


# Disability Racer: A Digital Game for Raising Awareness of Ophthalmological: Related Issues

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**Abstract:** This paper presents an educational serious game aimed at raising awareness about ophthalmic issues. The game, titled 'Disability Racer,' is based on the mechanics of a car battle-royale and was developed for the computer platform. It incorporates four ophthalmic conditions, challenging players to compete against each other while experiencing impaired vision. To mirror real-life problem-solving, the 'glasses' item has been included, which, when collected, temporarily improves the player's vision. In this way, the game promotes an understanding of the importance of regular ophthalmic check-ups.

## 1 INTRODUCTION

Estimates from 2015 indicate that one in five people in Latin America and the Caribbean has some degree of visual impairment (de Oliveira et al., 2022). Considering this average, the other four people may not be aware of how a visually impaired person perceives the world around them. To raise awareness among these people, an alternative is through digital games known as serious games.

Serious games aim to do more than just entertain, they seek to be a vehicle that intensifies learning in a dynamic, interactive, motivating and engaging way, thus facilitating the learning process. Most of them are accessible for people with disabilities. Taking this into consideration, it is clear that serious games can serve as a channel for learning and raising awareness about complex or less familiar subjects (Noemí and Máximo, 2014).

Raising awareness about the experiences and challenges faced by people with a disability is crucial to promoting inclusion and empathy in our society. Understanding these experiences in a more direct and engaging way through a simulated experience can have an even more significant impact.

This article presents a serious educational game called Disability Racer, with the aim not of providing


accessibility for individuals with limiting conditions, but of providing an experience that allows people to understand the vision of individuals with ophthalmological disabilities. Developed for the computer, in which four players compete against each other while experiencing eye problems on their screens. This way, the game becomes more challenging for users.

## 2 RELATED WORK

Eye problems in children are often underestimated, and parents may not be aware of these issues, which can have serious impacts on their children's visual health. Early detection is crucial to avoid future complications, therefore, parents should be alert to signs of visual difficulties and seek ophthalmological evaluation regularly (Graziano and Leone, 2005).

Most cases of visual impairment can be corrected by using low-cost glasses or lenses. This highlights the importance of access to ophthalmologic evaluation, especially in communities with limited resources. Democratizing access to glasses can significantly improve the quality of life and opportunities for those with visual impairment (de Oliveira et al., 2022).

Educational games are an effective tool for transmitting content and values in an engaging and effi-

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cient way. They can be developed based on scientific research, which makes them a valuable contribution to contemporary education (Noemí and Máximo, 2014).

Serious games represent another tool that can cover a wide range of complex and under-addressed areas, such as government, education, corporations, and self-care. They offer an engaging and practical approach to learning and training in diverse contexts (Susi et al., 2007).

Serious educational games are a powerful and effective combination for learning, especially on complex or less familiar topics. They allow the application of theoretical concepts in practical scenarios, promoting a deeper and lasting understanding. The interactivity and immersion provided by serious games result in dynamic and participatory learning, making them valuable for developing knowledge in challenging areas (de Freitas, 2018).

Simulation games in higher education have garnered considerable interest for their ability to actively involve students with course content, fostering increased engagement and motivation while facilitating learning outcomes (Faisal et al., 2022).

The use of serious games to simulate experiences such as myopia and blindness offers valuable tools for transmitting awareness messages to the public. Increasing awareness among the public could help create inclusive communities and improve the quality of life for individuals with visual impairments (Melthis et al., 2015).

A virtual reality serious game as a tool for social awareness of disabilities has proven effective in tests and has the potential to assist in social awareness regarding ophthalmological symptoms (Medeiros, 2022).

In fact, games with this focus have proven to be highly effective in achieving their goals. For example, the *Phishy* game, which aims to train a corporation's employees on identifying phishing, demonstrated its effectiveness in a company in which more than eight thousand associates participated and completed the game. This program resulted in a significant improvement in employees' ability to identify phishing links (CJ et al., 2018).

Games like *Riskio*, a board game designed to raise cybersecurity awareness among people without a technical background who work in organizations. *Riskio* provides an active learning environment in which players gain knowledge about cybersecurity attacks and defense strategies by taking on the roles of attackers and defenders of critical assets in a simulated scenario within a fictional organization (Hart et al., 2020).

Persuasive technologies have the ability to shape

behaviors, instruct and educate people effectively. One example is *PowerHouse*, a computer game to influence energy-related behaviors and to foster an energy-conscious lifestyle, especially among teenagers (Bång et al., 2006).

### 3 CONTRIBUTIONS

The game *Disability Racer* represents a valuable addition to the field of serious games aimed at the community, introducing a topic little discussed. In addition to addressing a subject of social relevance, it differentiates itself by offering a unique group gaming experience. As it is a party game designed for four players, the dynamics and immersion reach a greater level. The interaction between participants, combined with the context of the game, provides an engaging and enriching experience, which goes beyond entertainment and promotes a greater understanding of the topic covered.

What makes the game truly innovative is the inverse approach to the concept of accessibility. Instead of a game aimed specifically at people with disabilities, the developers chose to highlight the life experience of individuals with visual impairments, placing it as a filter on the screen for all players (Figure 1). In this way, a unique opportunity is provided for people without disabilities to tangibly and interactively experience the perspective and challenges faced by those who have visual limitations. This approach, in addition to being educational, creates empathy and promotes greater awareness about the reality of living with a visual impairment. The game is freely available from this link<sup>1</sup>.

### 4 GAME DEVELOPMENT

The Game development followed an interactive Analyze, Design, Develop, Implement, Evaluate (AD-DIE) process (Molenda, 2003). The main idea of the game is to tackle a challenging topic (ophthalmic symptoms) and turn it into a fun experience, promoting interactivity among friends with engaging and captivating gameplay. For raising awareness about regular visits to an ophthalmologist, the team conceived an item that players would collect to temporarily improve their vision. Thus, the "glasses" item was implemented in the game.

The game was produced using the Unity graphics engine (Figure 2) in the CSharp language. All el-

<sup>1</sup><https://alpaconegames.itch.io/dr>



Figure 1: Screen during Disability Racer game play.



Figure 2: Game on Unity.

elements of the game (visual, textual, sound, effects, etc.) were developed by the course students themselves and were subsequently evaluated by their peers and course teachers, during an internal games fair that

takes place once every semester.

During the semester, there was also monitoring by a professional linked to the field of ophthalmological health, who was responsible for validating the choices



Figure 3: Working Game Screen.



Figure 4: Game Vision with the driver with Glaucoma.

and actions taken by the game development team and, at the end of the semester, validating the game as a tool that achieved its objective and could have a positive impact on society.

#### 4.1 Main Game Mechanics

The game was developed to be played on PC with DualShock 2 controllers. Players need to be gathered locally to be able to play. The game screen is divided

into 4 parts (local split) and each controller corresponds to a player on the screen as shown in Figure 3.

#### 4.2 Ophthalmological Issues Addressed in the Game

For greater immersion within the experience, some specific vision problems were chosen with the aim of emulating what the vision of a person with that prob-

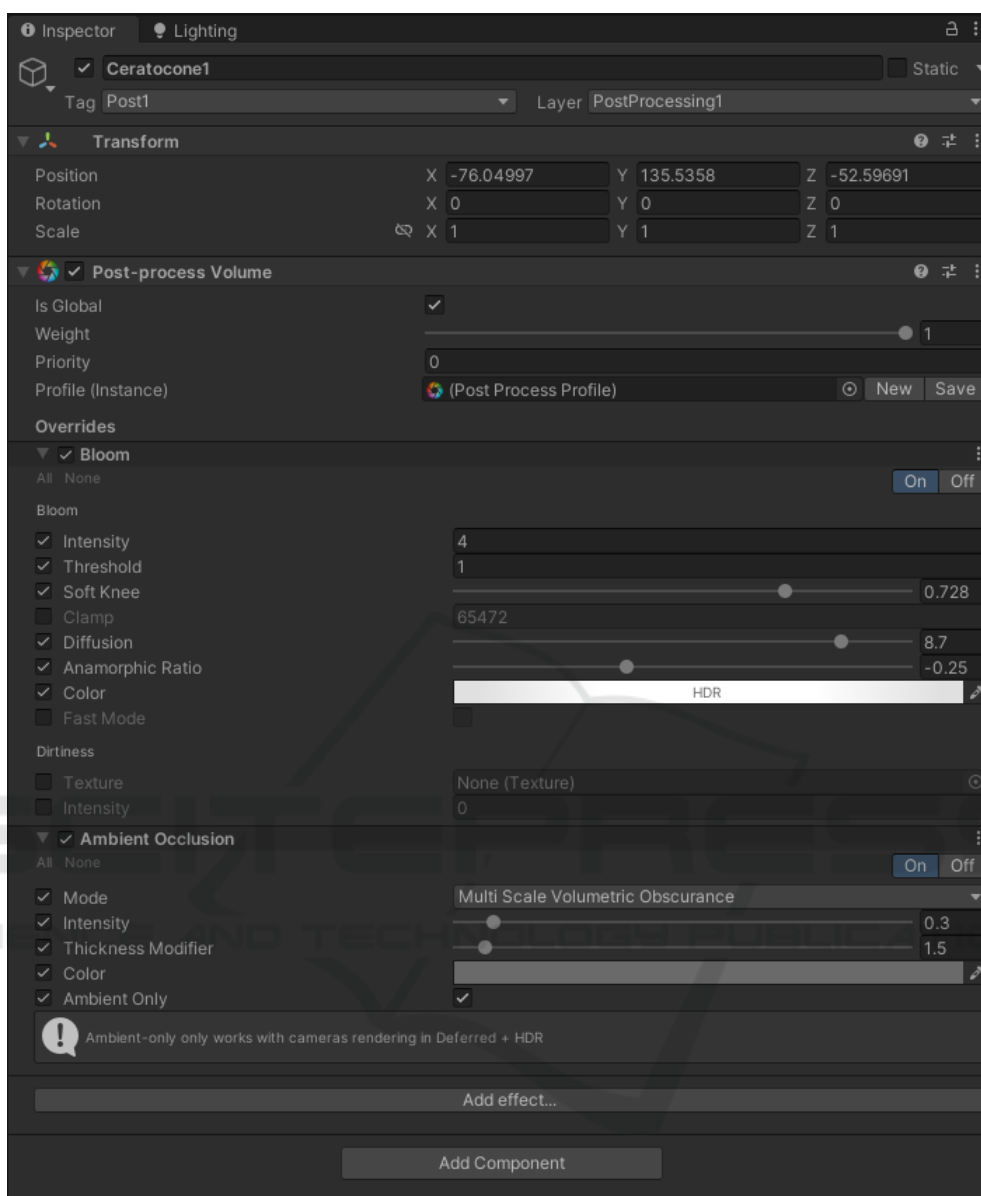


Figure 5: Game Vision with the driver with Keratoconus.

lem is like.

In addition to the difficulty of production at the time of development, several types of eye problems were excluded from the possibilities of choice, as they were extremely complicated to simulate correctly.

The vision problems chosen for the original version of the game were glaucoma, keratoconus, myopia and the cataract. These are the common problems that affect young people and adults. We will further describe them in the following subsections.

### 4.3 Glaucoma

Glaucoma is a slow degeneration of retinal ganglion cells, which increases eye pressure and can lead to blindness. The quality of life of people with glaucoma is drastically affected, even bringing psychological limitations to patients (Queiroz and Mota, 2021).

As glaucoma is a disease of genetic origin, preventive treatment can be correlated with consultations and treatments carried out in ophthalmological evaluations (Queiroz and Mota, 2021).

Figure 4 shows what glaucoma vision is like at play.



Figure 6: Game Vision with the driver with Cataract.



Figure 7: Game Vision with the driver with Myopia.

#### 4.4 Keratoconus

Keratoconus is characterized by a deformation in the cornea, causing it to assume a conical shape. It typically appears during adolescence, but also in young adults, and can appear after frequent rubbing of the eyes (Lopes et al., 2015). Figure 5 shows what the vision of Keratoconus looks like in play. Keratoconus' main effect on vision is irregular astigmatism, causing a major impact on daily life (Lopes et al., 2015).

#### 4.5 Cataract

Very common in the elderly, cataract is the opacification of the ocular lens, in some cases it can also affect adults and children, but it is more common in older people due to natural aging. The disease makes it difficult for light to enter the lens, making it difficult to form an image on the retina and disrupting the sufferer's vision (Lopes et al., 2021).

Figure 6 shows how the view of the Cataract is at play.



Figure 8: Texture.



Figure 9: Interface.

#### 4.6 Myopia

Being one of the most common visual abnormalities, myopia disrupts vision, causing the image of distant objects to form anteriorly on the retina. The appearance of myopia is linked to genetic factors, but it can also be related to the frequent use of screens. Fortunately, it can be treated with the use of glasses, contact lenses and refractive surgery depending on the case (Gomes et al., 2020). Figure 7 shows how Myopia vision is at play.

#### 4.7 Game Art

The game's art, as previously mentioned, was all developed by the team's students. The game used as a reference some well-known titles such as *Vigilante 8: Second Offense* developed by Luxoflux in 1999 for Playstation 1 and Nintendo 64 and *Twisted Metal* developed by Single Trac in 1995, also for Playstation 1.

Some aspects were used that emulated graphic limitations of the time, such as "dragged" textures and low fidelity in the 3D models created, in order to con-

vey a feeling that people were actually playing a game made for Playstation 1, which is exemplified in Figure 8.

For the game's interface, a theme was used that was very reminiscent of Rock'n Roll and Heavy Metal, something that was very connected to young people at the time of the Playstation 1. The game intend to convey an idea of nostalgia that accompanies the games of that time as shown in Figure 9.

#### 4.8 Game Soundtrack

The game's soundtrack was designed to convey the same feeling as the games mentioned above, which were created in the 90s, where Rock'n Roll was widely used in games. The music and sound effects feature heavy metal beats that also contribute greatly to the player's immersion.

### 5 THE GAME

Before the match starts, players will choose an eye problem on the selection screen (Figure 10). On this screen, only the name of the disability is displayed, without any visual preview. This is done with the purpose of surprising the player by revealing what the vision of someone who has the selected disability is like. This approach aims to provide an authentic and impactful experience, allowing players to gain a deeper understanding of the difficulties faced by individuals with this visual impairment.

After choosing a disability (Figure 10), players have the option to select from up to six different cars (Figure 11). This variety allows for greater customization and the opportunity to identify each other more easily during the game. After both selections the game begins.

The game has competitive dynamics between four players and challenges them to eliminate each other until only one winner remains. Each player chooses a simulated visual impairment before the game to play with and experience how someone with such a visual impairment sees and, throughout the game, can collect "glasses" to temporarily improve their vision (Figure 12). In addition to providing entertainment, the game promotes awareness about the reality of living with a visual impairment and also about the importance of ophthalmological consultations and the use of glasses.

### 6 TESTING AND PERFORMANCE

The game was taken and tested at several events, where the game was displayed on a table with a television, with the developers nearby to assist if players needed help. But one that stands out is the biannual game showcasing event, PUCPR Game Show. It was there that the game was exposed to around 200 people, including children, young people, adults and even the elderly. Through the feedback received and the expressions visible on their faces (Figure 13), it was possible to validate the effectiveness of the game. It was evident not only the high level of fun provided, but also the game's ability to promote awareness of the subject.

In addition to raising awareness, a lot of feedback was received related to representations of disabilities. There were suggestions both from people who pointed out the possibility of adjusting the conditional filters to make them more faithful to the technical reality, and from individuals who shared that their own visual experiences were similar to what was presented in the game.

### 7 DISCUSSION

With the statistic that one in five people in Latin America and the Caribbean has some degree of visual impairment, and considering that the other four people may not be familiar with this experience, the game played a crucial role. In all digital game's exhibition events, the development team received positive feedback regarding the awareness principle. This testimony highlights the game's ability to provide a deeper understanding of the experiences of people with visual impairments, thus promoting greater empathy and awareness in the community.

As noted by (Graziano and Leone, 2005), eye problems in children are often underestimated, and parents may not be fully aware of these issues. At a digital games exhibition event, the development team received touching feedback from a woman who shared: "I was able to understand how my daughter sees...". This statement highlights the effectiveness of the game in raising awareness among parents and preparing them for concerns related to their children's visual health. It offers a unique experience that can help parents better understand the difficulties of children with eye problems.

As mentioned by (Susi et al., 2007), serious games represent a powerful tool capable of addressing complex and little-treated areas. By combining a serious





Figure 10: Ophthalmological disabilities selection screen for each player.



Figure 11: Car selection screen for each player.

topic with the dynamics of a multiplayer battle game, it not only facilitated understanding of the subject, but also provided a tangible validation of that understanding. This was evident in feedback from players who shared similar or identical experiences of visual impairment.

As well as the educational aspect highlighted by (Noemí and Máximo, 2014), which proved effective

in exposing children who played the game to ophthalmological conditions previously unknown to them. They reported learning and expressed that they did not want to go through similar problems in the future.

The Disability Racer game stands out as a unique educational tool when comparing it to games like Phishy (Figure 14) (CJ et al., 2018), which aims to train employees to identify phishing links in corpo-



Figure 12: Player's vision after collecting glasses.



Figure 13: Event: Friends having fun while playing.

rate environments. While Phishy focuses on cybersecurity, Disability Racer has the potential to prepare parents to identify potential eye problems in their children based on the descriptions they provide.

Similar to the game Riskio (Figure 15) (Hart et al., 2020), which simulates the roles of attackers and defenders in a fictional organizational environment, Disability Racer also presents a unique dynamic where, players face challenges that simulate the development of eye problems when hit by other players or when not

regularly collecting glasses scattered across the map. This serves as an indirect reference to the importance of regular visits to the ophthalmologist.

The PowerHouse game (Figure 16) (Bång et al., 2006), in turn, persuasively uses its mechanics to promote awareness and change behaviors related to energy use. In Disability Racer, players are similarly encouraged to collect glasses and avoid attacks from other players to preserve their vision, indirectly reflecting on possible elements that could harm vision.



Figure 14: Playing image of the Phishy game (CJ et al., 2018).



Figure 15: Playing image of the game Riskio (Hart et al., 2020).



Figure 16: Playing image of the PowerHouse game (Bång et al., 2006).

## 8 CONCLUSIONS

This article presented a serious educational game called "Disability Racer" designed to promote awareness of eye problems. The game objective is to eliminate opponents while facing the everyday difficulties experienced by people with visual impairments in a simulated way. This unique approach provides an immersive and educational experience, allowing play-

ers to better understand the challenges faced by those with visual limitations. The game serves as a valuable tool to promote empathy and understanding the importance of accessibility in everyday life.

During the match, players can collect a special item: glasses. Which temporarily improves players' vision, conveying the crucial message about the importance of seeing an ophthalmologist and recognizing the vital role of glasses for those with correctable eye problems. This game mechanic highlights the relevance of visual health and encourages the search for ophthalmological solutions when necessary.

The developed game stands out from conventional games by adopting a unique inverse awareness approach to accessibility. It challenges people without disabilities to experience first-hand the difficulties faced by individuals with visual limitations. This distinction was proven in tests carried out at events and in the positive feedback received from players. These results reinforce the effectiveness of the game in promoting empathy and understanding regarding the experiences of people with visual impairments.

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