crossing experience. This could encourage users to engage more with the game and enrich the overall gaming experience.

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