



Designing for Engagement: Cozy Gaming for Long Term Goals

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ABSTRACT

Long-term adherence to a Home Exercise Programme (HEP) is a difficult task for many athletes after an Anterior Cruciate Ligament Reconstruction (ACLR), making it difficult to go back to play sports. There are some common barriers that contribute to the tendency of patients not continuing with their HEP, like fear of re-injury, boredom, and lack of expectations. In my PhD research, I am using a user-centered approach to determine design guidelines for an immersive VR application for physical therapy, focused on ACL injuries. After identifying the needs of the users, cozy gaming characteristics have been chosen in order to design this application. Initial literature review and feedback has shown that a relaxing and task-oriented game could increase engagement on the prescribed exercises.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **User centered design**.

KEYWORDS

Virtual Reality, Gamification, Rehabilitation

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1 INTRODUCTION

Anterior Cruciate Ligament (ACL) injuries are common among athletes that play in competitive sports such as rugby, soccer, basketball and gaelic football [10]. Ireland has a high rate of this type on injury, being one of the highest in the world [9], and although patients are expected to make full recovery after an ACL reconstruction surgery (ACLR), intense and constant physical rehabilitation is needed in order to strengthen the knee and regain the pre-injury Range of Motion (ROM). Patients that go through this process are informed about the importance of doing the exercises prescribed by their clinician, but only between 30 to 50% complete their rehabilitation programme [6]. Also, only 55% of ACL injury patients return to competitive sports [5]. This low rate of completion of

exercises is caused by both physiological and psychological barriers. This work seeks to design a VR application that will provide a safe environment for recovery, while at the same time use gamified characteristics to perform the exercises prescribed by their clinician.

2 RELATED WORK

2.1 Cozy gaming

There is a category of games which aims to evoke feelings of safety (low risk, no danger), abundance (basic needs are met), and softness (low stress environment visually) [13]. This type of game is known as cozy games.

Some of the most popular cozy games that are commercially available are Animal Crossing [2] and Stardew Valley [1]. The previously mentioned games have the player build up a farm and a home from scratch by fulfilling daily tasks. In VR, a similar dynamic is present in the game called "Garden of the Sea" [3]. Consistent engagement is rewarded more than spending several hours at a time on them. The dynamic of these games makes it easy for the users to connect with the gameplay for a short time everyday, given that it is not about winning levels or finish the game (they don't really have an end), but about relaxation and accomplishment of longer-term goals. In high stress situations, this category of games provides a safe space for players to relax and self-reflect in a virtual world where their current problems are non-existent [18].

2.2 Cozy gaming for rehabilitation

Taking into account that cozy games aim to provide a safe environment for the player, some research has been done in applying cozy features to rehabilitation. Chan et. al. [8] present an Augmented Reality (AR) demo of a card game designed for voice therapy for children. The work of Vieira et. al. [14] determines that casual games seem to be more effective in rehabilitation of patients with neurological pathologies, seeing improvements in movement speed, upper-limb function and dexterity, gait, and balance. Also, the use of mini-games can be more engaging given that they are simple and easy to understand.

The previously mentioned works highlight the benefits of adding characteristics of cozy games to rehabilitation therapies. One of them focus on children, and another focus on neurological injuries, but as per our current knowledge, there is no focus on designing this type of game for athletes with physical injuries such an ACL tear. Also, so far, the combination of an immersive (VR) and cozy game for enhancing engagement in home rehabilitation has not being studied.



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3 RESEARCH QUESTIONS

Taking into account the available related work, the following research questions have been formulated:

- Does a cozy game have the characteristics to increase engagement in physical rehabilitation programmes?
- Can we translate cozy gaming features to VR?
- Can we determine a list of guidelines of design practices specific for knee injury rehabilitation applications in VR?

4 METHOD

4.1 Understanding the needs of patients and clinicians

After examining previous research around the barriers that prevent ACL patients from completing their home exercise programme, we have identified five main themes [16][17][15][7]:

- (1) Kinesiophobia and other fears: The most common barrier among ACL patients. Fear of a re-injury can cause fear of certain movements or actions.
- (2) No relation with sport: Patients don't see how the exercises will help them go back to play.
- (3) Feelings of isolation / Boredom: Patients don't feel understood by their social circle. Added to that, repetition of the same exercises becomes a boring activity over time.
- (4) Expectations management: When the desired results are not met within the time patients expect it, impatience and frustration appears.
- (5) External factors: In-person supervised physiotherapy can be expensive, and ACL patients have the added difficulty of depending on other means for transportation to a clinician, making access to their healing process more difficult.

Virtual Reality has the potential to help overcoming these barriers. It gives the user a portable tool to access their exercise programme from home (Theme (5)), its immersion capabilities allow to create a guided tool for patients to follow and be informed about their progress (Theme(4)), and a cozy game dynamic could help in decreasing stress associated with kinesiophobia, boredom, and isolation (Themes (1) to (3)).

4.2 Exercises

Over a series of interviews to a clinician that often treats ACL patients, three types of exercises were defined as difficult for patients to perform. These exercises are Lunges, Reaction training, and acceleration drills, as these play an important role in strengthening knee and hip extensor muscles [11]. We will introduce gamified versions of these exercises as mini-games inside the application. Following the dynamic of cozy games, these mini-games will be the method in which the players will gather elements or "resources" to make improvements on an environment presented according to the narrative displayed.

4.3 Narrative

Storytelling is necessary to provide the player with a sense of connection to the game. Given that we are aiming to provide a medium to long-term healing journey to ACL patients, a narrative

around that topic has been created. The following is the narrative of the game that will be used:

You are a very famous athlete that one day, during a friendly match, injured their ACL. Doctors are optimistic on your recovery if you get an ACL reconstruction, but you also need time to heal, physically and mentally after such an event. For this, you have decided to retire to the country side, in a house in front of the sea, hoping to reflect and improve your overall health, and of course, take the time to help your knee recover.

When you arrive to the house, you notice it is quite empty, and that it could do with some repairs here and there. "Maybe I can do something about it, it will take my mind off the injury for a bit!". And with that, you hope to make this house a home while also being your recovery path.

4.4 Storyboard

In Figure 1a, a storyboard on the initial steps of the game are shown. The user arrives to the house they will stay in according to the narrative. Upon exploration, inside and outside the house, some elements will be clickable, meaning that there is an area of that space that can be improved. In this storyboard, an example applied to adding a window to the house is depicted, when interacting with that space, information about what resources are needed is shown. In Figure 1b, the storyboard describes how to get the resources. The user will explore the space, in this particular example, the user sees some pieces of wood laying on the ground, when interacting with them, a mini-game opens, where in order to get the one piece of wood, one lunge should be performed by the player. After finishing the mini-game, the user gets the resources and saves them in their inventory.

5 RESULTS

The process of gathering user feedback on the proposed concept has started with a participant, over 18 years old, who recovered from an ACL reconstruction around three years ago. The initial feedback on the storytelling, opening scenes, and how to access to the mini-games has been obtained. The next step is to create a mid-fidelity prototype using the ShapesXR tool available in the Meta Quest store [12]. More details on the mini-games design will be available in a publication that is currently under review.

6 DISCUSSION AND CONCLUSION

The feelings of safety that a cozy game offers have the potential to provide the patients with a more relaxed environment that reduces the pressures of quick recovery. Also, focusing on daily tasks to make improvements around the virtual house, could improve engagement on the prescribed exercises, as it acts as a reward system and the improvements can only be done in a certain frame of time, promoting a "snacking" behavior [4]. The feedback from the participant who has reviewed the first prototype has been positive in terms of engagement. The current limitations for the mini-games is that for some of the exercises, more physical space is needed (around 5x5m), and it is unlikely that patients would have that

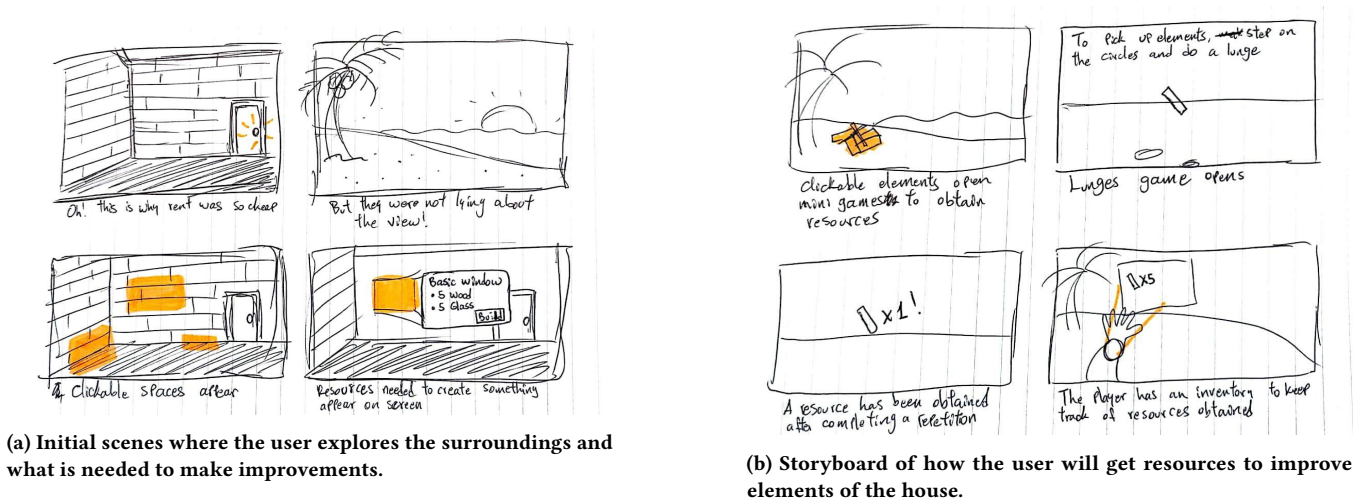


Figure 1: Storyboard of initial scenes of the gameplay.

space available in their homes. It is necessary to find an alternative for these exercises, so the patients can get the benefits from them.

Once my PhD study is completed, a more extensive study with users over a longer period of time will be needed to determine the real-world effectiveness of the solution. The main aim for this project is to determine a set of guidelines that can inform designers when building an application for physical rehabilitation in VR.

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