User experience of games for rehabilitation of children with a chronic condition

MASTER THESIS

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Abstract

Background
Gaming is supposed to be a fun and entertaining activity. Health games for rehabilitation programs are designed for individuals with a physical impairment to exercise in a slightly less tedious process. Although health games have been an active research area lately, a solid and proven evaluation method of the user experience in healthcare context is still lacking. Therefore, the goal of this study is to explore the user experience of health games.

Case studies
This study focuses on games for rehabilitation of children with a chronic condition. Two health games are selected: (1) Gryphon Rider, an exercise game for children with balance problem related to brain injury, in particular, children with cerebral palsy; (2) AIRplayground, an interactive playground to stimulate physical activity for children with asthma.

Theoretical framework
Existing theory on core elements of gaming experience is used as basis framework in this study. Besides, the study also investigates other factors that are necessary for positive experience while playing a health game, such as *social experience* and *physical experience*. Although these factors are often used in digital games for adults, there is a lack of research focusing in social and physical experience in health games for children with a chronic condition. Therefore, this area needs further exploration.

Method
Ten children, between the age of 7-13 years old, participated in the study. The research is designed as follows. First, the children were asked to play the game that is suited for their specific condition. Second, a post-gaming interview with the player regarding their experience with the game. The "smiley cards" are used in the interview to help the children to express their thoughts on the gaming experience.

Results
Based on thematic analysis, the results show that the current gaming experience model was only partly relevant in the healthcare context. The original key elements, such as *environment, game-play, control, ownership, facilitator*, and *enjoyment* remain the same. However, the model is extended with several new items related to health games. These new items are *cognitive loads, difficulty level, body movement, action, in-game instruction, external instruction, player's condition, social experience,* and *perceived benefit.*

Conclusion and discussion
This study proposes a new model of user experience of health games. The proposed model can be used to evaluate health games, as well as to design new games that result in enjoyment as a desirable user experience. The model should be further developed in future research to establish a more scientifically tested model. Nevertheless, the new model is potentially interesting for future gaming research in the healthcare.

Keywords: user experience, gaming, health games, rehabilitation, and children.

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1. Introduction

The first chapter provides an introduction of this study. It is organized into four sections. Section 1.1 presents the problem description, which is followed by the context of the research in section 1.2. Section 1.3. presents the research question, while section 1.4. delivers the structure of the following chapters.

1.1. Problem description

Nowadays games do more than entertain. In relatively short time, the entertainment software has become a valuable partner in serious business of healthcare. Gaming is considered as a solution to offer intensive treatments and, at the same time, relatively low cost. Games are often used in rehabilitation programs. Rehabilitation is defined as "a dynamic process of planned adaptive change in lifestyle in response to unplanned change imposed on the individual by disease or traumatic incident" (Gunasekera & Bendall, 2005, p.407). Children and (young) adults, who follow rehabilitation therapy as a consequence of variety of deficit from diseases or traumatic incidents, have to practice intensively to increase their chances of recovery (Gil-Gómez, Lloréns, Alcañiz, & Colomer, 2011). However, patients are often not motivated to follow the conventional training program, since the exercises are perceived as less valuable and less challenging (Rego, Moreira, & Reis, 2010). Previous research have shown that the use of games greatly increases the motivation of patients, because patients do not consider the game as a therapy (Tabak, Marin-Perianu, & Hermens, 2012; Prange, Kottink, Krabben, Rietman, & Buurke, 2013).

An important advantage of games specifically designed for rehabilitation purposes is the ability to adapt the exercise to the individual's capacities, as well as their limitations (Gil-Gómez et al., 2011). In this manner, the patients are more motivated to do their exercises on their own level, with meaningful and appropriate feedback. This results in a positive effect on the motor relearning process, enabling a therapeutic effect of gaming. Furthermore, Prange et al. (2013) point out that gaming offers the opportunity to increase the treatment intensity, as the patient can do the exercise independently, without one-on-one supervision of a physical therapist.

The amount of research in the field of gaming in rehabilitation has grown significantly during the past years. Prior studies in this field mainly focus on the effect of the game on patient's health. Tabak et al. (2012), who investigate a game for chronic progressive lung disease (COPD) patients, point out the game could provide an enjoyable way for performing exercise, either at home or as part of the regular treatment. In other research, Prange et al. (2013) investigate a comparison between gaming and conventional training to improve arm function after chronic stroke. Game training showed equally large improvements in arm function as equal intensity conventional training. Prange et al. suggest that gaming is a promising alternative to the conventional rehabilitation exercise.

Based on aforementioned studies, it seems obvious that the healthcare professionals and the researchers are eager to find out whether the patient's health has improved by doing exercises with the game. It should be noted that the patients are positive about the game (Tabak et al., 2012; Winkels et al., 2012). However, the evaluation method of the gaming experience in healthcare context is still lacking. Therefore, this research proposes to explore the gaming experience for health games. The gaming experience is referred as the user experience in this paper. The practical relevance of this study is to increase the fun in games for health, which lead to higher compliance to the therapy, and thus, enabling more effective treatment. The theoretical relevance is to deepen our understanding of user experience of gaming in healthcare context.

1.2. The research context

Games for rehabilitation programs have been an active research area within the last couple years. They have been used to assist therapy after stroke traumatic brain- and spinal cord injury, and in many other areas. Also the focus of therapy is very diverse, such as chronic pain rehabilitation (Schönauer, Pintaric, Kaufmann, Jansen-Kosterink, & Vollenbroek-Hutten, 2011), chronic lung disease rehabilitation (Tabak et al., 2012), or rehabilitation of specific body-parts (Prange et al., 2013). Unlike previous studies, this research has a different target group, namely children with chronic conditions. In particular, two target groups are included in this research: (1) children with balance problems related to brain injury and (2) children with asthma.

This study includes two health games: (1) the Gryphon Rider, an exercise game for children with balance problems and (2) the AIRplayground, an interactive playground to stimulate physical activity for children with asthma.

To be able to execute this study, the researcher is collaborating with the Roessingh Research and Development (RRD), which is a Dutch scientific research center for rehabilitation technology. This institution is linked to the Roessingh Rehabilitation Center, where the children with brain injury are treated for their balance problem. The children with asthma are having their treatment in a hospital, the Medisch Spectrum Twente (MST).

The games are selected merely on practical basis. First, both games are already developed, therefore the games are ready to be played. Second, the games are related to the ongoing research projects of the RRD, and thus, the institution has the network to the health professionals, who were able to help in facilitating the connection to the target group (e.g. children with a chronic condition).

1.3. The research question

In general, gaming is a fun and entertaining activity. Both games, Gryphon Rider and AIRplayground, are promoted as a fun game and are supposed to support the patients go through the rehabilitation in a slightly less tedious process. However, in reality, gaming during rehabilitation process is not always fun. One can imagine that it can be quite frustrating when patients are confronted with their disabilities or impairments while interacting with the game. Therefore, this study attempts to close the gap in the literature about the factors that shape the user experience of health games for children. It is hoped that through positive gaming experience, the children are more motivated, which then leads to higher compliance to the treatment. In order to understand the user experience of applied games, the research question is formulated as follows:

What factors shape the user experience of games for rehabilitation of children with chronic condition?

1.4. The structure of the report

This research is organized into six chapters. The following chapter presents the case studies are used in this study. Chapter 3 presents the relevant theories and studies that are selected and reviewed to provide theoretical framework of the research. Chapter 4 presents the research methodology, data collections, and data analysis procedure of the study that includes children with a chronic condition interacting with game. Chapter 5 is allocated for the presentation and analysis of the data from the interviews with children who played with the games (i.e. Gryphon Rider and AIRplayground). A comprehensive summary of findings and a discussion of points as bases for further studies are contained in Chapter 6.

2. Case studies

In this section, the two health games are elaborated. Also, a general description of the chronic condition of the target group is presented below.

2.1. Game for children with a brain injury

2.1.1. Gryphon Rider

For the children with the balance problems, the RRD has developed an exercise game for balance training, the so called the Gryphon Rider. The trailer of the game can be seen in the following link: https://www.youtube.com/watch?v=ul6ua0qLx6Q. A screen capture of the Gryphon Rider can be seen in Figure 2.1.

Gryphon Rider can be categorized as a "serious game". Zyda (2005) defines a serious game as "a mental contest, played with a computer in accordance with specific rules, which uses entertainment to further government of corporate training, education, health, public policy, and strategic communication objectives" (p.25). From this definition, one can argue that the educational component of a serious game is the one that makes them serious, not just the story, art, and software elements that compose them. Although the entertainment component is important, a serious game should also be able to educate and instruct, enabling the player to gain knowledge and skills.

Figure 2.1. Impression of Gryphon Rider (gryphonrider.com, 2015).

Gryphon Rider is a serious game specially designed for children that are coping with acquired disturbance of equilibrium (gryphonrider.com, 2015), or in simple words: they have trouble keeping their balance. The goal of this game is to support and help children while going through the rehabilitation process of regaining control over their balance (see Figure 2.2).

The technology behind Gryphon Rider is the Kinect, which measures the player's movements and translates them inside the game into instructions for the Gryphon. The data that is captured by the Kinect is automatically processed into graphs, enabling the therapist to supervise and direct the children while they play (gryphonrider.com, 2015).Gryphon Rider can be played both at the rehabilitation center and at home. Also, it allows the patients to play together with healthy family and friends. When the game is played at home, the therapist can follow the rehabilitation from a distance and determine whether the patient needs to come to the clinic for extra supervision.

Figure 2.2. A girl is playing the Gryphon Rider (gryphonrider.com, 2015).

2.1.2. Cerebral Palsy in children

Gryphon Rider is designed for children with brain injury. In particular, the target group in this study were children with Cerebral Palsy (CP). CP is the most common cause of motor disability in childhood. In the Netherlands, almost half of all children in pediatric rehabilitation have CP (BOSK.nl, n.d.). CP is a disorder caused by brain injury or brain malformation that occurs before, during, or immediately after birth, when the infant's brain is under development (cerebralpalsy.org, n.d.). As a result of the brain damage during brain development, a child's muscle control, muscle coordination, muscle tone, reflex, posture, and balance can be affected. It can also impact a child's fine motor skills, which refer to small movements (e.g. picking up small objects and holding a spoon) and gross motor skills, which refer to bigger movements (e.g. rolling over and sitting) that use the large muscles in the arms, legs, torso, and feet (Krigger, 2006).

A child with CP generally has one or more of the three types of impairment of the motor system, which are spasticity, dyskinesia, and ataxia (Novak, Hines, Goldsmith, & Barclay, 2012). Spastic CP is the most common and accounts for approximately 70-80% of all cases. Spasticity is characterized by muscle tone that appears stiff and tight. Dyskinetic is experienced by 6% of children with CP. Dyskinesia refers to a category of movement disorders that are characterized by involuntary muscle movement. Ataxia, which is experienced by approximately 6% of children with CP, is movement disorder typified by uncoordinated movements and inadequate postural control that is evidenced with imbalance and walking disturbance. Moreover, CP can affect different parts of the body, such as: diplegia (both legs), hemiplegia (one side of the body), or quadriplegia (the entire body) (Novak et al., 2012).

CP can be classified by severity whereby the Gross Motor Function Classification System (GMFCS) is very helpful as it indicates how much activity limitation the disorder imposes on the child with CP. Children at GMFCS Level 1 (mildest form) can walk and perform all of the activities of age-matched peers, although with limitation of speed, balance, and coordination. Children at GMFCS Level 5 (most severe) have extreme difficulties with trunk posture and have little voluntary control of limb movement (Palisano, Rosenbaum, Walter, Russell, Wood, & Galuppi, 1997).

2.2. Game for children with asthma

2.2.1. AIRplayground

The other target group is children with asthma. Asthma is the most common chronic disease in childhood. It is acknowledged that self-management is the key to successful treatment of childhood asthma (Klaassen, van Delden, Cabrita, & Tabak, 2017). Health care often fails to support in acquiring self-management skills, resulting in low treatment adherence and treatment failure (Burgess, Sly, & Devadason, 2010). To support children with asthma beyond the medical environment, the RRD developed the AIRplay, which is an app with gaming elements that runs on a smartphone or tablet.

The goal of AIRplay is to improve medication adherence and physical (re-)conditioning, as well as to teach children to self-manage their asthma in a fun manner. To achieve this goal, AIRplay incorporates sensing and smart coaching strategies in a mobile gaming environment. The smart sensor technology is able to measure daily physical activity (i.e. step counter) and to help monitor asthma symptoms (i.e. childhood asthma control test). On the other hand, the smart coaching strategies are able to boost intrinsic motivation (i.e. to perform a physical activity because the enjoyment of oneself), to provide feedbacks (i.e. physical activity, interactive tag playground, asthma symptoms), and to support competition (i.e. goal-setting + taunting/cheering friends).

The AIRplay consists of two components: (1) the interactive tag playground; and (2) the gamified application on smartphone or tablet. In this paper, the interactive playground is refer further as AIRplayground, as it is a part of the AIRplay project. The AIRplayground is an interactive version of the century-old game called "tag" (in Dutch: "tikkertje"). With AIRplayground the player is actively directed to interact with other players. The players are being tracked using Kinects. Different colored circles are projected around each player to indicate the role of tagger or runner. The tagger has an orange circle, while the runner(s) have blue circle. When these circles collide, a "tag" is detected and the roles of the players switch.

Through the AIRplay gamified application, the child with asthma is engaged in physical activities and social interactions. The app continuously monitors physical activity and symptoms. The concept overview of AIRplay is presented in Table 2.1.

Table 2.1. Concept overview of AIRplay

	AIRplayground	**Mobile application (smartphone or tablet)**
Sensing	Physical activity (step counter)	Symptoms, such as Childhood Asthma Control Test (C-ACT)
Coaching strategy	Intrinsic motivation (fun/pleasure)	Feedback (physical activity, Tagging 2.0, and symptoms), Competition (goal setting and taunting/cheering friends)

The AIRplay project is a collaboration between the researchers from RRD, the researchers from University of Twente in the field of human-computer interaction, and the healthcare professionals at Medisch Spectrum Twente (MST). This paper only covers the AIRplayground, as it is considered as a health game. The AIRplay app is categorized as "gamification", which is defined as the application of game elements and game principles to non-game contexts (Deterding, Dixon, Khaled, & Nacke, 2011). Therefore, the app is not considered as a game, and thus is not covered in this paper.

Besides the tag game on the AIRplayground, the developers also provided some modifications of the game. There are three modifications of the original tag game: (1) surrounding the runner; (2) collecting coins; (3) avoiding squares. In the first modified version of the tag game, the tagger is supposed to tag other player by surrounding the opponent(Figure2.3). A line appears behind the tagger's circle. Wherever the tagger is moving inside the playground, this line will

follow behind their circle. In order to tag, the tagger have to make a complete circle within three seconds around the runner. When the runner is surrounded within the given time, then the surrounded area is highlighted in bright color. This indicates that the runner has been tagged, and the roles of the players switch.

The second modification is to play the tag game and simultaneously collect coins(Figure 2.4). The idea behind this modification is to stimulate the players to move around to specific location on the playing field by placing the coins that can be picked up. The tagger can collect orange coins, while the runner collect blue coins. When the player gets the coin, it will disappear from the playground. After a few seconds, the coins will appear again in other location on the playing field. Although the game is designed to be played by multi-players, the game also contains single-player mode. The single player can simply move around the playground to pick up the coins.

Moreover, the game also offers a challenge mode, which is interesting for the more advanced players. In this challenge mode, the coins are moving around in the playground(Figure 2.5). Also, another moving object, namely a red ball, is added in the game. When the player collides with the red ball, they will lose a certain amount of points.

The third modification is a single-player game(Figure 2.6). The game generates multiple mini squares, which moving gradually from one-side to the opposite side of the playground. The player is supposed to avoid as many squares as possible. The idea of the game is to stimulate the player to run from side-to-side in order to avoid the squares for certain time limit. When the time limit is over, the game produces a bell sound effect, indicating the player to switch role with another player.

Figure 2.3. Tagging the opponent by making a circle around the opponent

Figure 2.4. Collecting coins

Figure 2.5.Challenging mode: with moving coins and a red ball.

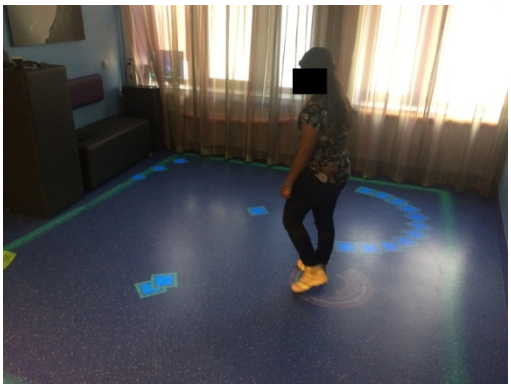

Figure 2.6. Avoiding squares

2.2.2. Asthma in children

The game AIRplayground is particularly aiming at children with asthma. In the Netherlands, about 5% of children between the age of 4-11 years old are coping with asthma (Boerdam & Knoops, 2016). Asthma is an inflammatory disease of the airways of the lungs. It is characterized by variable and recurring symptoms, including episodes of wheezing, coughing, chest tightness, and shortness of breath (Boerdam & Knoops, 2016).

Children with asthma are often discouraged from participating regular activity, which eventually lead to dropping out of play and sports. Many environmental factors have been associated with development and exacerbation of asthma, for instance dust mite, air pollution, tobacco smoke, and perfume. However, the extent to which each one of these factors induces exacerbation is highly personal (van den Bemt, Kooijman, Linssen, Lucassen, Muris, Slabbers, & Schermer, 2010).

Children with asthma are capable to manage their condition and get rid of most of their symptoms. Successful asthma control can be achieved by medication adherence, physical exercising, and education, which are aiming at improving ability of children to control their asthma themselves (Klaasen et al., 2017). Technology-based intervention, such as the AIRplayground, supports children in achieving asthma control in two main areas: (1) physical conditioning and (2) social, emotional and mental aspects (Klaasen et al., 2017).

First, self-management of asthma related to physical conditioning. It is generally accepted that maintaining active lifestyle is a matter of the utmost importance for management of asthma symptoms, and therefore, children with asthma must be encouraged to engaged in physical activity (Mancuso, Choi, Wenderoth, Wells, & Charlson, 2013; Walker & Reznik, 2014). Children with uncontrolled asthma is less fit. They report experiencing limitations related to various activities that involve a physical effort, such as playing outside, carrying heavy weights, or swimming (van den Bemt et al., 2010). Uncontrolled asthma is often associated with less time spent in intensive physical activity, resulting in reduced fitness (Vahlkvist & Pedersen, 2009). As consequence, children with asthma are more likely to be overweight, which might bring additional health related problems (Leinaar, Alamian, Wang, 2016). AIRplayground might support children in achieving the recommended levels of physical activity at their own pace, thereby increasing their asthma control.

Second, self-management of asthma related to social, emotional, and mental aspects. According to the literature, there is no consensus whether children with asthma are differently engaged in physical activity than children without asthma (Leinaar et al., 2016). However, children with asthma feel they are different, less popular, and lonely because of their disease and medication they have to take. Moreover, since children with asthma experience limitations during sports or any other activities with peers, they are often bullied, left out, and not believed by their peers (van den Bemt et al., 2010). AIRplayground might support social integration of children with asthma by enabling initiatives that require cooperation between children within the same group.

3. Theoretical framework

This chapter provides a summary of literature related to the user experience of games in the healthcare context. This chapter is divided into six sections. Section 3.1. describes the concept of user experience in general. Section 3.2. explains the gaming experience, while the models of the gaming experience are presented in Section 3.3. Other factors that considered to shape user experience of health games are social experience, which is elaborated in Section 3.4, and physical experience, which is presented in Section 3.5. The last section provides a brief review of the concepts that are presented in this chapter.

3.1. User experience

In the field of human-computer interaction (HCI), the user plays a major role. Therefore, this research proposes to explore the user experience of applied games for rehabilitation program. The ISO Draft International Standard 9241-210 (2008c) defines user experience (UX) as "a person's perceptions and responses that result from the use or anticipated use of a product, system, or service". From an HCI perspective, the goal of UX is to understand the role of affect as an antecedent, a consequence, and a mediator of technology (Hassenzahl & Tractinsky, 2006). The concept of UX focuses on positive emotions and emotional outcomes, such as joy, fun, and pride (Hassenzahl & Tractinsky, 2006).

The term "usability" is often included in a common umbrella of "user experience". The definition of usability in ISO FDIS 9241-210: "Extent to which a system, product, or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use". Based on the definitions, Bevan (2009) argues that the measures of user experience are similar to the measure of satisfaction in usability. However, a distinction can be made between the methods of measurement of two terminologies. Usability methods have the objective of improving human performance, whereas UX methods have the objective of improving user satisfaction with achieving both pragmatic and hedonic goals (Bevan, 2009). According to Hassenzahl and Tractinksky (2006), pragmatic goal of interactive system refers to the system's ability to support the achievement of behavioral goals (i.e. usefulness and ease-of-use). On the contrary, hedonic goal refers to the users' self, which relates to stimulation (i.e. the system's ability to stimulate and enable personal growth), identification (i.e. the system's ability to address the need of expressing one's self through objects), evocation (i.e. the system's ability to evoke memories and feelings).

The usability is a characteristic of the interaction between the user and the system (Mcnamara & Kirakowski, 2006). In other words, usability is about task-based interactions, the ability to do something intuitively and easily, and eliminating roadblocks. The user experience consider a wider relationship between the user and the system in order to investigate the individual's personal experience of using it (Mcnamara & Kirakowski, 2006). Thus, in this research, the user experience is how a person feels when they interact with the health game for rehabilitation purposes and their emotional connection to the task, which is namely to exercise as part as their therapy.

3.2. Gaming experience

Digital games can be found in various forms of applications (e.g. mobile games, online gaming, virtual reality, etc). Consequently, one-size-fits-all approach to the conceptualization and measurement is very difficult to accomplish (Bernhaupt, Ijsselsteijn, Mueller, Tscheligi, & Wixon, 2008). Terms, such as *fun, immersion, flow,* and *presence* are often used to explain UX in games. The term immersion refers to the sense of being away of the real world (Brown and Cairns, 2004).

The term flow, which is deriving from the field of positive psychology, refers to a state that an individual achieves after completing a series of steps while engaged in task (Csikszentmihalyi, 1990). In other words, being in flow is often said as being in "the zone". Besides, presence refers to the sense of being inside a virtual world (Slater & Wilbur, 1997).

Sweetser and Wyeth (2005) suggested flow as an optimal experience, which can be achieved by playing digital games. In contrast, immersion and presence do not automatically mean that the player is having an enjoyable activity. Being immersed and being in the state of presence are valued, but not the most favorable experience. Sweetser and Wyeth argue that it is the activity that determines the degree of the experience.

This study aims to investigate on gaming experience that results in enjoyment as favorable user experience. Even though the gaming activity is to exercise as part of a therapy, the player should experience the game as enjoyable. Therefore, this study tend to ignore to use the terms immersion, flow, and presence. One can argue that, firstly, it is difficult to achieve immersion, flow, and presence in health games, because the player is dealing with a physical impairment and limitation. Moreover, the therapy training only last for a short amount of time (i.e. more or less 30 minutes) and requires a lot of attention while interacting with the game. Calvillo-Gamez et al. (2015) argue that immersion, flow, and presence are extreme experiences. For example, when playing a game in the bus, the player still have to pay attention on the bus stop, how long the trip is, and whether he is on-time at his destination, etc. Thus, the player hardly achieves immersion, flow, or presence. In this case, playing game is just to pass time. It is not playing game for hours and hours, until the player forgets being in the real world. Secondly, the target group in this study is children. They might not understand the terms immerse, flow, and presence. These terms are rather too abstract for the young participants.

Enjoyment is the term that is used in this research to explain the UX of health games. It is acknowledged that enjoyment greatly increases the motivation of playing a health game, because the player does not consider the game as therapy (Tabak et al. 2012; Prange et al. 2013). Therefore, it seems to be a solid argument to use enjoyment as a main concept in this study.

3.3. Models of gaming experience

Two gaming experience models are elaborated in the following sub-sections. These two models explain the aspects of gaming experience that lead to good experiences. In particular, user experience of digital game that results in enjoyment.

3.3.1. Core elements of gaming experience

Calvillo-Gamez et al. (2015) investigate the core elements of gaming experience (CEGE). The data, which is used to develop the model, is based on the opinion of game reviewers. These reviewers are intended to describe the game, as well as to evaluate the game. So, the reader understand the idea of playing the game, and therefore, can decide whether they might like to play it. Thus, the reviews must necessarily refer to the elements of the game that lead to good experiences. Based on this investigation, Calvillo-Gamez et al. designed a questionnaire to evaluate UX in video games. The evaluation questionnaire has a focus on enjoyment as a key UX dimension.

The CEGE incorporate two elements: (1) video-game itself and; (2) the interaction between it and the user, which is labeled as "puppetry" (Calvillo-Gamez et al., 2015). The term *puppetry* refers to a metaphor for how a player is able to have agency within a game, while also being outside the game as the controller. Calvillo-Gamez et al. describe the *puppetry* as the fusion of the player with the actions available in the game that leads to a state akin to a puppeteer controlling a puppet.

Both elements, video-game and puppetry, are producing the enjoyment. The video-game is perceived by two elements, which are: (1) game-play and (2) environment. So, a video-game has, on one hand, the *game-play* that defines what the game is about, its rules and scenario. On the other hand, the *environment*, which refers to the way the game is presented to the player, the physical implementation into graphics and sounds.

The puppetry, which is the interaction of the player with the video-game, is affected by three conditions: (1) control, (2) ownership, (3) facilitators (Calvillo-Gamez et al., 2015). First, *control* refers to the process of the player learning to manipulate the game. Once the player starts to grasp control of the game, the player manage the game with the intention to make it his. Second, *ownership* is when the player takes responsibility for the actions of the game. The player feels the game as theirs, because of the result of their conscious actions. Then, the game acknowledges the ownership of the player by providing rewards. Third, *facilitators* are the external factors relate to the player's subjectivities (e.g. previous experience with similar games). It has been mentioned that in order to produce enjoyment, the player should get in control of the game, which leads to achieving ownership. However, it is possible for the player to achieve the ownership, then gain positive experience, even if the player fails to get control. Also, the player may have control, though they fail to achieve ownership, and still gain positive experience. This happens by the use of facilitators (Calvillo-Gamez et al., 2015).

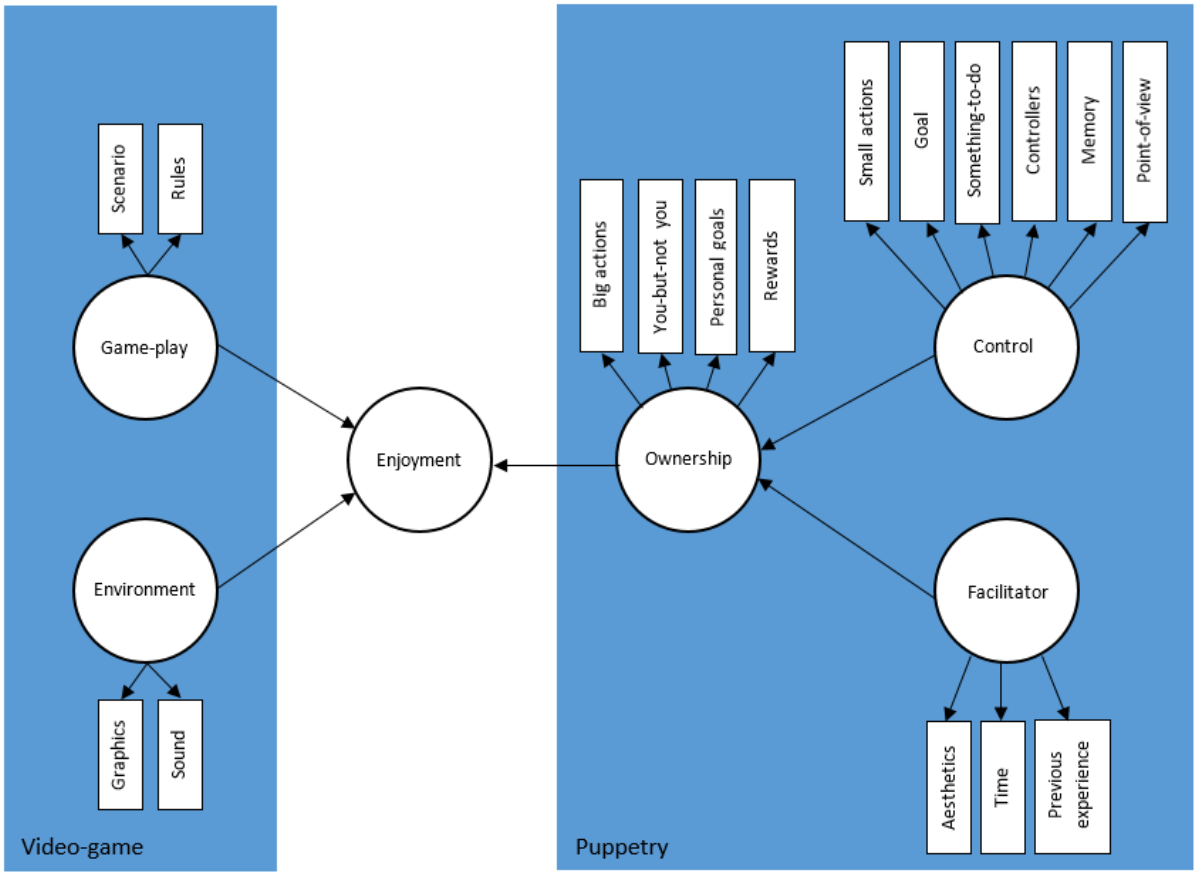

Figure 1. Core elements of Gaming Experience (Calvillo-Gamez et al.,2015).

Figure 1 shows the CEGE model. In the model, each element has several other observable components. The following are the members of each element that belong in the *puppetry*.

Control has six members (Calvillo-Gamez et al., 2015), which are as follows:

- *Goal* is the objective, the player has to understand what is the overall objective of the game, even if still not clear on the details.
- *Small actions* refers to the basic actions that the player can do on the characters, such as moving to the left or to the right.
- *Controllers* refers to the player's manipulation of the physical tool. In other words, controllers are the way through which the player can exercise the small actions, e.g. pressing a button makes the object move to the left.
- *Memory* refers to the ability of the player to recall the connection between small actions and controllers.
- *Something-to-do* refers to the concept that the player must be kept busy, or doing something.
- *Point-of-view* is how the information is displayed to the player.

Ownership refers to the player who once starts to grasp control of the game, he gears the game with his own intentions in order to make it his (Calvillo-Gamez et al., 2015). The process of ownership is described as using the elements that give the player control in his favor to enjoy the game. The elements that influence ownership are as follows:

- *Big actions* are those actions that the player implements as strategies, by using a collection of small actions, in order to complete the goal of the game.
- The player can also draw his *personal goals*, and use *big actions* to complete them. This process of the player achieving the game and *personal goals* through his actions is the basis of the process of ownership.
- The game acknowledges the ownership of the player by providing *rewards*.
- *You-but-not-you* are the idea that the player is engaging in activities that are alien to his everyday actions, which allows the player to create his personal goals.

Facilitator are the most subjective elements of the CEGE (Calvillo-Gamez et al., 2015). The member of *facilitators* are as follows:

- *Time* refers to the amount of time that the player is willing to play.
- *Previous experiences* with similar games or other games.
- *Aesthetic* values are important in facilitating ownership. If the player think the game looks attractive, then he may be willing to try longer.

The model seems to have a good credibility, because it is grounded in the experiences relevant to game players. However, it was recognized early on that the elements were partly hygienic factors leading to a good game-play (Calvillo-Gamez et al., 2015). In other words, the absence of these factors would mean that the players could not have a good experience, but their presence was not a guarantee of a good experience.

This study aims to extend the CEGE model by adding other elements of the UX of health games. Although the CEGE model is originally designed for traditional video-games, some of the elements can also be found in health games. Therefore, one can argue that the model serves as a good basis to further investigate the UX of games for rehabilitation of children with a chronic condition.

3.3.2. Game experience questionnaire

IJsselsteijn, De Kort, Poels, Jurgelionis, and Bellotti (2007) also attempt to identify the aspects of a gaming experience constitute a good experience. They emphasize the need for better measures

of the gaming experience and identified the terms *flow* and *immersion* as important concepts that should be better explored in relation to specifying the general gaming experience. In another paper, Poels, De Kort, and IJsselsteijn (2007) used a focus group methodology to talk to players about their gaming experiences. Then, Poels et al. construct a comprehensive set of categories that capture the major components of the gaming experience that occur both while playing, as well as subsequent to playing. The following are the nine items in the questionnaire: *enjoyment, flow, imaginative immersion, sensory immersion, suspense, competence, negative affect, control,* and *social presence.*

It should be noted that a validated form of this questionnaire has never been published and has not been made generally available by the authors (Cairns, Cox, & Nordin, 2014). However, some research groups used the GEQ to evaluate gaming experiences in many contexts, such as in educational games (Law & Sun, 2012) and the influence of 3D on gaming experience (Schild, LaViola, & Masuch, 2012). Furthermore, another reason for not using the GEQ in this research is because it includes the terms *immersion* and *flow*, which are already discussed in section 3.2.

The one and only component of GEQ that has received public validation is the "social presence". IJsselsteijn et al. (2007) describe the *social presence* as a component that contains psychological and behavioral involvement of the player with other social entities, which can be either virtual (i.e. in-game character), mediated (e.g. others playing online), or co-located. De Kort and IJsselsteijn (2008) made an effort to further investigate the social context in digital games. The literatures of *social presence* mainly concerned adults and children involved in traditional digital game-play. This study includes health games for a more specific target group, namely children with a chronic condition. One can argue that the social aspect is an area worth investigating for the aforementioned specific target group.

3.4. Social experience

Digital gaming brings many opportunities for social interaction. Apparently, people enjoy playing together or watching others play, sharing comments, and enjoying the experience that comes from a crowd (Jansz & Martens, 2005). Some scholars argue that it is the social interaction and participation that, to a large extent, explain the game enjoyment (Bryce & Rutter, 2003; Carr, Schott, Burn, & Buckingham, 2004).

However, the social aspects are often underrepresented in the conceptualizations and theories of gaming experience and enjoyment (De Kort & IJsselsteijn, 2008). It is argued by De Kort and IJsselsteijn (2008) that the concept of social interaction often contradicts with the conceptualizations of flow and immersion. The concept of flow and immersion are thought to be highly sensitive to external distractions, such as the presence of other people. Explanations of flow and immersion experiences often described as a mental absorption, a trance-like state, focus, or the loss of awareness of others (e.g. Holt & Mitterer, 2000). From this perspective, social interactions and concepts of flow and immersion represent potentially conflicting mechanism of gaming experience (De Kort & IJsselsteijn, 2008). Moreover, Sweetser and Wyeth (2005) also state: "social interaction is not an element of flow, and can often interrupt immersion in games […] However, it is clearly a strong element of enjoyment in games" (p.10).

Research with adolescents and adults has demonstrated that playing games with others adds to the game experience. Mandryk, Inkpen, and Calvert (2006) demonstrate that playing against a co-present friend elicits higher engagement, arousal, and more positive emotions (fun) than playing against a computer. Interestingly, playing against a stranger is also more arousing than against a computer, though not quite as much as competing with one's friend (Ravaja, Saari, Turpeinen, Laarni, Slaminen, & Kivikangas, 2006). Research into the social interactions of children during game-play has focused mainly on the influence of play configuration on the use and experience of educational games. Positive effects are reported on performance, social

interaction, and motivation for small group interactions around computers in classrooms (e.g. Hawkins, Sheingold, Gearhart, & Berger, 1982; Watson, 1990).
Social experience in health games is related to social interaction while playing the game. Research into exercise games for seniors shows that social experience was positively related to game experience (Nawaz, Skjæret, Ystmark, Helbostad, Vereijken, & Svanæs, 2014). The seniors also stated that the game would become more useful if it supported the social experience and allowed them to play with other peers. This study includes two health games that can be played with multi-players, thus offer opportunities for social interaction. Little is known about the social experience and its influence of the UX of health games for children with chronic condition. Also, it would be extremely useful to position the concept social experience more precisely in relation to the other concepts of UX of health games. Therefore, this area needs further investigation.

3.5. Physical experience

During rehabilitation, an important aim is to stimulate the recovery of a lost function of a particular part of the body. Health games for rehabilitation purposes offers physical exercises for the affected body parts. Burke, McNeill, Charles, and Morrow (2009) point out that a player with a physical impairment may not have been players of digital games prior to their trauma. They may be unfamiliar with the game technology. They may also going to have limited mobility in their affected limbs and, consequently, the risk of players not engaging with the game is high. Therefore, it is necessary to handle failure in a positive way, so that the players are more likely to remain engaged and not feel that the failure in the game stems from their impaired physical abilities.

An individual with moderate or severe impairments may only be able to move their arm within a small range and may not be able to achieve much in the real world (Burke et al., 2009). When a game is structured appropriately, the gaming environment allow individual with impairment to achieve much more.

Burke et al. (2009) also point out that challenge in health game should be adaptable. The game difficulty can be set to adapt according to the player's in-game performance and abilities. Thus, an adaptable challenge refers to the game elements that can be changed to maintain an appropriate level of challenge, making the game easier or harder as controlled by the player's performance.

Physical experience refers to the physical activity while playing with the game. Since the physical exercises are important part of health games, it seems necessary to investigate the position of the physical experience in relation to the other concepts of UX of games in healthcare.

3.6. Conclusion

Existing theory on core elements of gaming experience is used as basis framework in this study. Besides, the study also investigates other factors that are necessary for positive experience while playing a game, such as *social experience* and *physical experience*. Although these factors are often used in digital games, there is a lack of research focusing in social aspects and physical experience in health games for children with a chronic condition. Therefore, this area needs further exploration.

4. Method

This study was designed to explore the factors that shape the user experience (UX) of health games for children with chronic condition. Two distinct health games were included in this study. First, the Gryphon Rider, a game that is designed for children with balance problem related to brain injury. Second, the AIRplayground, which is an interactive game that is designed to stimulate daily physical activity of children with asthma.

To be able to explore the factors that shape the UX of the Gryphon Rider and the AIRplayground, this research is designed as follows: First, the children were asked to play the game that is suited for their specific condition. Second, a post-gaming interview with the player regarding their experience with the game.

4.1. Research instrument

Interviews were employed as data collection method. Interview is a suitable method for research with children, especially with small number of respondents (Markopoulos, Read, MacFarlane, & Höysniemi, 2008). One advantage of the interview is that a lot of detail can be obtained. Moreover, interview do not require children to read and write, which is essential for gathering information from young children, who particularly were also physically disabled children. As the interviewer is present to clarify unclear responses or ask follow-up questions to interesting responses, the gathered data can be more informative. Also, the interviewer can evaluate directly whether the child understands a question and can also determine the degree of comfort the child has with their answers (Markopoulos et al., 2008).

The interview questions, which can be found in Appendix A, are based on current knowledge on gaming in rehabilitation and the factors that influence the user experience of games, as was discussed in the theoretical framework. During the interview, all participants were asked questions that were relevant to the game they played (i.e. Gryphon Rider or AIRplayground). The interview question is related to seven topics. The first topic is "enjoyment", which serves as main topic in the interview, including broad questions, for example: what do you think of the game, and why do you like or dislike the game. The other five topics, serve as sub-topics, include more specific questions related to the game elements, game environment, physical aspect of the game, social experience, and daily activity. Considering that children tend to give short answers, these sub-topics with specific questions give them the opportunity to elaborate their answer on the main topic. The last topic includes demographic questions, such as age, gender, type of disability, and experience with computer games in daily life.

In the interview, each participant was provided with a set of picture cards (Figure 4.1), which are referred to as "Smiley cards" in this paper. Each card features a smiley, illustrating an 1-5 Likert-scale. The smiley cards are adapted from the picture cards method (Barendregt, Bekker, & Baauw, 2008) and the Smileyometer (Read, MacFarlane, & Casey, 2002). Each smiley was printed on a 5x5 cm carton paper, without the words. The participant was asked to answer each question by showing the appropriate card simultaneously. Then, the interviewer asked the participant to clarify their answer or to elaborate further.

The method used in this study differs considerably from the picture card method by Barendregtet al. (2008), in two main points: First, the smiley cards used in this study reflect a Likert-like score scale, in contrast to the eight specific emotional conditions of Barendregt et al. (2008) that are meant to identify usability problems on children's interactive products. Second, the study is post-test oriented, whereas the picture card method is used during the interaction with the product. As both games (i.e. Gryphon Rider and AIRplayground) are fast-pace, using the Smiley cards during the test would likely interrupt the interaction with the game.

Compared to the Smileyometer by Read et al. (2002), this study addresses one key difference. The participant has immediate contact with a single researcher, who can ask further question upon their judgments. This process is more likely to lead to open discussions than when the children are just ticking the smiley faces on a questionnaire. Moreover, the Smileyometer is similar to a scale that is often use to indicate children's feeling about certain experience on a medical treatment (e.g. to express pain, pleasant, or enjoyment). It was expected that the children with chronic conditions would be familiar with such a scale.

Figure 4.1. The Smiley cards

4.2. Participant and study procedure of the Gryphon Rider (Case study 1)

4.1.1.Participant characteristics

In the study with the Gryphon Rider, the participants were children that have balance problem related to brain injury. In particular, the balance problem must be the result of Cerebral Palsy (CP).

The participants were children between 8-13 years of age. All participants must be able to communicate in Dutch because the game setting and the interview were in this language. It was decided to exclude children with moderate or severe learning disability, as the Gryphon Rider might be overwhelming for this group. Also, children with physical impairments that pose a safety risk for doing exercise with the Gryphon Rider, were excluded in this study.

A total of five children with CP participated in this study. The demographic of participants with brain injury is presented in Table 4.1.

Table 4.1. Demographic of participants with brain injury (n=5)

	Gender	Age	Chronic condition	Familiarity with the game
P1	Male	13	Cerebral palsy	Yes
P2	Male	10	Cerebral palsy	No
P3	Male	12	Cerebral palsy	No
P4	Female	8	Cerebral palsy	No
P5	Female	11	Cerebral palsy	Yes

4.1.2. Study procedure

The study took place in a therapy room in the pediatric department of Roessingh Rehabilitation Centre. The data collection was done in the last week of June 2017 and was arranged on participant's regular scheduled clinic visit. To ensure the safety of the children, their personal therapist was present at the moment of playing the game. A declaration of the University of Twente ethical committee was received that the study fulfill to the criteria of the research involving human subject act. All participants and the parents provided a written informed consent (Appendix B).

The study procedure was as follows. The participant was asked to play the Gryphon Rider for about 15 minutes. After playing the game, the participant answered a few questions regarding their experience with the Gryphon Rider. During the interview, the Smiley cards were spread out

on a table in front of the participant. Then, the participant was asked to place and show the card to the administrator to indicate their feelings about certain experience in the game. The interview questions can be found in Appendix C. The study procedure of each session is presented in Table 4.2.

Table 4.2. The study procedure of Gryphon Rider session

	Activity	**Material(s)**	**Time**
1	Welcome		
2	Explaining the goal of the research		2 min.
3	Obtaining informed consent	Informed consent form	1 min.
4	Start video and audio recording		0 min.
5	Explaining Gryphon Rider		1 min.
6	Play with Gryphon Rider	Gryphon Rider, pediatric department	15 min.
7	Post-interaction interview	Interview scheme + smiley cards	10 min.
8	Assessing demographics	Interview scheme	1 min.
9	Closure		
		Total time	**30 minutes**

4.3. Participant and study procedure of the AIRplayground (Case study 2)

4.2.1. Participant characteristics

In the study with the AIRplayground, the participants were children with asthma, between 7-11 years of age. All participants must be fluent in Dutch language. It was decided to exclude children with physical impairments that pose a safety risk for playing in the AIRplayground.

Five children with asthma participated in this study. The demographic of the participants of the AIRplayground is presented in Table 4.3.

Table 4.3. Demographic of participants with asthma

	Gender	**Age**	**Chronic condition**	**Familiarity with the game**
P6	Female	9	Asthma	Yes
P7	Male	7	Asthma	Yes
P8	Male	7	Asthma	Yes
P9	Male	7	Asthma	No
P10	Male	11	Asthma	No

4.2.2. Study procedure

The AIRplayground was installed at the waiting room of the pediatric clinic at the hospital (MST). The data collection was done in July – September 2017. A declaration of the MST medical-ethical committee was received that the study fulfill to the criteria of the medical research involving human subjects act. All participants' parents provided a written informed consent(Appendix C).

The research design was as follows. First, the participant was asked to play on the AIRplayground with other asthma patients, parents, or siblings. The participant played the game for at least 30 minutes. Second, the participant was asked to take a pause and answer a few questions regarding their experience with the AIRplayground. During the interview, the Smiley cards were spread out on a table in front of the participant. Then, the participant was asked to place and show the card to the administrator to indicate their feelings about certain experience in the game. The interview questions can be found in Appendix C. The study procedure of each session is presented in Table 4.4.

Table 4.4. The study procedure of AIRplayground session

	Activity	**Material(s)**	**Time**
1	Welcome		
2	Explaining the goal of the research		1 min.
3	Explaining AIRplayground		2 min.
4	Obtaining informed consent (from participant's parent)	Informed consent form	1 min.
5	Play with AIRplayground	Interactive Playground, MST	30 min.
6	Post-interaction interview	Interview scheme + smiley cards	5 min.
7	Closure		
		Total time	**40 minutes**

4.4. Data analysis

The data analysis of the ten semi-structured interviews was done according to thematic analysis method. Braun and Clarke (2006) defined thematic analysis as "a method for identifying, analyzing, and reporting patterns (themes) within data" (p. 79). The thematic analysis contains six stages, which are described in the following paragraphs.

First, the data collected from all interviews were transcribed. During this process, the initial thoughts and ideas were noted down. The transcribed data was read and re-read several times. Also, the recordings were listened several times to ensure the accuracy of the transcriptions. This process of repeated reading and the use of the recordings to listen to the data, results in data immersion, which allows the researcher to be familiar with the data.

Second, the transcriptions were coded. The codes were assigned to interesting features of the data that the researcher considered relevant to the research question. Bottom-up approach was applied to build levels of coding. In bottom-up approach, the researcher created numerous very simple codes. Similar codes were then grouped together. Then, the researcher looked for similarities between the new codes and the items in the original CEGE model. Similar codes were then grouped together and were labelled the same way as in the item from the original model. Furthermore, the entire data set was given equal attention in order to recognize repeated patterns within the data.

Third, the codes were grouped in themes. The process of searching themes revealed larger sections of the data by combining different codes that may have been very similar within the data. All initial codes relevant to the research question were incorporated into themes.

Fourth, the thematic map was developed to aid the generation of themes, as suggested by Braun and Clarke (2006). At this point, any themes that were too diverse were discarded. This refinement of the themes took place on two levels. At first, to check the coded data ensuring a coherent pattern was formed. Then, the themes were considered in relation to the data set as a whole. This process guaranteed the themes to be accurately reflecting what was evident in the data set as a whole (Braun & Clarke, 2006). In this stage, the researcher looked again for similarities between the new developed themes and the themes in the original CEGE model. Similar themes were then grouped together and labelled the same way as the theme in the original model. Further coding also took place at this stage to make sure no codes had been missed in the earlier stage.

Before going to the following stage, another researcher from the RRD acted as a "second coder". The second coder reviewed all transcripts and controlled the assigned codes. In this stage, disagreements between the coders were about the assigned codes and the inclusion or exclusion criteria. These disagreements were then discussed by the two coders until consensus was achieved. Codes for thematic analysis is presented in Table 4.1.

Fifth, the themes were defined and named. Each theme needs to be clearly defined and accompanied by thorough analysis. Considerations were made not only on the story told within individual themes, but also on how these related to the overall story that was evident within the data.

The final stage includes the production of report, which involves selecting examples of transcript to illustrate elements of themes. These extracts clearly described issues within the theme and presented a clear example of the point being made. The report is presented in the results section in the following chapter.

Table 4.1. Codes for thematic analysis

	Codes	**Description of the code**	**Theme**
1.	Graphics	The graphics of the game.	Environment
2.	Sounds	The sounds effect and background music of the game.	
3.	Rules	Opinion about the rules of the game.	Game-play
4.	Body movements	Opinion about the body activities that the player needs to execute in the game.	Control
5.	Cognitive load	The total amount of information one can process while playing game.	
6.	Difficulty level	Perception of the difficulty level of the game.	
7.	Action	Player's actions that are performed in order to accomplish the goal of the game, e.g. to collect coins as many as possible within a certain time limit.	Ownership
8.	In-game instruction	The instructions of the game through voice-over narration or text.	
9.	External instruction	Refers to the instructions of the game that are provided by an administrator (i.e. person who is supervising the children when they are playing with the game), or a therapist.	
10.	Personal goal	The player's personal objective in the game, for example: to get more coins than previous achievement in the game.	
11.	Sport/daily exercise	Player's sport or daily exercise.	Personal activities (Facilitator)
12.	Frequent of sport/exercise	Frequency of doing sport or daily exercises.	
13.	Post-gaming physical condition	Player's feeling of their body after gaming.	Player's condition (Facilitator)
14.	Limitation	Player's (physical) limitation in daily life.	
15.	Familiarity with this game	Player's familiarity with this particular game (e.g. previous interaction with the game).	Familiarity with game (Facilitator)
16.	Familiarity with other game(s)	Player's familiarity with other computer games.	
17.	Preference of game within game	Player preference of game within the game. For example, there are 3 games within the AIRplayground, which are as follows: tagging, collecting coins, or avoiding squares.	
18.	Gaming as a distraction from treatment	Gaming is seen as a tool that is able to distract the patient from the (physical) treatment.	Perceived benefit of exercising with games (Facilitator)
19.	Benefit for health	Exercising with game is beneficial for the player's health.	
20.	To release some energy	Activities, such as exercising, allow releasing some energy.	
21.	Collaboration	Player prefers to collaborate with others in the game (e.g. to collect coins together with others).	Social experience (Facilitator)
22.	Competition	Player prefers to compete with others in the game (e.g. to win from the opponents).	

23.	Play game at home	Intention to play the game at home.	Play game in other location (Enjoyment)
24.	Play game at school	Intention to play the game at school.	
25.	Game enjoyment	Experience while playing the game.	Enjoyment
26.	Play game in the future	Intention to play game in the future (e.g. I would play this game again).	
27.	Play game in therapy	Intention to play the game as part of the therapy.	

5. Results

For this study, 10 semi-structured interviews were analyzed. A total of six themes are derived from the analysis of the interviews, which are as follows: *Environment, Game-play, Control, Ownership, Facilitator,* and *Enjoyment.*

In the following paragraphs, the results are discussed per theme category. The two case studies are relatively non-comparative, seeking to understand its objective more than to understand how it differs from each other. In other words, the information gathered in the interviews from the Gryphon Rider (GR) and the AIRplayground (AP) players were complementary, rather than exploring the differences between the two health games. The GR and AP are both physical health games, thus the experience of the players when interacting with the games are similar to some extent. Therefore, both games are discussed together in this section. Only when a very specific fragment happened in one of the game, then it is clearly specified in the description of the item. In the end of the result section, the thematic analysis network is presented to illustrate the analysis.

5.1. Environment

The theme e*nvironment* includes the following factors: *graphics* and *sounds*. The *graphics* refer to the graphic art of the game, while the *sounds* refer to the sound effect and background music of the game. The two games, i.e. GR and AP, differ greatly in terms of the graphics and sounds. The GR game contains rich animations, sounds effect, and background music. In contrast, the AP contains geometrical graphic arts (e.g. circles and squares). The sounds are rather less prominent in the AP game. The AP has minimal sounds effect and the background music is only apparent on the "avoiding squares" part. The other parts of the game, i.e. tag and collecting coins, are lacking of background music.

All GR players were able to provide appropriate answers to the questions about the graphics and sounds of the game. This indicates that the players recognized the environment of the game. In particular, all GR players described the graphics of the game as remarkably good. The GR players were also positive about the sounds. Two of them (P4 and P5) specifically described the sounds as calm, which were highly appreciated because they dislike loud noises.

> Participant 5 (GR), 11 years old.
> *P5: It's [the sound] not too loud. I particularly don't like loud noises… But the sound is nice, it fits the game well.*

One can conclude that the GR has appropriate environment. Although the game has rich animated graphic arts, the sounds are rather calm, which suits the game well. It is important to note that children with CP are often sensitive to loud noise, as it evokes an overwhelmed feeling. Therefore, a well-balanced environment is necessary for enjoyment of the game.

In contrast, the AP players had more difficulties to describe the graphics and sounds of the game. It seems that the AP players did not recognize the environment. They probably were focusing on the game, interacting with the game on fairly high pace, as well as interacting with other players in the playground. Despite the fact that the AP players could not identify the graphics and sounds of the game, the environment is still an important element of the game. During the observation, it was obvious that the game was very engaging.

5.2. Game-play

The theme *game-play* consists of one element, which is *rules*. Rules refers to the regulations in the game. For both games, i.e. GR and AP, the rule is to play the game with the body as the controller. The Kinect in GR recognizes specific body gestures, such as gesture of the arms, legs, and upper-body. In contrast, the Kinect in AP recognizes the whole body movements.

Only one GR player (P5) gave positive remark on the rules of the game. She considered the game as "cool" because it can be played simply by using body gesture.

> Participant 5 (GR), 11 years old.
> *I: So, why do you think the game is fun?*
> *P5: Because you… You are in a game, and then you have to move. That's really cool!*

When asked about their opinion on the rules of the game, the other players simply gave an answer that the ruled were clear to them. This indicates that the players understood the rules of the game. For the AP players, despite their asthma condition, they did not mind to play the AP game that required intense physical activities.

With regard to the rules, one can conclude that both GR and AP have clear rules, which are necessary to play the game and, eventually, to enjoy the game.

5.3. Control

The theme *control* refers to the process of the player to manage the game with the intention to make it his. In the game GR and AP, *control* is often related to the phase where the player has to overcome the challenges in the game. The theme *control* consists of three items, which are as follows: cognitive load, difficulty level, and body movement.

5.3.1. Cognitive load

The total amount of information one can process while playing game is covered in the factor *cognitive load*. The games GR and AP are not only involving the player's physical ability, but also requiring the player's cognition (the process of thinking) to some extent.

In the GR, the player needs to perform a balance exercise by leaning to the left or right. In the interview with one of the player, P5 indicated that she had difficulty in distinguishing whether she had to lean to the left or to the right. The following is an example of a fragment that is coded as *cognitive load.*

> Participant 5 (GR), 11 years old.
> *I: Was the game difficult?*
> *P5: Sometimes…Sometimes… You have to go to left and right all the time.*
> *I: You have trouble with… You don't know which is left and right?*
> *P5: No. Then, I'm doing this all the time [keeping both arms stretched and forming the letter L with the left hand], but then it's all a bit too late. But, yeah, I managed.*
> *I: Oh I see. That's how you do it.*
> *P5: Yes, you have to react fast.*

From this fragment, it seems that the player could not translate the visual cues in the game into proper direction of the exercise, i.e. leaning to the left or to the right. The player used her left hand as an indicator of the left direction. By doing so, she knew whether to lean to the left or to the right. Although her reaction was a bit delayed, she managed to play the game.

5.3.2. Difficulty level

The difficulty level refers to the perception of the difficulty of the game. In the case of the GR, when the player get into a higher level, the game will be slightly more difficult. In the case of the AP, the player or the administrator can choose the difficulty level of the game. For instance, the variation of the "collecting coins" game, where the coins are moving around and, for more difficulty, a red ball is present in the game too. The player who touches the red ball will lose four points.

In the interview with the AP player, P8 indicated that the game was slightly difficult. He expressed his statement with the middle smiley card. He explained that the most difficult part of the game was when playing the variant of the "collecting coins". According to P8, he did not like the red ball, because it was moving around in the playground, and it might hit you if you were not careful, which might cost you four points.

During the observation of the AP, the children were collecting coins and constantly running around in the playground. However, when they were playing the variant of the "collecting coins", where the red ball is present, they would stop running and only paid attention to where the red ball was heading in that moment. P8 also added that he was searching for the red ball, instead of collecting coins.

> Participant 8 (AP), 7 years old.
> *I: Was the game difficult?*
> *P8: It's somewhat (difficult).*
> *I: Which part of the game is difficult? Which part do you think is the most difficult?*
> *P8: The one with the coins and the red ball that are moving around.*
> *I: … Ah, I see.. Why do you think it's difficult?*
> *P8: Because the coins are running away, and you have to search for them—you need to search for the coins because they are running away and then you don't see the ball at all. It goes—it comes to you quietly and then you don't see it, you just bump into (the ball).. and BOOM! You lose four points.*

5.3.3. Body movement

Opinion about the body activities that the player needs to execute in the game is covered in the code *body movement.* The games GR and AP require physical activity of the player. In the GR, the balancing exercises in the higher level are more complicated. For instance, the game requires an extra pose or movement of other body parts, such as moving the arms.

In the interview with one of the GR player, P4 indicated that the game can be challenging. In the game, she needed to stand with one foot in front of the other, and put the weight on the back leg. At the same time, she had to steer the Gryphon straightforward, which means that she should not lean too much to the left or to the right. P4 considered this difficult, because she had to perform complex movements at the same time.

> Participant 4 (GR), 8 years old.
> *I: Was it challenging for you to keep your balance... To stand with one foot in front of the other, and put the weight on the back leg?*
> *P4: Yes, because you need to steer (the Gryphon) and, at the same time, you need to put one leg behind the other. That's just difficult.*
> *I: Ok.*
> *P4: If you put your leg behind the other at once, then you (automatically) also stop steering… you just stand still.*

5.4. Ownership

The theme *ownership* refers to the event that the players takes responsibility for the actions in the game. *Ownership* involves the following factors: *action, in-game instruction, external instruction,* and *personal goal*.

5.4.1. Action

The factor *action* refers to player's actions that are performed in order to accomplish the goal of the game. This goal can be, for example, collecting coins as many as possible within a certain time limit.

The item *action* is determined by one of the items in *control*, i.e. *body movement, cognitive load,* and *difficulty level.* In the interview with a GR player (see section 5.3.3.), P4 mentioned that she managed to stand straight while putting one of her leg in front of the others, although the movement was rather complex. In this case, she managed to complete her task in the game, which means that the *action* is successful.

On the other hand, the item *action* can also be influenced by one of the items in *facilitator*, for instance the *game preference*. In the interview with P9,an AP player who preferred not to play the AIRplayground with the multiple mini squares modification (P9 referred the multiple squares as "blocks" in the interview). The player is supposed to avoid the squares, but P9 was not able to do so and ended up hitting the squares all the time. In this case, the player did not accomplish the *action*, and therefore, did not enjoy this particular part of the game. The following is a fragment of the interview that is related to *action.*

> Participant 9 (AP), 7 years old.
> *I: Would you play the game again?*
> *P9: Yes, but not with the blocks.*
> *I: Not with the blocks, ok. […] Because? Why do you think it is less fun?*
> *P9: Because I always hit the blocks and I do not like that.*

5.4.2. In-game instruction

In-game instruction refers to the instructions of the game through voice-over narration or text. Only the game GR has in-game instruction. The AP does not contain any in-game instruction.

In the interview with GR player, P5 mentioned that sometimes the instruction was not clear. Especially, when she needed to perform the "arm swing" motion. It seems that the GR did not provide extra instruction, when the motions are not performed correctly. It should be noted that P5 received additional instruction from the administrator, and eventually, performed the "arm swing" correctly. Therefore, the item *in-game instruction* influences the *action*. The following fragment is related to the *in-game instruction*.

> Participant 5 (GR), 11 years old
> *I: Do you understand what the game expected you to do?*
> *P5: Yes. Well, not really… It is with the arm swing, it was not really successful, but it was clear. It [the instruction] was also in the text, what you have to do.*

5.4.3. External instruction

External instruction refers to the instructions that are provided by the administrator of the game. The administrator could be, for example, the therapist or a person who is in charge in supervising the children when they are playing the game. In the interview with AP player, P8 mentioned that the instructions are given by the administrator, which was needed in order to play the game. Therefore, the *external instruction* is related to *action*.

> Participant 8 (AP), 7 years old.
> *I: Do you immediately understand how to play the game?*
> *P8: That is what [name of the trainee of the MST] first explained quickly, and then I knew it too.*

5.4.4. Personal goal

The factor *personal goal* refers to the player's personal objective in the game. For example, AP player P6 mentioned that her personal goal is to collect more coins than the previous game session. It seems that having a personal goal can stimulate the player to play more actively in the playground. Therefore, *personal goal* influences the *action*.

> Participant 6 (AP), 9 years old.
> *I: Was the game difficult?*
> *P6: Yes, to collect the coins. And then you have to try to improve the scores that you already have achieved.*

5.5. Facilitator

The theme *facilitator* refers to external factors relate to the player's subjectivity. The following factors: player's condition, social experience, familiarity with games, and perceived benefit, are grouped under the theme *facilitator.*

5.5.1. Player's condition

The theme *player's condition* includes the following factors: post-gaming physical condition, limitation, sport/daily exercise, and frequent of sport.

(a) Post-gaming physical condition

Post-gaming physical condition refers to player's feeling of their body after gaming. The children were asked to indicate how tired they were after playing the game. Two of the GR players mentioned that they were not tired, which was also expressed by showing the positive Smiley cards. The other three players indicated that they were slightly tired. In particular, P3 indicated pain on his back, because of the pose "standing side bend" that was required in the game.

Moreover, the interview revealed that the player's condition depends on their daily activities. For example, P5 mentioned that she was already tired on that particular day, because she had many activities the past few days. She added, it was not the game that making her tired. Based on these examples, the factor *post-gaming physical condition* are not only from the game, but also related to the player's daily activities.

In contrast, the AP players are more varied in indicating how tired they were. Although they played the game for the same length of time, one of the AP players indicated that he was very tired, which was also expressed with negative Smiley cards. Other players indicated that they were quite tired, which was expressed with neutral Smiley card. But, there was also one player that was not tired after playing the AIRplayground. Sport and its frequency can be used as an indicator of how well the players can handle the physical activity in the game.

> Participant 10 (AP), 11 years old.
> *I: How tired are you now, after playing the game?*
> *P10: [I'm] not particularly tired. I'm just… A little out of breath from running, but it's ok.*

(b) Limitation

Children with CP seems to be self-conscious about their limitation. For example, when they are asked about whether they do any sports, they often also mentioned that they get tired easily [P2, P5], or that they are not able to walk long distances [P4]. In contrast, children with asthma did not mention any limitation.

(c) Sport/daily exercise and frequency of sport/daily exercise

All children were participating in sport. GR and AP players mentioned swimming, hockey, football, rugby, kickboxing, or gymnastic as their sports. One GR player was not actively participating in sport, but she participated in Scouting activities [P5] . She considered scouting as sport, considering her CP condition. The frequency varied between one to three times a week.

5.5.2. Social experience

The factor *social experience* refers to play game with others. Three GR players indicated that if they can play the game at home, they would play with other people. One GR player mentioned that he disliked the idea to play the game at home, simply because he did not want to be bothered by his siblings [P2]. Another GR player liked the idea of competition with her brothers [P4].

All AP players were enthusiastic about playing with others. P6 pointed out that playing together with other people would be more fun than playing by yourself. She added that more coins can be gathered when people play together. In this case, *play game with others* is associated with *collaboration*. In contrast, P10 would play together to win from the opponents, which is associated with *competition.*

> Participant 6 (AP), 9 years old.
> *I: What do you think of playing the game with other people? So, for instance, with your brother?*
> *P6: It will be much more fun than playing alone. Together you will be—you will be able to get more coins.*
> *I: Yes, indeed, then you will be able to get more coins.*
> *P6: And you have a lot more fun.*

5.5.3. Familiarity with games

The factor *familiarity with games* is related to familiarity with the game GR or AP and other commercial games.

(a) Familiarity with this game

Two GR players had played the game before. For both of them, it was one-time experience with the game and it was quite a while ago. It is assumed that the game was still in development at that time. The other GR players had never played this game before.

In the interview with the AP players, three of them had played the game in the hospital before. The other two players had no earlier experience with the game.

(b) Familiarity with other game(s)

All participants were familiar with commercial games. When they were asked whether to play GR at home, two players mentioned they would rather play other games, such as Minecraft or VIVA [P2, P3]. In particular, P3 preferred to play VIVA, because it could be played with a controller, and thus, did not need moving the body to control the game. The following is an example of a fragment that is related to *familiarity with other game(s).*

> Participant 3 (GR), 12 years old.
> *I: Would you play this game at home?*
> *P3: [pause] Hm, I have other games at home, so… Then, those games are my first choice.*
> *I: Ok. So, you prefer the game you have at home than this game?*
> *P3: Yes.*
> *I: …, which game do you play?*
> *P3: VIVA*
> *I: Oh, the football game?*
> *P3: Yes, but then you have a controller, so you don't need to move.*
> *I: Yes, I got it. You think it's better?*
> *P3: Yes.*

The GR and AP players mentioned some games that they played at home, such as GTA 5, Minecraft, and VIVA. They played game on various devices, e.g. Wii, PlayStation, tablet, or on smartphones. All participants played games at home on regular basis.

5.5.4. Perceived benefit

The factor *perceived benefit* refers to the perception of the positive consequences that are caused by performing physical exercises with the game. P1 mentioned that playing GR in therapy could provide positive distraction from the treatment. Another GR player, P4 pointed out that the game allowed her to release some energy, which is for her is an important point when doing an exercise in therapy. The item *play game in therapy* is often associated with the *perceived benefit*. The following fragment is related to the item *perceived benefit.*

> Participant 4 (GR), 8 years old
> *I: Would you like to play this game as a part of your therapy?*
> *P4: Yes.*
> *I: So, you like it enough to do this as a therapy? Why?*
> *P4: It does not look stupid or anything… It's just fun.*
> *I: I see..*
> *P4: Here [with this game] you can release your energy.*
> *I: Ok, that's important to you in a therapy?*
> *P4: Uh-huh (nodding)*

5.6. Enjoyment

The theme *enjoyment* includes four items, which are as follows: *game enjoyment, play game in the future, play game in therapy,* and *play game in other location* (i.e. at home or at school).

5.6.1. Game enjoyment

The factor *game enjoyment* refers to any opinion related to the experience while playing the game. Three of the GR players enjoyed playing the game. This was expressed with the positive Smiley cards. The two others had rather moderate opinions about the game and gave neutral Smiley card for the GR. In the case of the AIRplayground, all players enjoyed the game, which was expressed with positive Smiley cards.

In the interview with AP player, P8 clarified that he enjoyed the game because it is beneficial for his health. Therefore, the *benefit for health* is associated with for *game enjoyment.* The following fragment is related to *game enjoyment.*

> Participant 8 (AP), 7 years old
> *I: Why do you like the game?*
> *P8: Because… It's kind of doing sport. I really like sports. And, for me, it's kind of [an exercise] for the legs to run faster for football and rugby.*

5.6.2. Play game in the future

The factor *play game in the future*, includes *play game in therapy* and *play game in other location*. In the future, the GR and AP can be placed in other location. The GR can be used as a tool for therapy at home, while AP can be placed at school.

In the interview with GR player, P1 mentioned he likes the idea of gaming at therapy, because it can give positive distraction from the treatment. The following fragment is related to *play game in the future*.

> Participant 1 (GR), 13 years old
> *I: Would you like to play the game as a part of therapy?*
> *P1: Yes!*
> *I: Why?*
> *P1: [The game] seems fun to do… you're busy with something… Then, you just forget that you're actually doing exercise for therapy. That's nice.*

Other positive remarks was, for example, gaming in therapy is as a tool to release some energy [P4]. Moreover, P5 added that playing GR would be more fun than regular therapy. Similarly, P3, who had moderate opinion about the GR, stated that he would play the game for therapy, as complementary exercise in physical therapy.

To play the game at home is often associated with play game with other people, such as family members and friends. P1 mentioned that it would be fun to play at home, to challenge others. In the same line, P4 liked the idea of playing GR at home, to create a small competition with her brothers.

All AP players would like to play the game at school, which is associated with playing with others. In particular, P6 mentioned that she would play with fellow asthma patients at school.

5.7. Thematic analysis network

The thematic analysis network illustrates how the codes and the themes are related to each other. The result of this study can be seen in the network, which is presented in Figure 5.1. The results show the extended version of the original CEGE model with specific focus on health games. This proposed model shows the factors that shape the UX of games for rehabilitation of children with chronic condition. The factors were derived from the interviews with the GR and AP players.

The figures in the network are described as follows. The square represents the codes in the thematic analysis, while the circle represents the theme. The thick lines represent the relationship between the themes. The thin lines represent the relationship between the codes, which are based on the co-occurring codes in the interview fragments. The arrow indicates two related codes that were assigned in the interview fragment. Thus, the arrows represent the relation between the factors that was mentioned by the players in the interview. However, the direction of the arrow does not imply causal relationship.

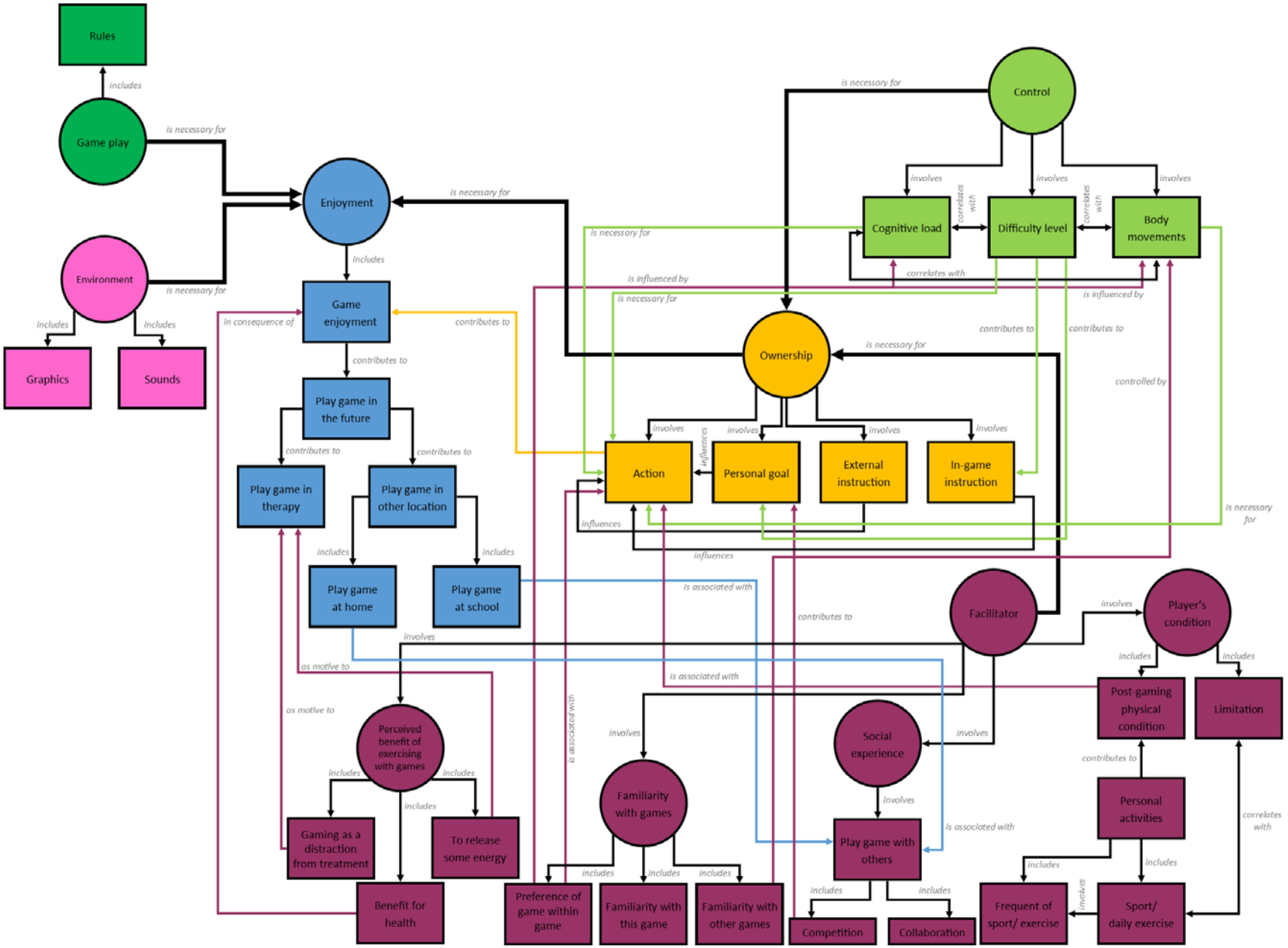

Figure 5.1. The thematic analysis network.

6. Discussion

"What factors shape the user experience of games for rehabilitation of children with chronic condition?" This question starts the exploration of this study. The main goal of this exploratory study is to identify the factors that affect the enjoyment of health games for children with a chronic condition. This chapter begins with a discussion of the main findings based on the theoretical framework in section 6.1., which is then followed by the presentation of the practical and theoretical implications in section 6.2. Then, section 6.3. provides an argument on the limitations of the study and further research. The chapter ends with some concluding remarks in section 6.4.

6.1. Main findings

This section presents the factors that affect the enjoyment of health games for children with a chronic condition. The factors are based on the literature on core elements of gaming experience (CEGE) model by Calvillo-Gamez et al. (2015). Therefore, the main findings are presented based on the six themes of the CEGE model. It appears that the key elements remain the same, however the items of the element are slightly different for health games in this study. In the following paragraphs, the key elements and the items are elaborated further in detail.

6.1.1. Environment

The theme *environment* includes the following items: *graphics* and *sounds*. These items are similar to the items in the original CEGE model. Appropriate graphic and sounds in the game are important for children with a brain injury. Complex patterns and loud noises might cause an overwhelm feeling to these children, so it is highly important to consider their sight and hearing senses when they are playing the game.

However, when the game is very engaging and requires the players to play at a high pace, the children would barely recognize the graphics and the sounds at all. This means that it is not necessary to have high-end graphics and sounds to entertain the children, as long as the game provide an experience that results in positive emotion (i.e. joy and fun), they would enjoy playing the game.

6.1.2. Game-play

The theme *game-play* includes one item, which is *rules*. This is similar to the original CEGE model. The original model also has another item, which is scenario. This is not mentioned by the participants in this study. Perhaps because children do not recognize the scenario of the game, because for most of them it is the first time playing the game. The time of playing the game is rather limited too in this study, so it is reasonable that they don't get the whole picture of the game, including the scenario of the game. Nevertheless, it is necessary to have clear rules. Clear rules are necessary to play the game and, eventually, enjoy the game.

6.1.3. Control

The theme *control* includes three items, which are: *cognitive load, difficulty level,* and *body movement.* All three items are slightly different from the original CEGE model. The item *cognitive load* is quite similar to the item *memory* in the original CEGE model. Cognitive load is a rather broad concept, because it is not only containing memory, but also the ability of solving problems and making a strategy. It is necessary to consider cognitive load as it is referring the player's mental ability in order to play the game appropriately.

With regard to the *difficulty level*, the player should be able to play the game according to their ability. When the game is too difficult, the children will feel discouraged and the game will be perceived as a negative experience. This means that the player is not enjoying the game. In contrast, when the game is too easy, the player will become bored. There should be enough challenges, otherwise it will be boring, and the game experience will be less than optimal.

The item *body movement* is similar to the item *controllers* and *small action* in the original CEGE model. *Controllers* refer to the hardware of the game, such as a keyboard. *Small action* refers to the action that is performed by activating the controller, i.e. moving to the left by pressing the left arrow key on the keyboard. In the case of the GR and AP, the *controllers* refer to the player's body and the *small action* is performed by the body. The participants did not mention these items in separate terms, because they probably were not able to distinguish the two items. These two items are closely related to each other, and children mentioned it as one item, namely *body movement.*

Other factors that are in the original CEGE model but are not mentioned in this study are, as follows: *goal, something-to-do,* and *point-of-view*. These factors might be necessary for adult core gamers, but less necessary for children who play the game as an exercise for therapy.

6.1.4. Ownership

The theme *ownership* includes four items, which are: *action*, *personal goal, in-game instruction* and *external instruction.* The item *action* is similar as the item *big action* in the original CEGE model. *Action* refers to player's action that is performed in order to accomplish the goal of the game. The items *body movement, cognitive load,* and *difficulty level* are necessary for *action.* In other words, the player should be in control of his abilities to be able to perform the action in the game. When the *action* is performed appropriately, it contributes to the player's enjoyment of the game. However, when the player has no (or is lacking) control of his ability, he can still perform *action*, with the help of the *facilitators.*

The item *personal goal* is the same as in the original CEGE model. *Personal goal* refers to the player's personal objective in the game. In this study, the *personal goal* influences *action.* It seems that having a personal goal can stimulate the player to play the game more actively.

In-game instruction is similar to the item *rewards* in the original CEGE model. *In-game instruction* refers to the instructions of the game through voice-over narration or text. *In-game instruction* can be in the form of feedback, compliments, or information that can help the player to level-up or to go further in the game. This study shows that the player's *action* is influenced by the instruction that is given in the game. The children appreciated the feedback when they achieved the goal of the game. The participants also expected more detailed instructions, when they failed to accomplish the exercise in the game. The player should receive instructions that help them to perform the motions correctly. Meaningful feedback is important in health games.

External instruction is the only new item in the theme *ownership. External instruction* refers to the instructions that are provided by the administrator of the game. Considering that most participants are not familiar with the game that they played in this study, *external instructions* are highly necessary to give more information about the game, to support the children, or as technical support to set the game appropriately. In the future, when the children are familiar with the game and have been playing it several times, external instruction might not be needed. Yet, it is necessary that the in-game instruction is presented appropriately and in a correct way, so it is clear for the children to understand the instruction. Clear instruction might be necessary, so the children think that the game has some credibility to score their performance quite fairly.

6.1.5. Facilitator

The theme *facilitator* includes four items, which are as follows: *familiarity with games, perceived benefit, player's condition,* and *social experience*. The only item in the theme *facilitator* that is similar to the original CEGE model is the *familiarity with games*. In the original model, it is labelled as *previous experience*, which refers to whether the player has experience with the game before.

Familiarity with games in the proposed model contains more details, which are: (1) *familiarity with this game*; (2) *familiarity with other games*; and (3) *preference of game within the game*. First, *familiarity with this game* is related to the familiarity with the game GR or AP. Some of the participants have played the game GR or AP prior to this study. These participants were more aware of what to expect of the game. Players who are familiar with the game tend to do better at the game, than players who never played the game before. When they do better than the opponents, the player have more fun. Second, *familiarity with other games* refers to the familiarity with other commercial games. Since the participants are children, they are often considered as "digital natives", therefore most of them have experience with commercial games. The interview reveals that the participants are playing games on a computer, tablet, or mobile phone on regular basis. Third, the item *preference of game within the game,* which mainly were mentioned by AP players because it has various game modes within the game. Players tend to have an opinion on which game mode they liked the most. It is often associated with the *body movement* or the *action* they have to perform in the game. Although the players tend to choose the easiest mode in their opinion, it is unclear whether they would choose the same mode the next time. When they become an expert in one particular game mode, they might choose another game mode with more challenges.

With regard to the theme *perceived benefit*, three items are found in this study, which are as follows: (1) *gaming as a distraction from treatment;* (2) *benefit for health;* and (3) *to release some energy.* First, this study reveals that gaming can be seen as a positive distraction from the treatment. Conventional therapy is often perceived as unpleasant, however, gaming enables the player to divert the attention on the repetitiveness of the exercise. This is often considered as a pleasant experience. Second, the interview reveals that gaming is seen as beneficial for health. In other words, gaming is considered as a complementary exercise that improves physical condition to be able to do better at sports. Third, the participants pointed out that they are not tired after doing exercise on the game. It appears that gaming allows player to release some energy, which does not make them tired, yet feeling satisfied in the end because they have been doing a meaningful exercise.

With regard to the theme *social experience*, two items are found in this study, which are as follows: *competition* and *collaboration*. These items refer to playing the game with others. Competition refers to the players who are playing against each other in order to win the game, whereas collaboration refers to the players who are working together to complete a task in the game. Both games (i.e. GR and AP) have the optional feature to be set as multiplayer game mode. In the case of GR, the participants played the game as a single player, yet mostly liked the idea to play the game with others. In the case of AP, the game was set in multiplayer mode, and the participants were enthusiastic about playing with others. However, one might prefer to play the game in single-player mode. An argument for playing single-player game is simply because one cannot get along well with others.

With regard to the theme *player's condition*, four items are found in this study, which are as follows: (1) *post-gaming physical condition;* (2) *limitation;* (3) *sport/daily exercise;* (4) *frequent of sport/exercise.* All participants were participating in sport. The frequency varied between one to three times a week. *Limitation* refers to the player's physical limitation in daily life. Children with CP seems to be more aware about their limitations (e.g. not being able to walk long distances, get tired easily). In contrast, children with asthma barely mentioned any limitation related to

their condition. The latter group might feel ashamed of their condition. Furthermore, *post-gaming physical condition* refers to player's feeling of their body after playing the game. It seems that every child has a different opinion about how tired they feel post-gaming. The participants used the Smiley cards to indicate the post-gaming physical condition. Considering the variation of the answers, one might suggest to use *sport and its frequency* as an indicator of how well the players can handle the physical activities in the game.

Other factors in the original CEGE model, namely *aesthetic* and *time*, were not mentioned in this study. *Aesthetic* refers to the attractiveness of the game to the player, which might get the player to play a little longer (Calvillo-Gamez et al., 2015). The participants might not pay attention on the detail aesthetic of the game. As long as the game is working properly, the aesthetic value does not really interest them. Moreover, *time* refers to the amount of time that the player is willing to play (Calvillo-Gamez et al., 2015). There were no comments about the time limit of playing the game. Both games were already set on a time limit that is reasonable for the participants. Apparently, the time limit was appropriate for the participants, therefore there were no comment on this item.

6.1.6. Enjoyment

The theme *enjoyment* includes two items, which are: *game enjoyment* and *play game in the future.* With regard to the *game enjoyment*, the group of children with cerebral palsy were considerably positive about the Gryphon Rider, whereas the group of children with asthma were very positive about the AIRplayground. This study shows that the *game enjoyment* arises when (1) the opportunity for action perceived by the player is equal to his ability to control the game; and (2) the exercise in the game is perceived as beneficial for the player's health.

Furthermore, when the game is considered fun, the player will most likely play the game again in the future. *Play game in the future* includes two items, which are: *play game in therapy* and *play game in other location.* It seems that the children are willing to play the game in therapy, because the exercise in the game is perceived as beneficial for their health. Also, the participants were enthusiast about playing the game in other location (i.e. at home or at school), which is often associated with *social experience* (i.e. playing with others).

6.2. Reflection on method

This study used interviews as data collection method. Also, participants were provided with a set of Smiley cards, which were used as a tool to indicate their feelings about the gaming experience. The Smiley cards were useful, as it helped the interviewer to ask further questions upon the participant's opinions. This process seems to lead to open discussions with the children.

Looking back at the process of data collection, it might be important to note that the children with CP appeared to be more fluent in answering the questions and more open into discussion than the children with asthma. An argument for this is that the children with CP have had this condition for their entire childhood, and thus, they are used to communicate with health professionals (i.e. doctors and therapists), who in general always ask open questions. In contrast, children with asthma only come to see doctors when it is highly urgent. The children with asthma tend to give short answers to the open questions. Both group used the Smiley cards during the interview. And it can be concluded that the Smiley cards were useful to help the interviewer to get the children to elaborate their answer. Children with asthma, who were having their medical check-ups at the MST, appeared to be more uncertain when answering question during the interview.

Moreover, the location of the data collection also play a role in this study. The children with CP go to the pediatric department at Roessingh Rehabilitation Center on regular basis (i.e.

once or twice a week). So, the children with CP are familiar with the location of the data collection. They seem to be comfortable with the location, which also helps them feel at ease during the interview. On the contrary, the data collection of children with asthma was located at the pediatric department of the MST hospital. As already stated above, the children were not familiar with the location, and thus, much more effort were needed to make them comfortable for the interview.

6.3. Strengths and limitations

Strengths of this study are as follows. Firstly, the data was gathered through case studies that include real users of the games, which are children with chronic condition. Recruiting children for research studies of all types can be challenging (Foss, Druin, & Guha, 2013). Especially, the challenges of recruitment for this study were more intricate, because we included specific boundaries restricting the participant pool (i.e. cerebral palsy and asthma). The low amount of participants reflect the reality of conducting research with children. The number of children with chronic condition is rather limited in both institutions (i.e. RCR and MST). Some scholars might consider the low number of participants as a limitation. However, the fact that we overcome the recruitment challenges, hopefully can be an inspiration for others to do more research with young participants in different contexts.

Secondly, the proposed model can be used to evaluate the gaming experience of other physical health games for other chronic conditions, for example: COPD, spinal cord injury, stroke, or other neurological condition. These conditions occur on older age groups, therefore the proposed model is also appropriate for different age population (e.g. adults and elderly).

The limitation of this study is related to the type of the game, which in this case only includes physical health games. The games, i.e. Gryphon Rider and AIRplayground, are designed to stimulate motor ability. Also, the study has a limited scope. Therefore, care must be taken when generalizing the results of this study for other games in different fields, such as in educational games.

6.4. Theoretical and practical implications

The main outcome of the study is a new model of user experience for health games. This proposed model can be used as a basis for further research and extension to operationalize this model to establish a more scientifically tested model.

The model aims to better help the healthcare professionals in the identification of factors influencing the UX in health games. In this case, the proposed model can be used by therapists or the management of the healthcare institution as a tool to help in the decision making process of purchasing games that have a potential to be applied in therapy program.

The new model can also be potentially interesting for a broader application than just digital games, such as for the user experience of gamified applications for health. Gamified application, also known as gamification, uses game design elements in non-game context. The proposed key elements can be used to design health-related gamification, which results in enjoyment as a desirable user experience.

In particular, the proposed model can be used by game designers to create a health game that is not only physically beneficial for the player, but also fun to play. The game designer can use the key elements in the model as a tool to support the design process of a health game. In the paragraph below, we present some recommendations for designing a health game in accordance with the key elements in the proposed model.

Recommendations on health game design with regard to the key element *Environment*:

- Consider appropriate graphics for the game. Complex patterns and colorful graphics might be too overwhelming for some players, in particular players with brain injury.
- Consider appropriate sounds for the game. Loud sounds might be distracting to some players.

Recommendation on health game design with regard to the key element *Game-play*:

- Provide clear rules. Clear rules are necessary to play the game appropriately.

Recommendations on health game design with regard to the key element *Control*:

- Moving can demand a lot of mental attention, particularly for people with motor impairment. This create a high cognitive load, especially when learning new movement.
- Provide various difficulty levels. Encourage the player to play according to their abilities, and as their mastery grows shift them to a higher difficulty level.
- Encourage the player to perform movement by giving feedback on movement quality regularly.

Recommendations on health game design with regard to the key element *Ownership*:

- Provide encouraging feedback when the player performed the action appropriately.
- Encourage and support the player to move more actively in the game to be able to achieve their personal goal.
- Present the instructions appropriately and in correct way, so the player understand the instructions.
- Take into account the administrator of the game (i.e. the therapist) who can provide more detailed information about the movements, so not too much information are given at one time.

Recommendations on health game design with regard to the key element *Facilitator*:

- Provide various game modes for player who is already familiar with the game. When a player become an expert in one particular game-mode, he has some options to choose a more challenging game mode.
- Facilitate social experience. Playing with others is fun. Engage other players and also the audiences to cheer the players.
- Know the targeted players, be conscious of their limitation or impairment. Create personas, which are a detailed description of the individual users, of the targeted players.
- Provide therapy-relevant play activities in the game.

Recommendations on health game design with regard to the key element *Enjoyment*:

- Know what motivates the player to play again in the future.
- Consider the location of the game (e.g. at home or at the clinic) and develop the game according to the requirements of the location. For instance, a game for at home requires a limited space to be suitable for playing in the living room.
- Discuss and evaluate the game during the development process with targeted players and the health professionals.

6.5. Conclusion

Gaming is supposed to be a fun and entertaining activity. Health games, such as Gryphon Rider and AIRplayground, are designed for children with a chronic condition to exercise in a slightly less tedious process. This study investigates the factors that shape the UX of health games for children with a chronic condition. The outcomes show that the current gaming experience model was only partly relevant in the healthcare context. Therefore, we proposes a new model of user experience of health games. The proposed model can be used to evaluate health games, as well as to design new games that result in enjoyment as a desirable UX. The model should be further developed in future research to establish a more scientifically tested model.

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Appendix A: Interview questions

ID	Sub ID	Questions	Gryphon Rider	AIR playground	Context
Q1	1a	Wat vind je van de game? *What do you think of the game?*	x	x	Enjoyment
	1b	*Waarom vind je de game leuk?* Why do you like the game? Or why not?	x	x	
	1c	Zou je de game weer willen spelen? *Would you like to play this game again?*	x	x	
	1d	Zou je de game spelen als een onderdeel van je (balans)therapie? *Would you like to play this game as a part of your therapy?*	x		
Q2	2a	Was de game moeilijk? *Was the game difficult?*	x	x	Game elements
	2b	Is het duidelijk wat je in de game moet doen? *Do you understand what the game expected you to do?*	x	x	
Q3	3a	Wat vind je van hoe de game er uit ziet? *What do you think of the looks of the game?*	x	x	Game environment
	3b	Wat vind je van het geluid van de game? *What do you think of the sound of the game?*	x	x	
Q4	4	Vindt je leuk om te bewegen/sporten? *Do you like to exercise/ to do sport?*	x	x	Daily activity
Q5	5	Hoe moe ben je nu? *How tired are you now?*	x	x	Physical condition
Q6	6a	Wat vind je van als je deze game thuis kan spelen? *What do you think if you can play this game at home?*	x		Social experience
	6b	Wat vind je van het spelen van deze game op school? *What do you think if you can play this game at school?*		x	
	6c	Wat vind je als je deze game thuis kunnen spelen samen met andere mensen (e.g. ouders, broer of zus, vrienden)? *What do you think if you can play this game at home with other people (e.g. parents, siblings, friends)?*	x		
	6d	Wat vind je van het spelen van deze game met andere mensen (e.g. ouders, broer of zus, vrienden)? *What do you think about playing this game with other people (e.g. parents, siblings, friends)?*		x	
Q7	7	Leeftijd, geslacht, ervaring met deze game, ervaring met andere games, aandoening(en) . Age, gender, experience with this game, experience with other games, type of chronic condition(s).	x	x	Demographic

Appendix B: Information letter (Gryphon Rider)

Roessingh
Research and Development

UNIVERSITY OF TWENTE.

Enschede, 5 April 2017

Informatiebrief voor ouders

Beste ouders/voogd,

Binnen Roessingh Centrum voor Revalidatie willen we graag de behandeling van kinderen leuker maken. Dit willen we doen met video games. Om te bepalen wat zo'n game nu leuk maakt voor kinderen willen we graag een klein onderzoek doen. We willen namelijk met kinderen 30 minuten een game spelen en hen vragen wat deze game nu leuk of niet leuk maakt. In overleg met behandelend arts, Marc Nederhand, zouden we ook graag uw kind deze game laten spelen en hem of haar hierover wat vragen stellen. Met deze brief willen we hiervoor uw toestemming vragen.

Doel van het onderzoek
Met dit onderzoek willen we te weten komen of de game, Gryphon Rider (waarbij je op een vogel rijdt en zo balansoefeningen doet), leuk is. Ook willen we te weten komen wat het spelen van de game leuk maakt. Met deze informatie kunnen we betere games maken en een positievere ervaring bij het gamen geven.

Het onderzoek
Het onderzoek bestaat uit de volgende onderdelen:

1. We stellen enkele vragen (leeftijd, woonsituatie, ervaringen met games, enzovoort).
2. We gaan de game spelen (15 minuten). Tijdens het spelen is de onderzoeker aanwezig om uw kind te helpen, mocht deze het moeilijk vinden. Ook maken we een video-opname.
3. Na het spelen, stellen we enkele vragen over wat uw kind van de game er vond.

Het onderzoek zal maximaal 30 minuten duren. De video-opnames die we maken zullen we alleen zelf gebruiken om later te bekijken hoe uw kind de game speelde. Daarna vernietigen we deze opnames. Alle deelnemers blijven anoniem: niemand zal weten of uw kind wel of niet mee heeft gedaan, en niemand zal weten wat uw kind heeft geantwoord.

Wij hopen u hiermee voldoende geïnformeerd te hebben. Als u toestemming geeft voor deelname van uw kind, vragen we u en uw kind om het bijgevoegde formulier te ondertekenen en terug te geven aan de fysiotherapeut. Mocht u nog vragen hebben dan kunt u natuurlijk altijd contact opnemen.

Met vriendelijke groet,

Donna Desiree
Universiteit Twente / Afstudeeronderzoeker bij Roessingh Research and Development
Email: d.desiree@rrd.nl
Telefoon: 088-08 75 725

Dr. Lex van Velsen
Senior researcher
Roessingh Research and Development

Figure A 1. Information letter for participant's parents and caregiver.

Roessingh
Research and Development

UNIVERSITY OF TWENTE.

Toestemming (van ouders/voogd)

Naam van het project: **Game UX**
Studie: Onderzoek naar gebruikerservaring van games voor revalidatie van kinderen met chronische aandoening

We verklaren hierbij dat we goed geïnformeerd zijn over de doelen en de methode van deze studie. Al onze vragen zijn beantwoord en we hebben voldoende tijd gekregen om een goede beslissing te nemen over onze deelname.

Onze keuze om deel te nemen aan deze studie is geheel vrijwillig. We hebben het recht om op elk moment te stoppen met onze deelname, zonder een reden op te hoeven geven.

We geven toestemming voor het gebruik van onze data voor de doelen van het Game UX project, zolang dit vertrouwelijk gebeurt en op een wijze waarop de data niet naar een persoon herleid kan worden. Hier bedoelen we mee dat de naam van de deelnemer nooit zal worden opgeslagen met of zal worden gelinkt naar de onderzoeksdata. Dit om de anonimiteit van de deelnemer te garanderen. De resultaten van deze studie mogen gebruikt worden voor wetenschappelijke publicaties en zullen anoniem opgeslagen worden in de elektronische administratie van Universiteit Twente en Roessingh Research and Development in Enschede, Nederland.

Naam:
Naam van uw kind:
Adres:
Woonplaats:

Datum: Handtekening ouders/voogd:

Datum: Handtekening onderzoeker:

Figure A2. Informed consent form for participant's parents and caregiver.

Roessingh
Research and Development

UNIVERSITY OF TWENTE.

Toestemming (van kind)

Naam van het project: **Game UX**
Studie: Onderzoek naar gebruikerservaring van games voor revalidatie van kinderen met chronische aandoening

Ik snap wat het onderzoek naar games inhoudt. Al mijn vragen zijn beantwoord. Ik heb voldoende tijd gekregen om een goede beslissing te nemen over mijn deelname.

Ik kies er zelf voor om mee te doen aan dit onderzoek. En ik mag hier altijd mee stoppen, zonder dat ik hoef te vertellen waarom.

De onderzoekers mogen alles wat ze me vragen en wat ze zien gebruiken voor hun onderzoek. Daarvoor mogen ze deze gegevens ook bewaren, maar wel veilig. Mijn naam zal niet worden bewaard, en niemand zal weten dat ik heb meegedaan.

Naam:
Adres:
Woonplaats:

Datum: Handtekening kind:

Datum: Handtekening onderzoeker:

Figure A3. Informed consent form for the participants.

Appendix C: Information letter (AIRplayground)

Roessingh Research and Development

UNIVERSITY OF TWENTE.

MST

Enschede, 14 Ju□ 2017

Titel onderzoek: AIRplay - gaming onderzoek Interactive Playground

Informatiebrief voor ouders/ verzorgers

Beste heer/mevrouw,

Binnen Medisch Centrum Twente willen we graag de behandeling voor kinderen met astma leuker maken. Dit willen we doen met interactieve games. Om te bepalen wat zo'n game nu leuk maakt voor kinderen willen we graag een klein onderzoek doen. We willen namelijk met kinderen een game spelen en hen vragen wat deze game nu leuk of niet leuk maakt. In overleg met behandelend arts, dr. Boony Thio, zouden we ook graag uw kind deze game laten spelen en hem of haar hierover wat vragen stellen. Met deze brief willen we hiervoor uw toestemming vragen.

Doel van het onderzoek
Met dit onderzoek willen we te weten komen of de game, Interactive Playground, leuk is. De Interactive Playground is een moderne, interactieve versie van het spel "tikkertje". De game is geplaatst in de wachtruimte van het MST. Kinderen kunnen spelen in teams en andere kinderen tikken en vangen. De game kan worden aangepast, dus ieder kind kan op zijn/haar eigen niveau meedoen. Ook is er een "safe house" in het spel, waar je op adem kan komen, of om strategisch in te zetten; je bent daar niet te tikken.

Het doel van dit onderzoek is om te weten komen wat het spelen van de game leuk maakt. Met deze informatie kunnen we betere games maken en een positievere ervaring bij het gamen geven.

Het onderzoek
Deelnemers aan het onderzoek zijn kinderen met astma (7-11 jaar), onder behandeling bij de kinderarts van het MST. Het onderzoek bestaat uit de volgende onderdelen:

1. De kinderen worden uitgenodigd om in het MST te spelen op de Interactive Playground in de wachtruimte van de kinderafdeling, samen met andere kinderen die deelnemen aan het onderzoek. Er is altijd een kinderarts aanwezig op de afdeling tijdens het spelen op de Interactive Playground, voor als de klachten verergeren door inspanning.
2. Na het spelen, stellen we enkele vragen (interview) over wat uw kind van de game er vond. Het interview duurt ongeveer 10 minuten. Er word een voice recorder gebruikt om het gesprek op te nemen.

Het gehele onderzoek zal maximaal 45 minuten duren. De audio-opnames die we maken zullen we alleen zelf gebruiken om later het interview terug te luisteren. Daarna vernietigen we deze opnames. Alle deelnemers blijven anoniem: niemand zal weten of uw kind wel of niet mee heeft gedaan, en niemand zal weten wat uw kind heeft geantwoord.

Wij hopen u hiermee voldoende geïnformeerd te hebben. Als u toestemming geeft voor deelname van uw kind, vragen we u om het bijgevoegde formulier te ondertekenen en terug te geven aan de onderzoeker. Mocht u nog vragen hebben dan kunt u natuurlijk contact opnemen.

Met vriendelijke groet,

Donna Desiree
Universiteit Twente / Afstudeeronderzoeker bij Roessingh Research and Development
Email: d.desiree@rrd.nl
Telefoon: 088-08 75 725

Dr. Lex van Velsen
Senior onderzoeker
Roessingh Research and Development

Pagina 1 van 2

Figure B1. Information letter for participant's parents and caregiver.

Roessingh Research and Development

UNIVERSITY OF TWENTE.

MST

Enschede, 14 Juni 2017

Titel onderzoek: AIRplay – gaming onderzoek Interactive Playground

Informatie voor kinderen

Hoi!

We willen graag wat vertellen over een onderzoek waar je misschien aan mee wilt doen.

We doen dit onderzoek omdat we willen weten of de game, Interactive Playground, leuk is voor kinderen met astma. De Interactive Playground is een spel dat je speelt op een scherm op de grond. Je kan er allerlei spelletjes doen, zoals tikkertje. Je kan spelen in teams en andere kinderen tikken en vangen. In het spel is ook een "safe house", waar je op adem kan komen.

De game staat in de wachtruimte van de kinderafdeling van het ziekenhuis. We zullen je vragen om de game te spelen met andere kinderen met astma. Er is altijd een dokter aanwezig in de buurt, voor als je astma erger wordt door het spelen.

Je mag spelen op de Interactive Playground zolang je wilt. Daarna willen we graag aantal vragen stellen aan jou over de game.

Kinderen aan het spelen in de Interactive Playground

Als je wilt meedoen, mag je dit overleggen met je ouders/verzorgers. Die moeten het natuurlijk ook goed vinden. Als je meedoet met het onderzoek, mag je ook altijd mee stoppen zonder te hoeven vertellen waarom.

Groeten!

Dokter Thio, kinderarts
Donna Desiree, onderzoeker
Lex van Velsen, onderzoeker

Pagina 1 van 1

Figure B2. Information letter for the AIRplayground participant.

Toestemmingsverklaring

Titel onderzoek: AIRplay - gaming onderzoek Interactive Playground

We verklaren hierbij dat we goed geïnformeerd zijn over de doelen en methode van deze studie. Al onze vragen zijn beantwoord en we hebben voldoende tijd gekregen om een goede beslissing te nemen over onze deelname.

Onze keuze om deel te nemen aan deze studie is geheel vrijwillig. We hebben het recht om op elk moment te stoppen met onze deelname, zonder een reden op te hoeven geven.

We geven toestemming voor het gebruik van onze data voor de doelen van het Gaming onderzoek Interactive Playground, zolang dit vertrouwelijk gebeurt en op een wijze waarop de data niet naar een persoon herleid kan worden. Hier bedoelen we mee dat de naam van de deelnemer nooit zal worden opgeslagen met of zal worden gelinkt naar de onderzoeksdata. Dit om de anonimiteit van de deelnemer te garanderen. De resultaten van deze studie mogen gebruikt worden voor wetenschappelijke publicaties en zullen anoniem opgeslagen worden in de elektronische administratie van Universiteit Twente, Medisch Spectrum Twente, en Roessingh Research and Development in Enschede, Nederland.

Naam:

Naam van uw kind:

Adres:

Woonplaats:

Datum: Handtekening ouders/verzorger:

Datum: Handtekening onderzoeker:

Een kopie van het ondertekend toestemmingsformulier en de informatiebrief wordt meegegeven.

Pagina 2 van 2

Figure B3. Informed consent form for participant's parents and caregiver