Motivational Factors in Physiotherapy Games

Master's thesis in Interaction Design and Technologies

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ABSTRACT

Physiotherapy can be a long process. Exercises can be mundane and the progress slow. For the patient, it can thus be difficult to maintain the motivation needed to follow through with the physiotherapy. Especially at home where the physiotherapist is not available to provide help. Games' ability to engage the user could potentially be used to help the patient to stay motivated. It is not obvious how one should design physiotherapy games to make them motivating to play. Hence, this thesis asks what factors should be considered, to maintain user motivation, when designing a physiotherapy game.

To find the factors, several subjects areas were explored, including interaction design, game design, gamification, motivation theory and physiotherapy. Theoretical knowledge was gathered by consulting previous studies, existing commercial games and through interviews with experts within the healthcare and rehabilitation field. The theoretical knowledge was then put into practice. By going through a design process, a concept and a prototype for a physiotherapy game was developed. The game was named *Kinetispace* - a game that uses Kinect to detect when the player performs physiotherapy exercises to refuel a spaceship. *Kinetispace* was playtested with school children to evaluate the prototype.

In total, 22 different factors, to consider regarding motivation in physiotherapy games, were identified. These factors were then divided into eight categories. The list of factors is not definitive as more factors may exist. Also, no conclusions regarding the factors impact on long term motivation can be drawn since the factors should be considered as preliminary results for further studies. They can also serve as a vocabulary for discussing motivation when designing games.

Keywords: Physiotherapy, interaction design, game design, Kinect, eHealth, motivation, gamification.

CONTENTS

1 INTRODUCTION

In physiotherapy, the physiotherapist is the one whom selects the exercises that the patient should do. The physiotherapist shows how the exercises are performed and the patient mimics them. However, the physiotherapist cannot always be present to aid the patient. The patient must then continue the training alone with the aid of printed or photocopied images of the exercises. Still images of movement can unfortunately be hard to interpret for a patient. Furthermore, physiotherapy typically takes time. Progress is slow and often not immediately apparent to the patient and mundane exercises can result in boredom. In turn, this might cause the patient to not do their exercises which prolongs the rehabilitation period.

Motivation is a factor that plays into this. When patients have direct contact with a physiotherapist motivation is not that much of a problem. The physiotherapist's guidance and support is there to provide motivation. But when supposed to repeat exercises at home it is not as motivating. The reasons could be many. Mundane exercises can cause boredom. Slow progress might make the exercises seem pointless. Being isolated at home could be another factor if there are no other people around to give the patient an extra push to exercise.

Information technology and games can potentially counter the motivation problem. Thus, researchers have considered the use of gaming hardware, like the Kinect motion sensor (Ridderstolpe, 2016), to create exertion games to be used in physiotherapy. The argument is often that games are fun and that will help with motivating the patients.

1.1 Research Problem

We, the authors of this thesis, found the argument that games are motivating because they are fun to be shallow and naive. Some games can engage their players for days and months. There are also games that are "fun" but can only retain a player's interest for a few hours. Because of this, we believed that the topic of motivation in physiotherapy games is deeper than "games are fun". Motivational factors must be considered when a physiotherapy game is designed for it to maintain the patient's long-term motivation. Alas, it is not obvious what these factors are. In this thesis, motivation in games is explored with the aim to answer the following question:

What factors should be considered, to maintain user motivation, when designing a physiotherapy game?

1.2 Working Process and Type of Results

The underlying assumption was that the motivational factors existed within psychology, game design and gamification. For answers, this thesis considered psychological models for understanding human motivation. The field of game design was consulted to determine what makes games engaging. Gamification is the process of applying games in non-gaming context (Deterding et al., 2011). Thus, it could provide answers on applying games on physiotherapy. Qualitative data from interviews with people involved with rehabilitation and physiotherapy was also gathered.

The issue was tackled from an interaction design angle by doing research through design (Gaver, 2012). By applying interaction design methods, enriched with game design methods, the thesis sought to provide further insight by going through a design process. During the design process, a prototype of a physiotherapy game was developed and evaluated through playtesting.

The game was later named *Kinetispace*. Kinect was chosen as input device due to its gesture detection capabilities, availability and low cost.

Through this process, factors that plays into maintaining player motivation were observed and compiled into a list. The list groups the factors, describes them and explains where they were observed.

1.3 Limitations

The study was limited to focus on using Kinect for physiotherapy games. Other technologies could have been explored. Alas, that would have required more time and acquiring lots of hardware would have been expensive. Also, Semcon (see section 1.4) had expressed an interest in Kinect and wanted to see its capabilities. The study did however look at existing commercial games that utilizes other technologies.

It was not studied whether if *Kinetispace* can provide long term motivation. This would require patients using the prototype over a longer period. This was not possible due to time limitations. Hence the thesis is a preliminary study that used theory and the design process to find motivational factors. However, by letting people test the prototype it was possible to evaluate their immediate interaction, which served as a first indication of motivation.

The study focused on the front-end game experience that the patient interacts with. For a physiotherapy game, one can imagine a front-end for the physiotherapist where she can access data on the patient's progress, create exercises and set up training programs. A back-end solution could combine the two to create a level of interaction between caregiver and caretaker when they are separated in space and/or time. We recognize the physiotherapist's knowledge, judgement and involvement as key factors in a fully developed physiotherapy game solution. However, the game front-end was the focus since we believed that this part of such solution has most impact on patient motivation when performing exercises on their own.

This is a thesis in interaction design. Code implementation is thus outside of the scope. Technology is however integral to the design. Technological implementation is therefore discussed briefly in cases where it affected the design. Some observations regarding the use of Kinect are also presented as they may be of interest to someone who is interested in developing a physiotherapy game.

1.4 Stakeholders

Several stakeholders were identified for the project. The identified stakeholders were Semcon, physiotherapists, physiotherapy patients and ourselves who were conducting the study.

The project was conducted in collaboration with Semcon. Semcon is an international product development company with their headquarters in Gothenburg, Sweden (Semcon, 2017). They were interested in exploring eHealth; “the use of information and communication technologies (ICT) for health” (WHO, 2017). Semcon had identified eHealth as an emerging business area for them. Hence, they reached out to the master’s programme in Interaction Design and Technologies, at Chalmers University of Technologies, with proposals on master thesis work. One such proposal regarded eHealth, gamification and physiotherapy.

This is how we got into contact with Semcon. Combined, we had knowledge in interaction design, game design, software development, informatics, design of children's technology and an interest in games in general. This background made Semcon’s thesis proposal ideal for us and we were interested in study how to use game design to motivate end user behavior.

The project aimed to benefit physiotherapist and their patients. For physiotherapists, the result of the thesis could be used to develop a tool they could use in their work. The patients would be the end user and thus the player of the game. Their gain would be a game that would aid and motivate them through their rehabilitation.

2 RELATED WORK

The related work chapter explores six different domains. Existing commercial games were consulted for the related work. There already exist several games on the market that focus on exercise. Below, these exertion games are examined as well as previous research related to them. The second part is dedicated entirely to Kinect and previous research on the sensor since it is the platform of choice for this thesis. The third part is design theory that explains the nature of the problems design tries to solve, as well as the different design philosophies that can be used to approach them. Fourthly, game design theory explains what games are, how they can be engaging, and provide tools for creating certain game experiences. After exploring game design, the chapter turns to gamification and how it applies game elements to areas unrelated to games. Finally, the attention turns to motivational theory. Focus is put on one of the major theories in motivational theory and how that theory has been applied to games.

2.1 Serious Games and Exertion Games

Serious games are games intended for other purposes than to be only games. One definition of serious games is “any form of interactive computer-based game software for one or multiple players to be used on any platform and that has been developed with the intention to be more than entertainment” (Ritterfeld et al., 2009).

One sub-category of serious games or games in general is exertion games. Mueller et al. (2015) defines exertion games or ‘exergames’ as digital games that require physical effort from players. Mueller et al. writes that in recent years, interest for these games have increased, both academically and commercially, because they can offer health benefits and new ways to experience games (Mueller et al., 2015).

Commercially there are several exergames available. Examples include *Xbox Fitness* (Sumo Digital, 2013), *Zumba Fitness* (Pipeworks Software, 2010) and *Wii Fit* (Nintendo, 2008). These games attempt to aid the players with training. *Wii Fit*, for example, allows the player to set weight goals and employs a virtual coach that demonstrates the exercises and gives feedback on the player’s efforts. Physically active video gaming has had positive effects on motor and process skills in everyday life activities (Sabel et al., 2016). Findings suggest though, that not all commercial exergames makes the player reach recommended activity and intensity levels for certain health outcomes (Mellecker & McManus, 2014). However, dance games, like *Just Dance* (Ubisoft, 2009) and *Dance Dance Revolution* (Konami, 1999), provides a chance to develop cardiorespiratory fitness (Rudella & Butz, 2015). Rudella and Butz concludes that exergames can be used as a supplement in physical education to provide enjoyable activities and encourage physical activity outside of school. Some exergames that Rudella and Butz recommends are *Just Dance*, *Dance Dance Revolution*, *Wii Fit*, *Wii Sports* (Nintendo, 2006) and *XaviX* (SSD COMPANY LIMITED, 2004).

There is a wide area of research related to exertion games. Some of the research concern different treatments, such as treatment for stroke (Alankus et al., 2010; Davison et al., 2014; Ridderstolpe, 2016) or treatment for obesity (Koivisto et al., 2011; Keum et al., 2015). These studies show promise and promotes rehabilitation by using games but they are very specific, both in what they treat and what kind of games they use.

Other research focus on the design of exertion games, and how these can motivate users (Sinclair et al., 2007; Chen et al., 2014; Mueller et al., 2015; Buddharaju & Lokanathan, 2016). While these studies focus more on developing the methodology of exergaming, and less by designing specific games, they show that the research field is expanding. Sinclair et al. observes that one of the important tasks of exergame designers is to make the game attractive to players while still being effective as an exercise (Sinclair et al., 2007).

When designing serious games for health, it is recommended to adopt practices that the games industry uses for entertainment games (Ushaw et al. 2015b). These practices include selection of appropriate input device, feedback, give response to the player's efforts through rewards, providing a level structure, focus player actions and keeping the game design simple (Ushaw et al. 2015b).

2.2 Kinect

Kinect is a full body motion sensor developed by Microsoft and was originally released in 2010 for the Xbox 360 video game console (Fisher et al. 2014). It featured a camera that could track the bodies of multiple people in 3D space and a microphone for speech input. According to Fisher et al. (2014), Kinect was mainly intended for video games and would expand the field of motion based gaming; an area that had become popular due to the 'Wii-mote' developed by Nintendo for their Wii video game console. However, the Wii-mote is a handheld device and thus only track how the hand moves it and ignore the rest of the user's body. Kinect tracks full body motion and is thus more akin to Sony EyeToy which used body tracking for input, though it was more limited than the Kinect (Fisher et al., 2014). A second version of Kinect (Figure 1) was released in 2013 for Xbox One, the successor of Xbox 360, and improved on the original Kinect's capabilities. Including a wider field of view, higher camera resolution and improved motion tracking (Ridderstolpe, 2016). The second version is also sensitive enough to recognize facial expressions and heart rates (Ushaw et al., 2015a). It has also been noted that Kinect can handle drastic changes in illumination and does not need any illumination to extract depth data (González-Ortega, 2014).

Figure 1. *Kinect v2 for Xbox One*

Kinect is mainly used for video games. However, the functionality it provides have caused developers and researchers to explore other potential uses for the Kinect beyond pure entertainment. Studies have considered the use of Kinect for treating patients with various kinds of conditions. Including rehabilitation for stroke (Ridderstolpe, 2016), Parkinson's disease (Galna et al., 2014), injured athletes (Vernadakis et al., 2014), motor disabilities (Chang et al., 2011) and cerebral palsy (Chang, 2013). Clark et al. (2012; 2013a; 2013b) examined the validity of the data provided by Kinect for posture and gait. Some poor results were noted when discrete time points had to be measured but overall the data was deemed to have a high enough quality to be used in a clinical setting.

Low cost, portability and the fact that no markers need to be attached to the body, have been highlighted as advantages over traditional motion capture systems. However, a marker based system will provide more accurate data (Fernández-Baena et al., 2012; Chang et al. 2012). One reason for this is occlusion (Bonnechère et al., 2014). Kinect is a camera and only has one view point. Thus, joints can be obscured by the body, for example if the hand is placed behind the back (Ushaw et al., 2015a). Depth tracking does however mitigate this problem to some extent. If a hand covers the face, depth tracking can determine if the hand touches the face or not. This makes Kinect superior over similar 2D based systems that does not measure depth (González-Ortega, 2014).

Kinect has a hard time detecting smaller movements like minor tremors and hand clasping (Galna et al., 2014; Hosseinpour, 2015). However, work has been done to enable finger tracking at close range with the Kinect (Cook et al., 2015). Still, large full body movements are what the Kinect excels at and research shows that the Kinect is fully capable to be utilized for this in physiotherapy.

Kinect can be connected to a PC's USB port via a special adapter (Ridderstolpe, 2016). An adapter is not necessary on the original Xbox One because the console has a dedicated Kinect port. However, the newer Xbox One S lack this port and requires the adapter. Reportedly, Project Scorpio (the next version of Xbox One) also lacks a Kinect port (Grant, 2017).

2.3 Design Theory

In science, researchers attempt to dismiss theories by falsifying them (Popper, 1963). However, falsifying is problematic in design research (Gaver, 2012). One reason is that design deals with problems that differ from the ones present in science (Rittel & Webber, 1973). Instead, one may try to solve a design problem through a design process. The design process has been broken down into three stages and which may contain activities described by Design Thinking (Brown, 2008). Different design philosophies exist and here we present human centered design and activity centered design. These differs in focus but agree upon the concept of working iteratively on design. Furthermore, affordances and feedback is also introduced as is their importance to guide the user.

2.3.1 Wicked Problems

Falsifiability is a prominent concept in scientific research. It states that finding proof that confirms a theory is easy. To properly test a theory, one should instead attempt to falsify it by finding cases where the theory breaks. If something happens that the theory forbids, then the theory is wrong and can be dismissed (Popper, 1963). Should one accept falsifiability as the way to do research, then design research becomes an unscientific practice due to vague theories and methods that tries to validate them through confirmation (Gaver, 2012). Design research may be unfalsifiable. However, this is because science and design deals with different kinds of problems.

Rittel and Webber (1973) identified two types of problems, tame and wicked. Science and engineering deal with tame problems. A tame problem has a correct answer and it is clear when a solution has been achieved. The solution is also likely to work on similar issues. In contrast, a wicked problem has no correct answer. Instead solutions are either good or bad and therefore there is nothing that indicates when a solution has been found. Wicked problems are also unique. Thus, what worked on one wicked problem will probably not work on another.

Design is wicked "because design has no special subject matter of its own apart from what a designer conceives it to be" (Buchanan, 1992, p. 16). The designer possesses a broad understanding on how to apply design. When designing however, the designer starts with a loosely defined subject-matter that will be specified and concretized later. Thus, narrowing down the scope to define the problem becomes the main problem (Rittel & Webber, 1973).

2.3.2 Design Thinking

It is hard to adequately cover the diversity of ideas and methods used in all subsets of design with a single definition. The design field expands continuously both as a trade and a research field (Buchanan, 1992). During the twentieth century Design Thinking emerged as a design strategy, and with it also came the need for scientific basis. The reason for this, according to Buchanan, is a will to connect and integrate knowledge from both arts and sciences.

One such scientific endeavor by J. C. Jones is the three stages of design. According to him a design process can be broken down into three separate stages. These stages are called divergence, transformation and divergence (Jones, 1992).

Divergence can be viewed as the explorative phase. Here the problem is undefined and the designers free their minds from preconceptions, research the area and expand the problem space to search for a solution in.

Transformation aims to narrow down the divergent results. The problem space is specified and subgoals are established. Ideas are combined, simplified, discarded, and modified. Here important variables and existing constraints are pinpointed and decisions are made.

Convergence is the stage where the problem is defined and the objective is decided. Vagueness is a sin during convergence and the designer should be tenacious and methodical in removing uncertainties until a single design solution remains.

Design thinking was adapted for business purposes by the design firm IDEO in 1991 and they have developed and refined the concept since. Tim Brown defines a system of three spaces that all design must eventually go through. It is not an orderly list, but rather related activities grouped together (Brown, 2008):

- Inspiration is a group of activities that include defining the problem, researching related work, observing and interviewing users, and defining business constraints and limitations.
- Ideation consists of activities and processes related to generating, developing and testing ideas that may lead to a solution of the problem.
- Implementation is the activities that take the concept from idea to finished product.

Design projects will loop through these design spaces, especially inspiration and ideation, more than once during a design process when new directions are explored and when ideas are refined.

2.3.3 Human Centered Design

'Human Centered Design' (henceforth HCD) is described in *What is Human Centered Design?* (Giacomin, 2014). Giacomin starts by describing how the process of Design Thinking, as explained by Brown (2008), lays the foundation for human centered design.

HCD has its origin in fields such as artificial intelligence, computer science and ergonomics. These origins are apparent in international standards such as ISO 9241-210. This standard specifically recommends six characteristics for HCD (International Organization for Standardization, 2010):

- Use of multidisciplinary perspectives and skills
- Clear understanding of users, tasks and environments

- User-centered evaluation driven design
- User experience consideration
- User involvement in entire design and development process
- Iterative process

HCD emphasizes that user centered systems fail to focus on human needs in their aim to satisfy a certain user model. Giacomin also mentions that contemporary HCD is founded on the use of tools and methods that communicate, interact, and stimulate the people involved in the design process, so that a correct understanding of their needs, experiences and desires are made (Giacomin, 2014). The focus is on the people for which the product is intended, rather than the creative process of the designer or the actual artefact made. When used right, HCD enables the designer to make products that are intuitive in how they are constructed, perceived, understood, and how they are experienced emotionally (Giacomin, 2014).

2.3.4 Activity Centered Design

If knowing the user is critical to design, Donald Norman questions what happens when designing for something to be understood and used by almost anyone in the world (Norman, 2005a). Norman argues that a lot of the everyday things we see all around us, such as kitchen utensils, garden tools and woodworking tools, work well because they were all developed with a deep understanding of the actual work and activities that were to be carried out. This is what Norman calls ‘Activity Centered Design’ (henceforth ACD). The tools and utensils were developed iteratively over generations to suit the activities involved. And with activities Norman means larger groupings of multiple tasks that fit together (Norman, 2005b). Yet, if you put one of these tools or utensils in the hand of someone that do not know the activity, the use is not obvious. The most successful artifacts are the ones that suit the underlying activity best, supporting it in a way that is understandable once the activity is known. The designers that came up with and developed these tools and systems often had good reasons for their design. When these reasons can be explained, it is much easier to understand the affordances of the tools or systems (Norman, 2005a).

Despite some differences, ACD is like HCD. Many of the best attributes are shared, but the biggest difference is, according to Norman, that of attitude. The activities are human activities that need people to work. And human constraints affect the activities. For ACD to work, the designer still needs to understand humans. But ACD is more than that, it also needs the designer to be aware of technology, tools and the reason why the activity exist (Norman, 2005a)

In *Logic Versus Usage: The Case for Activity-Centered Design*, Donald Norman states that a lot of technology is developed by engineers. But this technology is too logical and rational according to Norman. Human behavior is anything but, and therefore, to support real behavior, we need ACD (Norman, 2006).

2.3.5 Affordances

Don Norman defines the term affordance as the relationship between a person and a physical artifact. It relates the properties of the artifact to the capabilities of the person interacting with it, and by doing this describes how the artifact could possibly be used. A chair affords sitting, but a heavy chair only affords lifting to those strong enough to do that (Norman, 2013, p. 11).

Don Norman states that the term affordance, and the insights provided by this idea originated with J. J. Gibson, and Norman built upon this concept (Norman, 2013, p 12)

When it comes to virtual objects and systems, Norman thinks that affordances are confusing and therefore also describes ‘signifiers’. Affordances define available actions on a physical object. Signifiers on the other hand specify how people discover these possibilities (Norman, 2013, p. xv).

- Affordances are possible interactions between users and artifacts. Some are perceivable, some are not.
- Perceived affordances are often similar to signifiers, but can be ambiguous.
- Signifiers signal things, like what actions are possible and how to do them. Signifiers must be perceivable, otherwise they fail to function (Norman, 2013, p. 19).

Cooper et al. (2014) talks about Norman’s affordances in the context of screen based interfaces. ‘Pliant’ is the term Cooper uses to describe a screen based object that the user can interact with. Cooper states that pliancy should be visually ‘hinted’ by letting the objects have static visual affordances. The affordances should then dynamically change as response on input and system events.

2.3.6 Feedback

Affordances and pliancy tells the user that an object can be interacted with. Feedback on the other hand could be described as what happens when the user has interacted with it. Benyon says that an interface “needs to provide some mechanisms for the system to tell people what is happening by providing feedback”. The feedback can be output which could come in the form of pictures, animations and information (Benyon, 2010).

Cooper et al. (2014) recommend feedback to be modeless, Modeless feedback does not disrupt the flow of an application. One example Cooper gives is Microsoft Word 2010 where the user always can see the number of pages and where she is in the document by glancing at the navigation pane and status bar. The opposite is modal feedback. A pop up dialog window is modal according to Cooper. It is a special state that must be handled before the user can continue using the application as normal.

There are other forms of feedback beyond visuals. A major tool for feedback is audio. Cooper et al. (2014) proposes audio as a complement to visual feedback. The user may not always look at the screen and could therefore miss the visual cue. Audio circumvents this by allowing the user to rely on hearing. However, Cooper strongly suggest that negative audio feedback should be avoided. Emitting noise when the user does a mistake is a public announcement of the user’s failure and is therefore discouraging according to Cooper. Instead, silence should be used for negative feedback and audio for positive feedback. Positive feedback leads to a friendlier application since people like to be rewarded for their success (Cooper et al., 2014). Audio can also affect the overall mood of the user and wake emotional responses (Sweet, 2008).

Force feedback is another option for feedback. Force feedback can be used to convey sensations. Like the feeling of footsteps or drive a high-speed car (Benyon, 2010).

In games, feedback is a design practice (Ushaw, 2015b). It is argued that feedback should be ‘juicy’ (Gray et al., 2005). To achieve juicy feedback, Gray et al. claims that there should be a lot of feedback constantly for minimal input. Juul and Beggy (2016) did a preliminary empirical study on juiciness where they compare two mechanically identical games where one had minimal feedback and the other large amount of redundant audiovisual feedback. They found that the juicy version was rated higher by the player on average. However, the players also performed worse in the juicy version. While they could not draw any definitive conclusions, they suggested that the reduced performance could be due to an increased cognitive load.

2.4 Game Design Theory

Game design theory aims to explain what a game is. Several authors have tried to define games and they touch upon ingredients like rules, goals, outcomes, make-believe, conflict and voluntary participation. As well as how games differ from puzzles. Though no real consensus exists among the definitions. The term ‘gameplay’ is also explored which, like games themselves, has no definitive description. Though it tends to relate to the challenges, experiences and content a game provides through play. Playcentric design recommends how a game designer should approach the design process of a game. Game loops are also explored, what they are and how they can provide an engaging experience. The MDA framework is then dissected to see how game mechanics can provide the player with different emotional experiences.

2.4.1 What is a game?

What is a game? It seems to be a simple question. Yet, once you enter the rabbit hole of game definitions it becomes immediately apparent that the hole runs deep and that no consensus exists among scholars and game designers. Renowned game designer Sid Meier said that “A game is a series of interesting decisions” (Meier, 2012). Others have also pointed out decision making a vital part of games (Abt, 1970; Crawford, 1984; Costikyan, 2002). On the other hand, Meier states that his definition does not fit all kinds of games, for example music rhythm and puzzle games (Meier, 2012).

However, music and puzzle games do have rules that determine what actions are allowed. When Salen and Zimmerman (2003) compared eight different game definitions they found that all except Costikyan (2002) mentioned rules. Rules make the game activity possible and the participants will accept the rules in order to play (Suits, 1990) Furthermore, Jesper Juul stated that a game is a “rule-based formal system” (Juul, 2003). This form of play fall under “ludus”, an activity structured by rules. Play can also occur in the absence of rules. A form of play labeled “paidia”, which can occur spontaneously (Caillois, 1961). For example, animals and children can play without agreeing on rules. Thus, a distinction can be made between formal and informal play (Parlett, 1999). Informal play would be children fooling around and an example of formal play would be two people playing Chess. A game should however be a voluntary activity according to some (Caillois, 1961; Avedon & Sutton-Smith, 1971; Suits, 1990). If a game must be voluntary, would a game stop being a game if someone is forced to play despite not wanting to? (Salen & Zimmerman, 2003).

Voluntary or not, a player’s actions do seem to have a different meaning within a game context than what they would have otherwise. Kicking a ball into a net seems pointless but it is utterly important when playing soccer (Adams, 2010). Costikyan (2002) refers to this as games having an endogenous meaning. However, the term “magic circle”, taken from Huizinga (1955), is more commonly used. The concept suggests that there is a clear boundary between playing and not playing. Within its boundaries, behavior, artefacts and values can differ from the world outside it. A game can thus be viewed as a form of pretended reality (Adams, 2010) or make-believe (Caillois, 1961). A view not shared by all since it has been argued that games are real “and are puzzles to solve, just like everything else we encounter in life” (Koster, 2005, p. 34). There is also an argument for a middle ground between pretended reality and real life. Juul (2003) argues that games “can *optionally* be assigned real-life consequences” that are negotiable.

If puzzles are game is a controversial question. Puzzles have many game like features. Puzzles have rules which was the most common ingredient in game definitions. The second most common was having a goal (Salen & Zimmerman, 2003). A solution to a puzzle can be viewed as the goal state (Russel & Norvig, 2015). On the contrary, that they can be solved is an argument for that puzzles are not games (Kim, 2008). Games tend to have an uncertain outcome (Caillois, 1961; Fullerton, 2008) which does not apply to puzzles like crosswords. Perhaps it is not useful to look for definitions that encapsulates everything that is and is not games. Instead one can look at the characteristics that they share (Elias et al., 2012).

2.4.2 Gameplay

'Gameplay' is a term that often comes up when discussing games. Costikyan (2002) finds the term to be vague. According to Costikyan, saying that a game has 'good gameplay' says nothing about why the game is good. That is why Costikyan suggests that gameplay should be divided into smaller identifiable parts to discuss games with a clearer vocabulary. However, gameplay has been defined as "the formalized interaction that occurs when players follow the rules of a game and experience its system through play" (Salen & Zimmerman, 2003, p. 303) and Lundgren et al. writes that "the term gameplay relates to the interplay between a game's rules and the player's interaction with them which, in combination lead to an aesthetic of gameplay" (Lundgren et al., 2009). These talks about gameplay as a form of interaction. Others speaks of gameplay as the game's content. The Oxford dictionary defines gameplay as a noun that is "The features of a video game, such as its plot and the way it is played, as distinct from the graphics and sound effects" (Oxford University Press). Adams (2010) believes that gameplay is the challenges and actions that the game offers. While Crawford (1982) finds, like Costikyan, gameplay to be an ambiguous term. Crawford suggest that gameplay is the combined pace and cognitive effort that a game requires.

2.4.3 Playcentric Design

A playcentric design process "focuses on involving the player in your design process from conception through completion" (Fullerton, 2008). A playcentric approach is similar to HCD (see section 2.3.4). But where HCD focuses on the needs of the user, a playcentric approach focuses on the experience of the players. Fullerton (2008) recommends that the designer starts a design process with setting 'experience goals' for what the players will experience while playing.

A playcentric approach is an iterative process that can be used to create games regardless of platform according to Fullerton. In a playcentric approach the key to game design is feedback from players, which Fullerton states should be involved at an early stage. With the player experience as the core of the process, Fullerton argues that the game mechanics can be built from the ground up to create an engaging game.

The game designer's role is "to be an advocate for the player" (Fullerton, 2008, p. 2). With this Fullerton means that the designer must see games from the player's point of view. Fullerton also claims that the designer's focus should be on gameplay since that is what hooks the player.

2.4.4 The Game Loop and Progression

All games have a few set of activities that the player repeats constantly while playing. This is the core "loop" of the game (Lara, 2016a). An engaging game needs a loop with compelling activities, provide positive feedback to make completion of the activities satisfying and provide an incentive to return to the game. The loop needs to be closely connected to the purpose of the game. For example, teaching, earning money or changing behavior. The loop should also contain all the ingredients that makes up an engaging experience. Lara states that the ingredients are compelling story, interesting mechanics, eye-popping art, community building and a theme (Lara, 2016b).

Werbach and Hunter (2012) writes about activity cycles. They state that games often have a beginning and an end but the path in between consists of loops and branching trees. Two kinds of cycles are identified by Werbach and Hunter. Engagement loop and progression stairs. Engagement loops is the core loop of the game but it does not cover progression. A game that always remains the same will become stale and boring. Therefore, Werbach and Hunter suggest the use of progression stairs. A progression stair puts out goals, both short and long term, for the players to achieve. Typically, the progression stair amps up the challenge by starting of easy and becoming increasingly harder as the player advances through the game. Though the increase should not be linear. A major hurdle should be followed by an easier segment so the player can catch her breath (Werbach and Hunter, 2012). This could be accomplished by implementing a level structure (Ushaw et al., 2015b)

Similarly, to progression stairs, Fullerton (2008) writes about goals and subgoals. A game can have several subgoals that lead to an end goal. According to Fullerton, players sometimes "create their own subgoals within a system".

2.4.5 MDA

MDA stands for Mechanics-Dynamics-Aesthetics (Hunicke et al., 2004) and is a tool for analyzing games. The framework breaks down games into the three major components labeled mechanics, dynamics and aesthetics.

Mechanics represents the individual building blocks of a game. They are the various rules that the player interacts with. Poker for example includes mechanics like shuffling, trick taking and betting.

Dynamics is how the mechanics works off each other during play which can cause interesting behaviors. For example, bluffing emerges from the mechanics in poker. Salen and Zimmerman (2003) refers to this as 'emergence'.

Aesthetics is evoked from the dynamics and is the emotional experience the player perceives. Bluffing in poker by placing a high bet can cause a roller-coaster of emotions. The fear of the bluff being called, the joy of succeeding or the frustration of losing.

Players and game designers have different perspectives on games according to the MDA framework (Figure 2). A game designer's perspective is from the mechanics' side. They construct and combine rules to achieve certain dynamics within the system. Players on the other hand views the game from the other side. Experiencing the aesthetics that stems from the dynamics. The aesthetics is what makes a game fun.

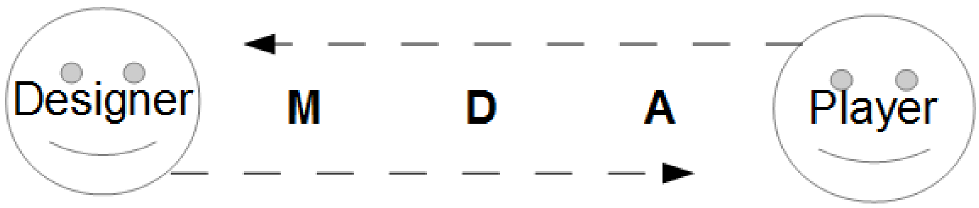

Figure 2. *Different perspectives in the MDA framework*

However, Hunicke et al. (2004) suggests a clearer vocabulary instead of the arbitrary "fun". Their suggested taxonomy includes eight kinds of fun: sensation, fantasy, narrative, challenge, fellowship, discovery, expression and submission. Similarly, Lundgren et al. (2009) lists several aesthetic ideals. For example, meditation, pottering, emergence and reenactment. Furthermore, Lazzaro (2004) identified several emotions that players enjoy in games. Among them is schadenfreude, fiero (personal triumph over adversity) and naches (pride over a child's accomplishment). Even negative emotions like fear and disgust were identified by Lazzaro as possible causes for player enjoyment.

Different kinds of people have different aesthetic ideals. Meaning people prefer different kinds of games. Thus, knowing a person's ideals makes it possible to guess if that person would like a specific game by understanding its aesthetics (Lundgren et al., 2009).

2.5 Serious Games and Gamification

Games seem to have the power to capture the player's engagement. This sparked an idea to implement game elements into non-game systems to make the user more engaged. This is often called 'gamification' and Sebastian Deterding et al. (2011) proposes the following definition:

Gamification is the use of game design elements in non-game contexts

The definition seems simple, but the devil is in the details. To understand it fully, both 'game design elements' and 'non-game contexts' needs to be explored.

If the end result is a game, is it gamification even if it is in non-game context? One can argue that it is not. If it is a game, and not just something that have been added game elements to, it can be defined as a serious game. Serious games are prevalent in the military, in education and in health care. Their main goal is not to be games, but to provide something more, such as education, training and healing (Michael & Chen, 2006). Michael and Chen also states that serious games are more than just education through entertainment.

From this follows that gamification is less than a game, it contains game elements or game qualities but it is not a complete game. To confuse this further, gamification differs from what Deterding describes as 'gameful design' (Deterding et al., 2011). Building upon the concept 'gamefulness' introduced by McGonigal (McGonigal, 2011) Deterding systemize the terminology as follows: Gamefulness is the term for the behavioral and experiential quality of gaming, gameful interaction is interaction with artifacts that affords gamefulness, and gameful design is the act of designing for gamefulness, often by using game design elements or game design qualities. Deterding states that even if the concepts gamification and gameful design usually coincide they differ in their intentional properties. Gamification is when the design strategy is that of using game design elements, gameful design is when the design goal is that of designing for gamefulness (Deterding et al., 2011).

A model (Figure 3) shows how gameful design and gamification maps into a larger picture that Walz and Deterding (2014) calls the 'gameful world'.

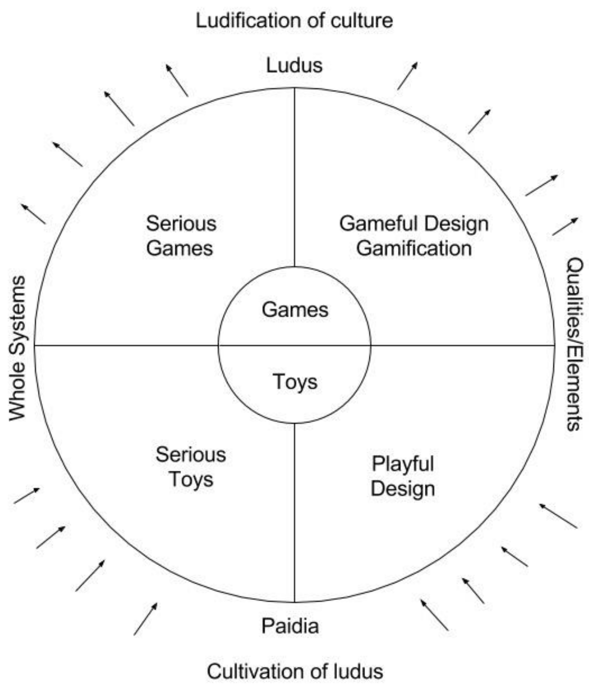

Figure 3. *Walz and Deterding's conceptual mapping of the gameful world*

It is these intentional properties that make Ian Bogost claim that "Gamification is bullshit" (Bogost, 2014). He states that 'exploitationware' would be a better name for gamification since it is truer to its deceptive nature (Bogost, 2011). Bogost criticizes some central game elements used in gamification, such as points, badges, leaderboards, levels and rewards. He claims that these are not central elements of games, instead it is the game elements that produce the user experiences of interest, enlightenment, terror, fascination, fun, or any number of other sensations that are central to what makes a game (Bogost, 2011). Bogost argues that the reason for points, badges and leaderboards (PBL) being so popular with gamifiers is that it suits the '-ifying' part of gamifying. Further, the goal with gamifying is not to create a more gameful experience, it is to create more gamifying projects for short term gain (Bogost, 2014).

As a counter movement to this short-term stance of gamification but also its criticizers, Sebastian Deterding proposes to rethink gamification. When it comes to the motivational aspects of gamification it is important to consider user autonomy. If a gamified system is mandatory and not voluntary it can be considered an electronic whip rather than something fun and motivating. In fact, it can even be de-motivating and invite a certain "gaming of the system". The designer also need to consider user embarrassment when designing. Doing a certain task in the safety of home is different than in public. A way to mitigate lack of autonomy, gaming the system and embarrassment is to design the activity rather than designing only the system (Deterding, 2014).

Separating game design elements from other design elements is nigh impossible, because of this it is also hard to identify a gamified system due to the presence of certain design elements. It has been argued that some of the design elements associated with gamification are not even game elements. In fact, some of the services that have been called gamified, have been done so retroactively. Therefore, it has been suggested that gamification and gameful design is when the design goal is to afford gameful experiences (Deterding et al., 2011; Huotari & Hamari, 2012).

From this reasoning follows that if the design goal is to motivate end user behavior, the limitation to gameful design is suboptimal from a design perspective. Gameful design is a subset of motivational design which in turn is a subset of persuasive design. According to Deterding it would be nonsensical, if the goal is to motivate user behavior, to limit the design space to gamification (Deterding, 2014).

Another thing that is important to notice is that when it comes to gameful design the designer needs to take a holistic approach. The individual design elements do not deterministically produce a certain motivational experience, but instead it is the combination of context, users and what affordances that the design provides that produce the experience (Deterding, 2014).

Following this reasoning, that game elements does not deterministically provide a certain outcome, and that a holistic view is more efficient when it comes to providing motivational affordances, Deterding asks what to do instead. The answer he provides is simple; game design. With the MDA framework (Hunicke et al., 2004) or other models like Jesse Schell's design lenses (Schell, 2009) and Fullerton's playcentric design (Fullerton, 2008), the designer can use game design to reach the intended goal. By stating what the desired motivational experiences are, and applying design lenses to analyze activities, the designer can use iterative prototyping until the prototype affords the intended motivational experiences (Deterding, 2014).

The ethical aspects of gamification have been questioned for a long time with criticizers calling it exploitationware (Bogost, 2011) and implying that gamification is not good for the user. It is easy to compare this to what Zagal et al. describes as 'dark game design patterns' (Zagal et al., 2013). When the game creator, or in this case the gamifier, designs something that is not in the user's interest, one can question the ethics of this. Fogg discusses the ethics of persuasion and mention that it is disputed if it is unethical or not. Some claim that changing another person's attitudes or behavior is unethical or at least questionable. In the extreme cases persuasion can lead to indoctrination, brainwashing, coercion and other unwanted outcomes (Fogg, 2003). Acting ethically with gamification would be to avoid negative effects like coercion and harm for users and at the same time keep the user informed about the intention of the gamified system (Deterding, 2014). To counter the exploitation of the user, Deterding suggest to instead design for the good life, or 'eudaimonia' as Aristotle called it (Nicomachean Ethics, Book 1, chapter 4). If the designer uses this "ethical" design lens when doing gameful design the result would be ethical gamification that can have a positive outcome, supporting human flourishing and make a positive impact not only for the user, but also for others. This positive vision of gamification, a design practice for motivational affordances in the service of humanity, Deterding calls eudaimonic design. When doing eudaimonic design the designer needs to consider not only the small task of motivating user behavior, but the entire context of the gamified system (Deterding, 2014).

2.5.1 Achievements

Achievements has been defined as "goals in an achievement/reward system (different system than the core game) whose fulfilment is defined through activities and events in other systems (commonly in the core game)" (Hamari & Eranti, 2011). Achievements are typically offered as a reward for completing in game tasks like playing in a difficult way or performing activities that are not part of the main game (Björk, 2015). As a result, achievements function as additional goals that can prolong a game's lifetime (Elias et al., 2012). The system the achievements exist in is typically part a game platform, like Microsoft's Xbox Live (Hamari & Eranti, 2011) where it is required to implement achievements (Björk, 2015). Although, achievements can be integrated into the game itself. For example, the Wii version of *Mega Man 9* (Capcom & Inti Creates, 2008) implemented achievements as in-game challenges.

Hamari and Eranti states that achievements typically have a name, a visual (badge) and a descriptive text. They have a trigger event that unlocks the achievement. Sometimes it also has additional pre-requirements and conditions to trigger. Completing the achievement yields a reward. Some achievements give virtual items to be used in the game. Others, like Xbox Live, give a cumulative score (Hamari & Eranti, 2011). Since achievements can be assigned a numerical value, they can function as a foundation for leaderboards (Björk, 2015).

The achievement systems offered on different platforms "gamify the games that are offered on those platforms" (Hamari & Eranti, 2011). Since achievements can gamify a game, it is maybe not surprising that achievements have become a common pattern to use in gamification. Which lays as a foundation for Bogost (2014) critique that gamifiers focus too much on points, badges and leaderboards since they are fit to be applied on anything.

2.6 Motivation

The basics of motivational theory is covered below. Focus lies on Self-determination theory, what it is and how it builds upon the concepts of intrinsic and extrinsic motivation. The engines of play are then presented, which takes the concepts from motivational theory and applies them to games and how player motivation changes over time.

2.6.1 Self-determination Theory

It has been argued that there exist two kinds of motivations. 'Extrinsic motivation' is doing something because of external reasons, like being rewarded with money (Ryan & Deci, 2000a). Extrinsic motivation has its roots in operant theory (Skinner, 1953) which states that behavior is motivated by external rewards. In contrast, 'intrinsic motivation' comes when something "is inherently interesting or enjoyable" for the individual (Ryan & Deci, 2000a) and is "the inherent tendency to seek out novelty and challenges" (Ryan & Deci, 2000b). Something Deci and Ryan (1985) claims people seek when they lack other stimuli. Extrinsic motivation has been viewed as a poorer form of motivation compared to intrinsic motivation (Ryan & Deci, 2000a). However, Ryan and Deci argue that the effect of extrinsic motivation can vary. For example, if a student sees the value of doing an assignment or simply does it because it is mandatory (Ryan & Deci, 2000a).

Self-determination theory (SDT) builds upon the ideas of extrinsic and intrinsic motivations (Deci & Ryan, 1985). SDT claims that motivation is grounded in the human's psychological needs. SDT has pinpointed three types of needs; competence, relatedness and autonomy (Ryan & Deci, 2000b) (Figure 4). Competence refers to being in control of the situation. Relatedness is one's connection and relation to others. Autonomy is "the experience of choice" (Deci & Ryan, 1985, p. 155). Choice does not mean the act of making a decision. One can be forced into making a decision which would not satisfy autonomy. A genuine choice requires the freedom consider and reject other options for it to be autonomous.

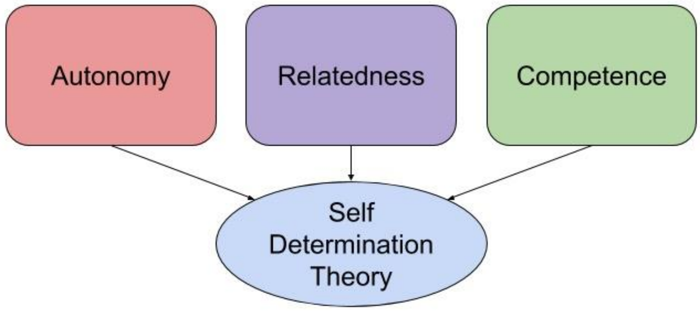

Figure 4. *The three needs in SDT*

SDT builds upon the belief that psychological needs drives motivation. SDT points out three but more needs have been argued for and Maslow (1943) claims that certain needs have priority over others. At the basic level are the physiological needs. The drive to eat, sleep and drink. The physiological needs are then followed by the need for safety, love, esteem and self-actualization. According to Maslow, the needs on the lower levels must be satisfied before the needs on higher levels can be realized. Reiss (2004) proposes a theory of 16 basic desires. Human individuality is multifaceted. Hence, Reiss argues that reducing human motives into a few broad categories would cause a loss of information.

2.6.2 The Engines of Play

Player Experience of Need Satisfaction (PENS) elaborates on SDT and applies it on video games (Ryan et al., 2006). Ryan et al. argues that autonomy for playing is high, as games usually are voluntary. However, autonomy within the game can vary depending on the degree of choice the game offers. Competence can be satisfied with intuitive controls, challenges to master and positive feedback that highlights success. Relatedness could potentially be met by artificial intelligence though Ryan et al. believes that relatedness is mainly relevant for multiplayer games.

Jason VandenBerghe (2016) has studied player motivation. He based his work on “the big-five” personality traits (Goldberg, 1990) and mapped them to which kinds of games a certain personality types prefers. VandenBerghe calls this the “five domains of play” which he later developed into taste maps. A taste map can be used to visualize what types of players would be interested in playing a certain game. According to VandenBerghe, player motivation changes over time and a taste map only explains why someone initially is interested in playing a certain game. Therefore, he combines taste maps with PENS and a model of time that goes from the individual hearing about the game to identifying herself as a player of the game. VandenBerghe calls this the “engines of play”. The personality profile has a strong influence motivation when the player is getting acquainted with the game. This influence decreases over time. Instead, the influence of the needs described by STD and PENS increases and becomes the main source of motivation.

The engine is not complete. VandenBerghe, states that the engine does not account for player emotion. VandenBerghe suggests that the 4 keys model (Lazzaro, 2004) potentially can cover emotion. The 4 keys include: ‘hard fun’; games as a challenge, ‘easy fun’; games as an immersive experience, ‘altered states’; games as therapy, and ‘the people factor’; games as a social experience.

Finally, VandenBerghe points out ‘drives’ as a missing part of the engine. No model is suggested for this. However, he describes as the urge players feel when they are presented with a locked door.

3 METHODOLOGY AND TOOLS

The methodology consists of research through design. This goes through an iterative design process consisting of ideation, prototyping and playtesting; methods that are recommended in various design philosophies (see section 2.3) and game design (see section 2.4.3).

The thesis conducts game design rather than gamification. Deterding et al. (2011) says that gamification occurs when game design elements are used in a non-game context. What a game is depends on who you ask (see section 2.4.1). However, physiotherapy games are games aimed to promote health. For this purpose, it has been recommended to adopt practices from the game industry (Ushaw, 2015b). Therefore, the methodology is game design rather than gamification.

This chapter also covers the technological tools used in the project, including the game engine Unity, the Kinect sensor and the software used with it for gesture detection.

3.1 Research Through Design

Design is a wicked problem and finding the problem is a problem in itself (see section 2.3.1). Thus, common steps to kick off design research are identifying the research topic, reviewing related literature and then specifying the research question, the kinds of data required and the methods needed to analyze it (Lankoski & Björk, 2015). For games, several possible methods are discussed in Lankoski and Björk's book *Game Research Methods* and the different approaches range from being qualitative, quantitative and mixed methods.

Waern and Back (2015) argues that a game design process is experimental in nature. Going through a design process can therefore be a method to gain an understanding of games. While it is true, according to Waern and Back, that all game designers experiment with their game's design it is not 'experimental game design'. For game design to be experimental, it must be done with rigor to gain a more generic and fundamental understanding of games. Not just to improve a single game.

Frankel and Racine (2010) points out three categories of design research. Research for design, research through design, and research about design. They write that new knowledge can be generated through learn by doing. The process is the important part. Not the end product. Like Waern and Back, Frankel and Racine claims that research through design "seeks to provide an explanation or theory within a broader context".

Gaver (2012) discusses what one can expect from research through design. Gaver writes that design is wicked and generative. As a result, design research lacks the falsifiability and convergence that is prominent in natural science. Because of this, Gaver suggests the use of annotated portfolios to highlight a set of design examples.

3.2 Game Design

Playcentric design (Fullerton, 2008) is an elaborate way of conducting game design. Key methods in playcentric design are iterating, ideating, prototyping and playtesting. These are covered in detail in the following sections.

Playcentric design focuses on the player experience and it suggests that experience goals should be set in the early design process (Fullerton, 2008). In the MDA framework (Hunicke et al., 2004), the aesthetics makes up the experience. Therefore, the aesthetic components can be considered for the experience goal. The player experiences the aesthetics that the dynamics create because of the game's mechanics. Thus, the designer can walk through the MDA framework, from the player's viewpoint, to identify the mechanics that causes the experience. Faulty mechanics can then be isolated and addressed to improve the player experience. Furthermore, applying MDA in this way can lead to better gameplay. If one refers to 'gameplay' as being related to the player's experience rather than the game's content.

3.3 Iterative Design

One model for software development is the 'waterfall model'. It is a non-iterative process where the product passes linearly through the stages of requirement analysis, design, coding, testing and maintenance (Alshamrami & Bahattab, 2015). One stage is completed before the next begins. Alshamrami and Bahattab argues that this comes with the benefit of recognizing design flaws before the actual development starts. However, they also note that the model is inflexible and not appropriate for long and complex projects.

In contrast, there is the iterative model. The product is developed in a series of shorter iterations. After each iteration, the product is tested and evaluated. The information gained is used to increment the product by improving the functionality during the next iteration (Alshamrami & Bahattab, 2015). This iterative approach has been adopted by many interaction designers. Cooper et al. (2014) lays out the 'interaction framework' that "defines not only the high-level structure of screen layouts but also the product's flow, behavior, and organization" (Cooper et al., 2014, p. 121). The process is numerically sequenced but Cooper stresses that it occurs in iterative loops. Gould et al. (1987) writes that design must be iterative. Issues must be addressed as they surfaced and no designer, regardless of skill, can get a design right on the first try (Gould et al., 1987). Moggridge (2007) claims that interaction design can be generalized into constraints, synthesis, framing, ideation, envisioning, uncertainty, selection, visualization, prototyping, and evaluation. These elements are cycled through iteratively according to Moggridge. Often in the same order but not always. In some cases, the order can even appear to be random (Moggridge, 2007). In HCD, an iterative process consisting of specifying use context, user requirements, producing design solutions and evaluating against the requirements is suggested by Maguire (2001). If the requirements are met, the design is finished. Otherwise the loop starts over.

Iterative design is also valid for game design. Salen and Zimmerman writes that iterative design "is a play-based design process" (Salen & Zimmerman, 2003, p. 11). They argue that it is impossible to know exactly how a game will play beforehand. Hence, the game must be played and the experience gained should be used to iterate the game. Costikyan (2002) is on the same line. Stating game design is about iterative refinement because of the many ways it can fail. As a result, playcentric design suggests an iteration cycle where ideas are generated, formalized, tested and evaluated until the game fulfills the experience goals (Fullerton, 2008).

3.4 Ideation

Brown (2008) claims that there is a myth about creative ideas. That they are generated by lone geniuses. Contrary to the myth, Brown argues that the best ideas comes from interdisciplinary collaboration and hard work aided by iterative design. A common way to tackle ideation is brainstorming.

Brainstorming involves bringing a group of people together so they can inspire each other with idea generation (Maguire, 2001). Maguire writes that these people should be a group of experts. However, Tom Kelly (2000) disagrees with the expert mentality since you can never know who can provide the needed insight. According to Kelly, having only experts can kill a brainstorm session. Other ways to fail is by letting the boss speak first, doing turn taking, brainstorming out of the office, not being silly and writing down everything. Instead, Kelly promotes playful brainstorm session with a clear problem statement. Ideas should be numbered and build off each other. Kelly also encourages the use of space and physical artefacts. Fullerton (2008) also points out that a brainstorm should aim for many ideas. Preferably a hundred ideas in an hour. If an idea is good or not is of no concern. Ideas can be evaluated later. Therefore, ideas should never be criticized during the brainstorm since it might discourage some practitioners.

There are several tools that can aid a brainstorm and to evaluate ideas afterwards. Ideas for Ideas mentions several methods that can be used in a brainstorm. For example, collaborative sketching, reverse brainstorming and personas (Ideas for Ideas). Ideas for Ideas also gives examples of evaluation methods like voting and SWOT analysis. The IDEO method cards (IDEO, 2003) also suggest several methods. Among these methods are affinity diagrams. More methods have also been suggested (Chua), including time travel, reverse thinking and exaggeration. Chua also suggests various “What if” scenarios, ranging from super powers and iconic figures to resource availability and teleportation to distant places.

Brainwriting can be used as an alternative to brainstorming. In contrast to the oral brainstorm, brainwriting is silent. Participants writes down their ideas on pieces of paper (Heslin, 2009).

3.5 Prototyping

Building prototypes is the core of an iterative design process. A designer should “Prototype early and often, making each step a little more realistic” (Moggridge, 2007, p. 643). Moggridge states that prototypes can be used to test any aspect of a design’s intended functionality and examine uncertainties. Early prototypes are rough and with each iterative step the interactions the prototypes provide becomes more realistic. Later prototypes also more closely resemble the final product (Moggridge, 2007). Prototyping can be done in a myriad of ways. For example, through paper, video, storyboards, ‘wizard-of-oz’ or software (Maguire, 2001). These are all viable methods within interaction design but they are also applicable in game design.

In game design, the prototype is a model of the game idea and provides the possibility to test if a concept is achievable and how it can be improved (Fullerton, 2008). As in interaction design, early prototypes are rough. A videogame can for example be prototyped with pen and paper before any code is written (Salen & Zimmerman, 2003). Physical prototypes can provide a first estimation on how the game mechanics will function and has the benefit of being faster to make compared to a digital prototype. Digital prototypes can then build upon the results of the physical prototype. If the game is intended to be digital, then there are aspects that physical mediums cannot emulate accurately according to Fullerton (2008). For example, input devices or the “feel” of the game (Fullerton, 2008). Digital prototypes may only include placeholder art and sound to give a rough approximation of what the game will be (Fullerton, 2008). However, a polished prototype will feel better when art and sound are coherent (Gray et al., 2005). Though Gray et al. claims it will only make a good game better since it cannot save a bad design. Hence, one should not be afraid to scrap ideas that does not seem to work, according to Gray et al. One approach is to make a toy first that focus on a core mechanic. If the toy is fun it can probably be turned into a game (Gray et al., 2005).

Gray et al. writes that prototypes should be made in short development cycles where failure is acceptable and seen as a learning experience. Shortcuts are encouraged and quick and dirty code is preferred over fine engineering. If it makes the prototype playable faster it is a good thing (Gray et al., 2005). According to Fullerton, code in a prototype is not the code that should go into the final product. It only serves to test ideas. Later, the knowledge gained from the prototype can aid the planning of the proper code (Fullerton, 2008).

3.6 Playtesting

Prototypes are evaluated through user tests to evaluate effectiveness, efficiency and satisfaction (Maguire, 2001). However, within game design, 'playtesting' is more commonly used to refer to user tests. As the word suggest it means to play the game to test if the system is functional. Playtests can also be used to evaluate if the game meets the experience goal or to collect feedback from the players (Fullerton, 2008). Maguire suggest that data can be collected in several ways. Including interviews, questionnaires, video recording, manual note taking by the test facilitators and automatic data gathering by the system.

The game designer can play the game herself though it is recommended to let external playtesters play (Fullerton, 2008). Fullerton claims the game designer knows everything about the game and is likely to play as it is intended. A regular player on the other hand probably knows nothing or very little about the game. Hence, an external playtester has a higher chance of stumbling over problems the designer could not foresee. Ideally the playtesters belong to the game's target audience. The playtest can then reveal if the game is enjoyable for its intended users. Nonetheless, Fullerton states that it can be useful for the designer to play her own game. Especially in the early stages of prototyping when possible core mechanics are explored. Self-testing is also useful to uncover and address obvious problems (Fullerton, 2008).

When should external playtesters be brought into the process? It has been argued that players should be brought in as early as possible (Gingold, 2008). Fullerton states that player feedback can be used to make dramatic changes to the game early in development. This cannot be done late in the development cycle. The game needs to be shipped eventually. If playtesters are only brought in during the last few weeks, then it will only be possible to address minor issues. It will however be too late to fix any problems with the game's core (Fullerton, 2008). As a rule of thumb, the absolute latest point when playtesting should commence is twenty percent into the project (Salen & Zimmerman, 2003).

There are two reasons for evaluation. The first one is to improve the product by evaluating as part of the development process, or formative evaluation. By identifying usability problems early, you have time to adapt. The second reason is to find out if people can use the product as intended, or summative evaluation (Maguire, 2001).

When playtesting with children it is important to decide what is going to be tested. If you want to have a formative evaluation of a prototype, a good method is to observe the children during evaluation. And in line with this, if you want to know what children think is fun in a prototype, a candidate method is asking them in a survey or similar (Markopoulos et al., 2008).

3.7 Technology

Preexisting technology have been used for this thesis to develop a digital game prototype. These technologies consisted of the game engine Unity, the Kinect sensor and its related software tools which are presented in the following sections.

3.7.1 Unity

The digital game prototype was developed with Unity 5 which was the latest version of the Unity game engine (Unity Technologies, 2017) at the time of this project. It features tools for 2D and 3D graphics, physics, audio, scene editing and more. The engine has support for a variety of platforms. Including Windows, iOS, Android and different game consoles. Commonly Unity is used for game development but can however be used for any form of application that require computer graphics. For scripting, Unity supports C# and JavaScript. For this project, code was written in C# using the Visual Studio 2015 IDE (integrated development environment) on Windows computers.

3.7.2 Kinect and Visual Gesture Builder

The second version of Kinect was utilized for player input. To develop for Kinect, the Kinect for Windows 2.0 SDK, released in 2014 (MSDN, 2014), was used. Kinect was integrated with Unity via the Kinect for Windows Unity Pro package developed by Microsoft. Kinect development was done on a PC running Windows 10 and a Kinect Adapter was used to connect the sensor to the PC via a USB port.

To enable the Kinect to recognize a player's movement, gestures were recorded in Kinect Studio 2.0. The recordings were then processed in Visual Gesture Builder (VGB). VGB utilizes a machine learning algorithm to "train" the Kinect to recognize gestures. This is done by taking clips from Kinect Studio and tag where in the clips a desired motion takes place. VGB can then process the clips and produce a gesture builder file containing the data that describes the gesture. Finally, the Kinect SDK can read the gesture builder file to evaluate if the player performs the correct movement.

Gestures in VGB come into forms. The simplest one is discrete gestures. A discrete gesture is a static pose that is either happening or not and VGB can give a confidence value from zero to one that describes how certain it is that the gesture is detected. Continuous gesture is the other kind. Continuous gestures can be used to track dynamic motion to evaluate how far into the motion the player currently is.

4 TIME PLAN

A rough time plan was initially made for the project. Roughly it was divided into three phases over a period of twenty weeks.

The first five weeks were dedicated to preparations and background research. Preparations included the acquisition of a Kinect, setting it up to work with Unity and gaining an understanding on how to develop applications for it. Other preparations included the arrangement of interviews and planning upcoming playtests of the game. Parallel with these preparations, background research was to be conducted. Which meant reading literature, survey the internet for information and look at preexisting games related to exercise, rehabilitation and Kinect. The first phase was to end by summarizing our findings into a planning report.

The following ten weeks would consist of a practical design process. This meant research through design by designing a concept for a physiotherapy game and developing a prototype in an iterative process. Generating new knowledge is possible when designing (Frankel & Racine, 2010). But there are risks. Waern and Back (2015) writes that it is time consuming to develop a game and a proper study of it cannot be done before the game is finished. However, Semcon was also interested in the technologies and wanted a prototype to display at the Vitalis eHealth conference in Gothenburg, Sweden in late May 2017. The conference would provide an opportunity for feedback from professionals in eHealth and mark the end of the design phase.

The last phase was evaluation. In other words, playtest the developed prototype and draw conclusions based on our design process, results and existing theory. Lastly our findings would be condensed into the final report.

The table below was the overarching time plan for the thesis.

Project Week	Date	Description
1 - 4	2017-01-16 to 2017-02-10	Preparations and background research
4	2017-02-10 to 2017-02-10	Finalize planning report
5 - 15	2017-02-13 to 2017-04-28	Designing and prototyping
15	2017-04-24 to 2017-04-27	Demoing at Vitalis
16 - 20	2017-05-02 to 2017-06-02	Evaluate results and finalize the report

Table 1. *Initial time plan*

5 PROCESS

Our process mostly follows our original planning as it is separated into three phases. The planning phase contains our preparations and background research where we gathered information about the subject area. In the development phase, we put theory into practical use. We designed a concept for a physiotherapy game and developed a prototype of it. The evaluation phase was the last stage of the process. The developed concept and the prototype was put to the test by getting feedback from experts and schoolchildren.

Throughout the process, thoughts, decisions and findings were written in a project diary. The following chapters are based on those diary notes. They are presented in chronological order unless anything else is noted. Some parts ran in parallel and chronology is broken in those cases for the sake of clarity and readability.

The original time plan changed slightly due to events throughout the process. These changes are presented and explained where they happened.

Our goal was to find factors to consider, to maintain player motivation, when designing a physiotherapy game. At the end of each phase, we summarize factors we had seen throughout that phase.

5.1 Planning Phase

The planning phase was devoted to background research, preparations and planning for the rest of the project. Initial discussions with Semcon regarding the project was held. We did some ideation to find potential target audiences, concepts and game ideas. Desk research was conducted, crucial Kinect features were implemented and experts within health care were interviewed. The time plan was revised with knowledge gained during the planning phase and some motivational factors were observed.

5.1.1 Semcon

The project was done in collaboration with Semcon. Hence, a meeting was held with Semcon representatives that where involved with the company's different eHealth projects. Semcon had extensive technical knowledge in-house but lacked competence within games. Therefore, they wanted our help with game design and gamification in connection to eHealth. One initial goal was to have something ready to show at the eHealth conference Vitalis at the end of April 2017. We also discussed demoing a prototype at Semcon as well.

During this meeting, we discussed the target demographics of eHealth and how broad this group is. A specific emerging group we discussed were immigrants. A new environment, with new cultural norms, religious beliefs, cuisine and language, have changed their daily habits. According to Semcon, diabetes, weight issues and sedentary are an increasing problems due to this, both with children and adults. We discussed how we could facilitate physiotherapy and cardio in a home environment. By doing this we could help user groups that otherwise are hard to reach. The physical environment for these groups is another aspect to consider. They might need to move around often and it might be hard to design for their home environment if they live in small apartments. Designing for public locations, like cafés or youth recreation centers, might prove more useful for these groups as these locales can provide more space. However, this would come at the cost of availability as these public spaces may not be accessible at all times. Another problem we discussed was how to provide a social setting and to bridge language barriers.

From this first meeting, we had a goal going forward, to decide what and for whom to design. Depending on the limitations we set up, a prototype could vary widely. We also had an aim to contact relevant persons to interview in the Gothenburg region, such as healthcare experts, physiotherapists and similar.

5.1.2 Preliminary Ideation

What target group to design and develop for was an initial problem for us. We held a preliminary ideation where we first tried to identify possible user demographics and problem areas. We got some input on target groups from the discussions we had with Semcon as well as some basic desk research that we held in parallel with this ideation.

The field of physiotherapy is vast, including rehabilitation for athletic injuries, Parkinson’s disease, stroke and motor disorders. The patients involved are equally varied. Coming from every kind of cultural background and age group. Hence, we mapped out some various target groups on Post-it notes and arranged these on a table. Some groups stood out and we discussed what we wanted to do and where we saw that our research could provide something new and interesting.

We realized that the theory was age independent and could probably be applied on a concept for adults. However, we chose to target adolescents. Initially we chose to focus on the ages ten to fifteen. Although, we soon realized that the age span was too broad. A ten-year-old is still a child while a fifteen-year-old is a teenager. The two are in completely different phases of their lives and will most likely have different interests, values and priorities. Hence, we narrowed down the age span to the ages ten to twelve instead. The age group was selected since we had previous experience with designing for children and one of us had children in that age range.

Physiotherapy patients can come from every kind of cultural background However, we choose not to include the user’s cultural background as a limitation since we felt that we did not have the experience or knowledge to make informed choices regarding culture. Adding an unfamiliar culture would add another topic to our desk research list which already contained a lot of subjects.

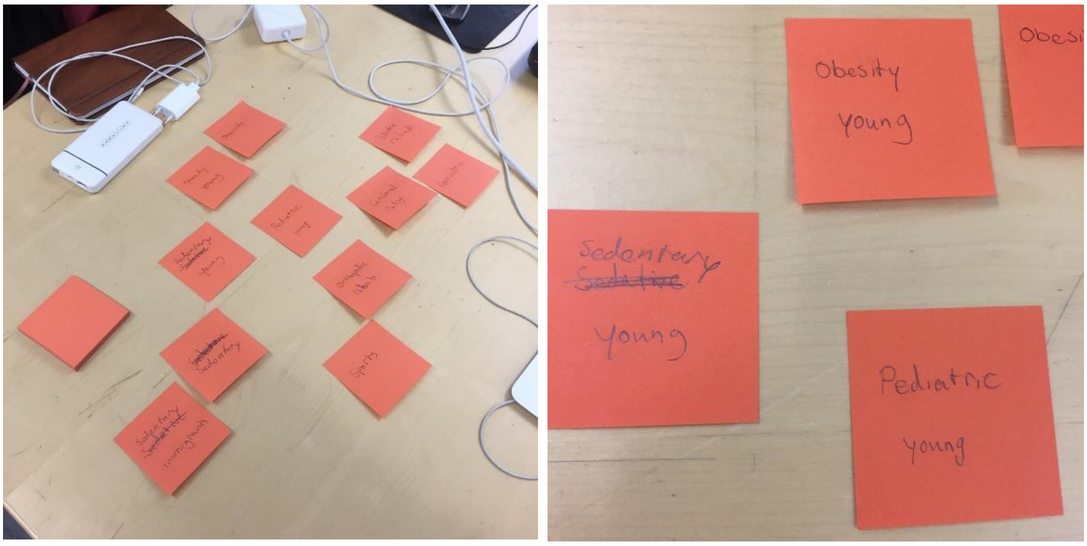

Figure 5. *Mapping out target audiences*

A combined focus on obesity, sedentary lifestyle and various needs for physiotherapy were included in our problem area (Figure 5). We agreed that the game concept should have the following characteristics:

- Use Kinect to track user gestures.
- The concept should be motivating over a long time.
- It should be rewarding to play for short sessions.
- The concept should provide progression over time.
- We should aim for a rich theme and compelling storylines.
- We should provide some sort of collecting.

We realized that we should limit ourselves from doing a social module and a back-end module in the concept due to time and scope restraints.

With this preliminary ideation done we could continue with our desk research more focused.

Two weeks later we also decided to limit ourselves to focus on single player experience. The reasons for this is that it is easier to implement and playtest. We decided to focus on single player but have an open mind for multiplayer.

We agreed that the concept is irrelevant from a research point of view. The concept is rather a result from the research and the system architecture also comes from this. Further discussions led to that we wanted to design for a pool of gestures. Having gesture pool would allow for having interchangeable exercises in the game. Which would circumvent an issue we had identified in existing exergames, where a new minigame must be created for every new exercise. We realized that it was important to consider what interchangeable gestures would imply for our design. Gameplay and the game concept would have to accommodate that the user can do any kind of movement. We had to keep this aspects in mind when we were going into the development phase

5.1.3 Initial Game Ideation

From our preliminary ideation, we had concluded that a game concept was not vital for the desk research. However, Semcon would during meetings often ask about the game idea and when we would have one to present. This pushed us to pursue another ideation round focused on finding a game concept. We divided this round into two phases. A generative phase focused on brainstorming and an evaluation phase to prune ideas.

Before the brainstorm we picked out several brainstorm methods that we could fall back on during the session. Besides having prepared some methods, we had no set plan for how or when to use them. Kelly (2000) argues that a brainstorm should be playful and we figured that having a strict plan would kill the playfulness. One hour was set aside for the brainstorm. During the brainstorm, we would take a method and suggest ideas based on it. Every new idea was written on a Post-it note and placed on the table in between us. If we got stuck with coming up new ideas, we would rapidly switch method and keep on going. Some of the methods we ended up using was brainwriting (Heslin, 2009), what if scenarios, reverse thinking, time travel, exaggeration (Chua) and what would [person's name] do. The "what would" was a method we came up with during the brainstorm. Where we would ask ourselves what people we knew would do if they were to make this game.

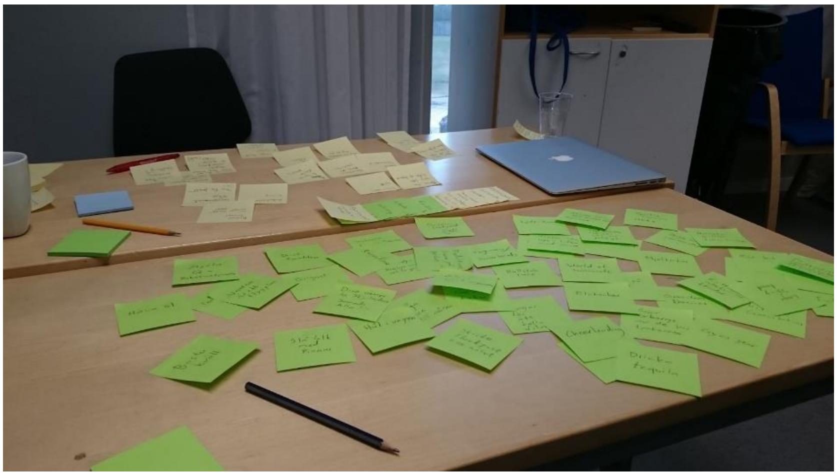

Figure 6. *Ideas from the brainstorm session*

By the end of the brainstorm we had had 75 different ideas on the Post-it notes (Figure 6). To quickly prune them we decided to rank them. Ideas written on Post-it notes were placed on a one-dimensional scale going from bad to good. The placements on the scale were subjective and based on what we had seen in the preliminary ideation. For example, if it was feasible with the Kinect's limitations, suited the age group ten to twelve, had potential for long-term play and was ethically justifiable. Once all ideas were placed on the scale, we made a split in the middle (Figure 7). The ideas on the bad side was rejected and thus we excluded roughly half of the ideas. Some of the excluded ideas included airplane, race driver and window cleaner. The ones we decided to move on with was gardening, space travel, spell casting, combos, monster fighting and tower defense.

Figure 7. *Ideas ranked from good to bad*

The game ideas we had chosen were at this stage vague and not well-developed concepts. However, we concluded that further development of the game concept should be put on hold. Desk research had not been completed and we still had not conducted any interviews. As a result, we felt that we were lacking needed knowledge to pursue a fleshed-out game concept. Pursuing a game idea without all the facts in place seemed foolish. Hence, we put game ideation on hold till the planning phase was completed.

5.1.4 Desk Research

This study spanned a wide range of topics. Including game design, interaction design, gamification, motivation, exergames and physiotherapy. Deep diving into all topics was impossible due to this broad span. Instead we focused to gain a broad understanding of these subjects via desk research. For this, we consulted literature, online sources, video material and commercially available games.

Game and interaction design colored our methodology. Working in an iterative process is the widely adopted method and is suggested by multiple authors (Maguire, 2001; Salen & Zimmerman, 2003; Moggridge, 2007; Fullerton 2008; Cooper et al., 2014). With this followed the common methods that goes with iterative design: ideation, prototyping and testing. Design theory also told us to focus on the end user and their experience rather than technology. As suggested by HCD (Brown, 2008) and playcentric design (Fullerton, 2008). For which the MDA framework (Hunicke et al., 2004) can be used as a tool to provide different aesthetics for the play experience.

In game design theory, we also found the concept of game characteristics (Elias et al., 2012). One characteristic is 'play lifetime'. A player may stop playing a game for many reasons. One could be that the player has exhausted the game's content. Something Elias et al. argues is more common in single player games as they tend to end eventually. However, the lifetime can be extended through means like randomly generated content, difficulty levels and different character classes to play, according to Elias. Elias also claims that games for more than one player is as easily exhaustible. Each new player will cause the goal to "always renew itself" (Elias et al., 2012). People can play together offline. Elias also states that online games tend to have long lifetime and support it through means like raids, item collecting and player versus player challenges. Elias also states that humans like to collect things. Elias states that collecting can be part of the gameplay, like in *Pokémon Red Version* and *Pokémon Blue Version* (Game Freak, 1998). However, Elias also states that the collecting can exist outside of the game, for example collecting cards for *Magic: The Gathering* (Garfield, 1993).

Gamification was the term Semcon would use when talking about their ambition. Gamification is the practice of using game elements in a non-game context (Deterding, 2014). Typically done to motivate the user of the gamified system. The potential to gamify physiotherapy was appealing. However, with Bogost (2011) criticizing gamification for missing the central elements of games appeal and Deterding promoting game design tools like MDA caused us to realize that gamifying physiotherapy was not the way to go. Rather we should apply game design theory to create a physiotherapy game.

While studying motivational theory, we were interested in how it relates to games. Deci and Ryan's (1985) Self-determination theory stood out as the major player. Ryan elaborated on SDT to fit video games (Ryan et al., 2006) and VandenBerghe (2016) whom places it into his "engines of play" to explain how player motivation changes over time. Time is a factor discussed by Werbach and Hunter (2012). Who argues that loops and progression stairs are used keep a game from becoming stale and boring as it becomes too predictable. Which led us to conclude that a good physiotherapy game would need a core loop of short term goals that would build a progress to more long-term goals.

We looked at existing exergames to see what they provide. In conjunction to this, other studies related to exergames and games for rehabilitation were examined. Extra attention was given to studies that used the Kinect as it had already been decided that it would be used in the project.

Commercial games like *Wii Fit* (Nintendo, 2008) provides several minigames, each focusing on a certain exercise. Studies show that the technology used for exergames is capable (Clark et al., 2012; 2013a; 2013b) and that playing these games can have positive effects on everyday life (Sabel et al., 2016). However, we noticed that the commercial exergames have weak progression stairs. *Wii Fit* for example, tracks physical progress like body weight and results in exercises and lets the player set personal goals for their weight loss. But the minigames themselves lack progression. Aside from a few difficulty levels, the minigames do not change much and thus runs the risk of becoming mundane once the user has exhausted the available content. Furthermore, the minigames are unrelated from each other as the success in one exercise has little effect on the overall game experience. The same applies to the songs in dance games. However, games like *Dance Dance Revolution* (Konami, 1998) and *Wii Fit* do allow for subgoals in the form of ranking and points.

On the physiotherapy side, we were interested in what kind of exercises are used in physiotherapy and how rehabilitation unfolds. Most of this information was received via interviews (see section 6.1.5) a study by Maclean et al. (2002) provided insight from professionals dealing with stroke rehabilitation. For example, clinical aspects like age, severity of the condition, cognitive function and depression. Cultural norms induced by religion. Setting rehabilitation goals that are relevant, small and achievable for the patient. Maclean et al. also points at social factors, like encouragement from family members. However, it can backfire if the family is pushing too hard (Maclean, 2002). The physiotherapists behavior can also affect motivation according to Maclean's. One doctor in the study said that it becomes a self-fulfilling prophecy when a healthcare professional labels a patient.

We also looked through different rehabilitation exercises available in an extensive video library on Mobilus (2017) website. From this we started to notice a division in different kinds of physiotherapy. One kind that focus on muscle strength and another that focus on cardio.

5.1.5 Initial Kinect Implementation

Kinect had been decided upon during the initial discussions with Semcon. Hence, we knew that some functionality was going to be crucial. Regardless of what kind of game we would make. This included integrating Kinect in Unity, visualizing the player's movement and detect specific gestures.

Researching and implementing these fundamentals was therefore done before we had decided upon a game concept. Testing the technology early was also a way to guide our design decisions regarding what would be possible for us to do with Kinect.

Integrating Kinect was achieved via package developed by Microsoft. The package included a Unity project, complete with source code, that demonstrated some basic Kinect functionality. For example, accessing body data from Kinect to access joints to draw a skeleton. Simply opening the package in Unity did not work however. Microsoft had developed it in an older version of Unity and it contained code that was obsolete in Unity 5. Microsoft's source code was therefore updated to make it compile in Unity 5.

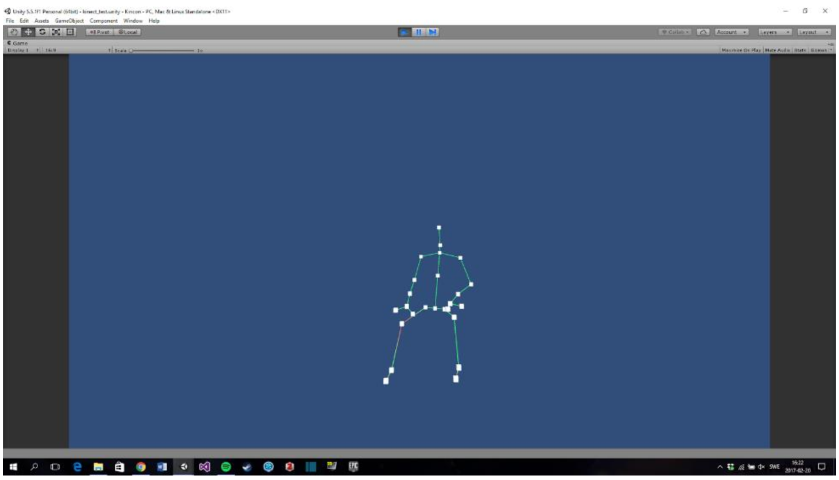

Figure 8. *Drawing a skeleton in Unity from Kinect data*

Originally, we wanted to visualize the player via a 3D model that moves based on the motions detected by Kinect. We did not pursue this however. Having no experience with neither modeling nor animating made us fear that it would be too time consuming. Thus, we considered using a green screen effect instead to simply draw the player onto the screen. Green screen was featured in Microsoft's example code for both the standard Kinect SDK (Figure 9) and the Unity package. The approach was therefore selected as we could quickly modify it to our own needs. Green screening also came with the benefit of mimicking a mirror, which was mentioned the interviews (see section 5.1.6).

Figure 9. *Green screen effect by using Kinect*

Gesture detection could be done via Visual Gesture Builder (VGB). VGB was implemented by following a video tutorial by Lower (2014a) and some additional work was done to read the data in Unity. One discrete gesture was implemented in this early stage. We called this gesture the T-pose. A gesture where the user would stretch her arms straight out in a pose that resembles a T. Due to its clear positioning of the arms, the gesture was easy to test with and was later used through the whole development phase.

5.1.6 Interviews

To complement the theory, we wanted to talk to people with expert knowledge in the field. Semcon facilitated contact with the company Alkit, Professor Martin Rydmark and Jurgen Broeren. We phoned and mailed the children physiotherapy ward at Drottning Silvias Barn och Ungdomssjukhus in Gothenburg and got in contact with physiotherapist Katarina Johansson.

We arranged interviews and prepared some topics to discuss. One of us talked with the interviewee while the other took notes. We wanted the interviews to be more like discussions that would give us a concept of the field as it is today and what problems there are. All the interviews are our interpretation of the meetings, and potential personal opinions of the interviewees do not have to represent the organizations or companies they work for. Some minor changes have been made according to the wishes of the people interviewed.

We summarize the interviews in chronological order.

Interview with Alkit

Semcon arranged for us to meet Alkit Communications AB. Alkit is a Swedish research and development company focusing on technology and concepts for data collection, analytics and collaboration for many different applications. Amongst other things their products include systems for telemedicine and eHealth co-operation. We discussed with them initially because they have developed several applications related to rehabilitation, and specifically rehabilitation in a home environment. We summarize our interpretation of the meeting:

Regarding eHealth, it is important to help patients individually. ICT (Information and Communications Technology) is good to use since it can help with this process. ICT can assess what the patient does but also influence what the patient does. Some patients have a hard time getting to the caregiving institution and in these contexts ICT is helpful. The focus should be on what is important for the individual. When it comes to physiotherapy motivation takes a dive when the patient comes home. The live communication between the physiotherapist and the patient is important for motivation. In this regard, video feed would be useful for evaluation.

Doing any exercises are better than not doing any at all. For some diseases like COPD (Chronic obstructive pulmonary disease) movement is essential and in geriatrics fall prevention is central. An active lifestyle reduces the risk of falling and trains balance. In an application for physiotherapy it would be great to be able to tailor exercises according to the needs of the individual. Diabetes is another disease where movement has a positive impact. When treating COPD, games are used, but this research is still on trial. Globally there are several similar projects going on and many of these use Kinect.

It is important to support different exercises and for each exercise it is important to know when to do it, what the goal with the exercise is, what intensity to use and for how long. Exercises should be done in sets. If the patient can participate in their own health plan it would strengthen motivation as well.

Alkit has developed serious games, where they provide the back-end solution and worked together with game developers that provide the front-end part. Games can keep track on results, the quality of exercises, and improvements over time. In a previous master thesis at Chalmers, in collaboration with Alkit (Ridderstolpe, 2016), sixteen mini games were developed to help with stroke rehabilitation. They did not have to reinvent the wheel for each game, a lot of code could be re-used depending on how similar the games were. Different games are suitable for different ages and Alkit are interested in what games work with different ages.

The social aspect of gaming is an important and strong motivator. The patients can play together, both locally and virtually (online). According to the one we spoke with, children are motivated by fun games, lots of feedback, quality time with parents and weekly pocket money.

Alkit suggested that we should avoid implementations using mouse and keyboard. There is a potential need to adapt menus individually depending on the user limitations. When it comes to the use of Kinect, it can be combined with other sensors to complement its shortcomings. Kinect have a hard time adapting with angles, people that pass in front of the camera and it is limited in the space where the user can stand to be sensed. Alkit concluded by suggesting that we limit ourselves before developing.

Interview with Professor Martin Rydmark

We held an interview with Martin Rydmark, MD, Ph.D. and professor in medical informatics and computer assisted education and associate professor in anatomy. This interview was arranged by Semcon. Martin Rydmark's education efforts are in the fields of anatomy, biomechanics and medical informatics and his research interests cover neuroscience, image analysis, 3D visualization, haptics, neurorehabilitation, virtual reality and learning. He does not see himself as a technical expert, but describes himself as a "superuser".

According to Martin Rydmark, eHealth can be complicated to develop since healthcare institutions tend to be conservative. Getting in contact with the right people is hard, you need to find people that are devoted to eHealth. There are similar problems in academia as well, but there has been progression. An example of such progression are hackathons to come up with IT-solutions.

Regarding use of the Kinect, Martin Rydmark is positive and claims that it is better with recognizing hand and finger movement now than it was when it was first released. Due to it being relatively easy to acquire, a lot of people are working with the technology. Using the Kinect to control an interface is unexplored though.

When it comes to physiotherapy, Rydmark says that it is a classical dilemma that motivation drops when the patient comes home from the caregiving institution. When coached by a professional, physiotherapy is more motivating than when the patient is at home. It is easy to skip exercise when you oversee it yourself. He also believes that it is problematic that eHealth is connected to healthcare and illness rather than something that is promoting wellbeing. Healthcare is considered less exciting by many and lowers motivation of use. It is better to design a game that is fun for everyone, but at the same time help patients with their problems. Rydmark states that it is important to remember that having an illness is a life crisis. Labeling a person as ill does not help the person's motivation.

Game design is something that Martin Rydmark has explored relation to eHealth before. He believes games must capture the attention of the player or patient and get them hooked. Knowledge about what people like to do is a way to find inspiration for this. For example, patients might like dance, games, fishing or other stuff.

Martin Rydmark has collaborated with Staffan Björk and Daniel Goude. They concluded that there are different taxonomies in medicine and game design (Goude et al., 2007). The bridge between the taxonomies of medicine and game design pattern could be further developed. He thinks that he could make a game from a medicine point of view that could work but it would probably be boring. From this follows the need of collaborating with people that have a game design perspective. Commercial off the shelves games are good inspirational sources when developing games for eHealth.

Another aspect of games is the social factor. Martin Rydmark believes that multiplayer is better than single player since it breaks social isolation and that the social context is important. Facebook and other social media are important since it makes people socialize. A woman that Martin Rydmark told us about had the following morning routine: Toilet, coffee, then social media to see what her friends were up to.

When it comes to children that go through painful procedures in healthcare, Martin Rydmark thinks it is good with things that distract from the pain. Games are good with this.

Interview with physiotherapist Katarina Johansson

To get an insight into how physiotherapy treatment works for children today we contacted the unit for physiotherapy at Drottning Silvias Barn och Ungdomssjukhus in Gothenburg, Sweden (DSBUS). We arranged an interview with Katarina Johansson who works as a physiotherapist at the physiotherapy unit at DSBUS. Her focus is working with overweight children or child obesity.

In general, the exercises for a patient vary individually and depending on the reason for physiotherapy. An overweight person using a gym might have around nine exercises, whereas a person rehabilitating from an injury might have fewer, more specialized exercises that focus the injured area. Physiotherapy progression is often measured in degrees of flexibility and how this changes over time. The patient can be made aware of progression in how the exercises become easier to do.

When it comes to the use of technology in physiotherapy, Katarina Johansson admits that they do not use that much technological equipment at DSBUS. They have a Nintendo Wii, but it is never used as it is perceived hard to start. She thinks that technology should be easy to set up and it should not be a hassle. Mirrors are good for physiotherapy since the patient can see herself and adapt accordingly.

Usually the physiotherapist shows the exercises to the patient, who is supposed to continue at home in various intervals and sets. Duration of the rehabilitation period and how often the patient meets the physiotherapist depends individually, some come back once a week, other come back once a month. If the patient does not do his exercises at home he might need to meet the physiotherapist more often.

The unit for physiotherapy at DSBUS use a tool developed by the company Mobilus. This tool has been used as long as Katarina Johansson remembers. In this tool, the physiotherapist can choose between various exercises and construct an individual exercise program for the patient. This program is printed on a paper so that the patient can take it home. Together with the patient, and potentially the parents, the physiotherapist explains the exercises and might add arrows, or similar, to explain the exercises even further. The printed images on the exercises are of adults but Katarina Johansson thinks this works for the children as well.

Katarina Johansson thinks that games might be a good way to assist with physiotherapy since all the patient groups, no matter their diagnosis, are interested in games. If the patient can do exercises at home aided by a game it might lessen the need to go to the hospital to do exercises with a physiotherapist or other patients.

Working with children changes depending on the age of the children. When the children enter their teens, they tend to become more independent. Younger children have more playful exercises where the parents are more involved, whereas older children do not want exercises they consider to be too childish. The involvement of the parents gradually lessens, but according to Katarina Johansson they are almost always involved somehow, even if it is individual in how much. With younger children the parents might participate in games, and with older children the parents might join them for walks or take them to gym. According to Katarina Johansson, it is always good to involve parents though. Another way to motivate children is to make the exercises more fun by switching them regularly. If the patient skip exercises they must come to the hospital more often. Motivation is an important factor, and if needed, the physiotherapist will give new and more fun exercises to motivate the patient.

Sometimes the patient can feel that they do not need an exercise. For example, they might say that they can walk, but then the physiotherapist can show them that they have a limp. It is Katarina Johansson’s impression that new, exciting equipment can make treatment more fun. Another way to motivate young people is to have group sessions so that the individual patients see that they are not alone.

Katarina Johansson focus on working with overweight children or children with obesity. The main goal is to stop weight gain. The work is team based to reach the entire family and the multidisciplinary teams consists of counselors, psychologists, dieticians and physiotherapists. The patient group are of various ages up to eighteen years old when they come to the physiotherapy unit and they often have a history of going to other units before this. They can go to gym to build strength but otherwise the exercises are more focused towards cardio. Examples of cardio for this group are step up boxes, running, biking, and dancing. For this patient group motivation is important to make them do exercises. All regular training is basically good for this group so motivating them is of importance. Training in group works well since it provides social motivation.

Interview with PhD Jurgen Broeren

Jurgen Broeren is a PhD and an occupational therapist. He has studied the effects of physically active video games. One of the studies focused on children who had survived brain tumors. The study showed that playing physically active games had positive effects on cognition and everyday life activities (Sabel et al., 2016). One girl could even join gym class in school after a while, according to Broeren. Jurgen Broeren has also been involved in game development for Parkinson patients. In that project, they tried to use several senses, such as rhythm and tactile senses. The equipment could be quite costly but compared to ordinary rehabilitation it was cost effective.

In eHealth and physiotherapy, he suggests that we could make it more interesting for physiotherapists if it reminds them of how they already work. When doing exercises, we should consider what they are good for in the end. What can the patient do and what does the patient need to train? It is of less use for the patient to train something that the she already can do without problem. Fall prevention is another important field where gaming can assist in training balance and provide a healthier lifestyle when growing old. World Health Organization have norms and standards on flexibility and mobility at different ages.

We asked Broeren whether overtraining can be a problem. According to Broeren, there is no danger in exercising too much if you are only using your own body as resistance. However, Broeren pointed out that not everyone has the strength to stand up and play. Thus, it is good to provide them the option to sit down. Broeren also states that the foundation for movement is being still. To accommodate this, Broeren recommends exercises where the user needs to be still.

Feedback is important according to Broeren. The patient needs to know he is doing right and making progress. Broeren mentions that physiotherapists can measure degrees to show increased flexibility but that may not mean much to the patient. Broeren also talked about using the game as a mirror. Claiming that it can be helpful for the player to see herself in the game's virtual world.

Jurgen Broeren thinks that when designing games, it is important to make them adaptive, they need to become harder as the user becomes better at them. At the same time, they need to be easy to start and get going with. Games need to have a coaching aspect when needed to and give feedback at the right times. For example, they can tell you how long it takes for you to do something. The motivational aspects of games are many, Jurgen Broeren mentions that they make you happy, build confidence and can provide a social aspect where someone else can stand next to you and provide encouragement. Commercial off the shelves games are of interest when it comes to developing for Kinect. There is no need to reinvent the wheel. He mentions *Kinect Sports* (Rare, 2010) and *Wii Sports* (Nintendo, 2006) as examples and thinks that reusing familiar games such as *Tetris* (Pajitnov, 1984) is a good way to go.

Reflections and themes from Interview

If we summarize the interviews we can see some recurring themes. In most cases it seems to be better to train, no matter what, than to not train at all. For some conditions like diabetes, obesity and COPD this seem even more true. With this said, training is individual and there is a need for individual training schedules and health plans. A wide range of exercises are needed to cater all possible needs.

There is a difference in motivation when it comes to training with a physiotherapist and training at home. Motivation drops in a home environment and since training is so important, the effects of motivating users to train at home would be great.

The parents are important to help children do their exercises, providing feedback, encouragement and rewards. In fact, various social interactions can help with motivation. Some users like to be social with other users online, others like to socialize locally.

The novelty factor is motivating. Switching out old exercises for new ones can keep things fresh, according to a physiotherapist. New technology and methods can also motivate the user. Considering this, technology have a lot of benefits and possibilities but there is also some resistance to new technology due to conservatism in healthcare and academia. It is important that technology is easy to setup and use for it to be able to overcome possible conservatism.

Games are motivating for a lot of people and they can be motivating in a lot of ways. Children are especially motivated by games and there are several approaches that can be used. Games can motivate the children to do exercises at home but can also be used to lessen the effect of pain if needed.

5.1.7 Time Plan Revision

The planning phase ended according to schedule. At this point, it had been decided to focus on children. Therefore, we wanted to playtest with children around the age ten to twelve. Through Semcon, we got contact with a local school where we could conduct a playtest. The pupils did not need physiotherapy and hence did not represent the target audience perfectly. On the other hand, they were in the same age group and their feedback was therefore of interest. The test was preliminary scheduled to take place during the project week 14 or 15. It was deemed necessary to have all the prototype’s features implemented before the test.

Originally there were plans to display our work on the Vitalis eHealth conference. Alas, it turned out that it would not happen since Semcon had not gained admission for the conference. An internal demo of the game at Semcon was scheduled in its place.

Table 2 displays the revised time plan for the thesis.

Project Week	**Date**	**Description**
1 - 4	2017-01-16 to 2017-02-10	Preparations and background research
4	2017-02-10 to 2017-02-10	Finalize planning report
5 - 15	2017-02-13 to 2017-04-28	Designing, prototyping and implementation
14 - 15	2017-04-18 to 2017-04-28	Potential playtest with school children
15	2017-04-24 to 2017-04-28	Demoing the prototype for Semcon
16 - 20	2017-05-02 to 2017-06-02	Evaluate results and finalize the report

Table 2. *Revised time plan*

5.1.8 Factors from Planning Phase

During the planning phase, several factors emerged that may be of relevance regarding player motivation. Below, the factors are written in bold.

In discussions with Semcon, the user's **culture** surfaced due to the broad target group in eHealth. As well as **clinical** aspects like age, weight and diseases. **Physical environment** where the patient conducts rehabilitation and **clear instructions** on how to perform exercises.

During preliminary ideation, we discussed the **time** aspect of physiotherapy and the **culture** and **clinical** state of various target groups. **Multiplayer** possibilities were also considered and **collecting.**

Initial game ideation touched upon the **gameplay aesthetics**, **theme** and the feasibility of realizing ideas with the Kinect's **technological limitations**. Age were considered as a **clinical** factor.

The desk research highlighted a game's **gameplay aesthetics**, **theme** and **story**. Art and sound can provide pleasing **audiovisuals**. **Feedback** and affordances which plays part with providing **clear instructions**. SDT that tells us that humans crave **autonomy**. The change of player motivation over **time**. Progression stairs to provide short and long-term **game goals**. **Collecting** can prolong a game's play lifetime. Also, **physiological goals** which commercial exergames track. Furthermore, professionals within physiotherapy have pointed at **clinical**, social life (**online** and **offline**), **culture** and **physiological goals** as factors connected to motivation.

Initial Kinect implementation provided some firsthand experience with Kinect and its **technological limitations** and **setup** requirements.

Interviews backed up a lot of motivational factors that we got from other sources and provided new factors to consider. Factors we got from interviews included **novelty**, **autonomy**, **feedback**, **clear instructions**, **clinical** factors, **physical environment**, **external encouragement**, adaptivity, **technological limitations**, **setup time**, the social aspect, both **offline** and **online** as well as **gameplay aesthetics**.

5.2 Development Phase

Design is a wicked problem so knowledge provided from theory is not guaranteed to work in every case (Rittel & Webber, 1973). The development phase therefore focused on research through design to put theory into practice. Using knowledge gained in the planning phase as a foundation, we set an experience goal for the game and started designing a game concept. The concept selection built upon the ideation from the planning phase. Exploring earlier ideas with the new-found knowledge led us to a space themed game concept. A concept we then refined with ideas about how the game would work, what the player would do and what goals the player would strive for. The development phase then split up in two tracks for prototyping. The first track utilized PowerPoint to create a mockup of the overarching game concept. The second track focused on the Unity prototype that used Kinect for the game's exercises. The split was made due to time constraints. Implementing all our ideas into the Unity prototype would be impossible. It was deemed faster to visualize the grand scale of the game in PowerPoint.

5.2.1 Experience Goal

Fullerton (2008) recommends the game designer to establish an experience goal early. The MDA framework (Hunicke, 2004) speaks of aesthetics as the players emotional experience when playing. Thus, mapping an experience goal against aesthetics identified in existing theory seemed appropriate. This included the taxonomy by Hunicke et al. (2004), the aesthetic ideals by Lundgren et al. (2009) and the emotions identified by Lazzaro (2004).

From our preliminary ideation, we had concluded that the game should be rewarding to play for short sessions. However, the player will have to play a little each day over long periods of time. Therefore, the should also motivate long-term play. Considering the works of Lara

(2016a; 2016b) and Werbach and Hunter (2012). Short sessions should be satisfied by the core game loop while the progression stair sets out goals for long-term play.

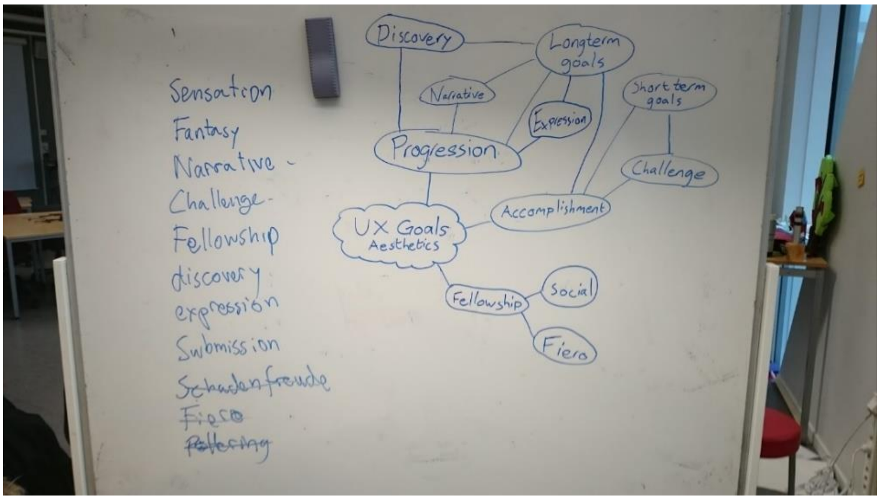

Figure 10. *Mind map over aesthetics*

With the theory in mind, we wrote up different aesthetics on the whiteboard and started connecting them in a mind map (Figure 10). This was done to visualize how different aesthetics relate to each other. For example, progression can be felt by discovering a new area or digging deeper into the narrative. While a sense of accomplishment can come from completing a challenge. Furthermore, we discussed how these experiences connects to long- and short-term goals. Aesthetics tied to progression naturally felt connected to long-term goals since a physiotherapy patient must feel progress through the entire rehabilitation process. The short-term goals, would then be to accomplish challenges that are steps towards the more long-term desires. Through this reasoning, we arrived at the following experience goal:

A game where the player strives for short term goals, that builds towards long term goals, by completing challenges where gestures are the tools for success.

Presenting an immediate challenge to the player would be the short-term goal for each play session. This is the core loop where the player would perform their exercises. The incentive to perform these challenges would be the long-term goals. To find new places, learning more about the story or collecting items to be used for self-expression.

Fellowship and social aspects were identified as its own branch of the user experience. It was recognized as an important branch but we had limited ourselves to single player during the planning phase. Hence, we did not explore this area thoroughly and left out aspects tied to a social context. For example, schadenfreude.

The mind map’s layout is based on our own subjective reasoning. It is not intended as a complete visualization on how gameplay aesthetics relates to long and short-term goals. Other configurations could be made that would lead to other experience goals. For example, challenge could potentially be replaced with submission or pottering to provide another kind of core loop that result in short-term goals. However, this model led to an experience goal which we could consult later when deciding upon a game concept.

5.2.2 Concept Selection

One month after the initial game ideation, we were ready to find and select a game concept. Our old ideas were brought back and put on the table. By doing an affinity diagram (IDEO, 2003), we grouped game ideas together by combining similar ones. Through this, we could see four distinct concepts take shape: monsters, space, spellcasting and farming.

We conducted a short brainstorming session to expand the concepts. The brainstorm was done by taking one concept at a time (Figure 11). General gameplay ideas were based on our findings from the planning phase. Potential themes for the game were also discussed. For example, the farm concept was initially about ordinary farm animals like cows, pigs and hens. But when discussing the potential of changing the theme, we ended up with a fantasy concept with fantastical creatures instead (Figure 12).

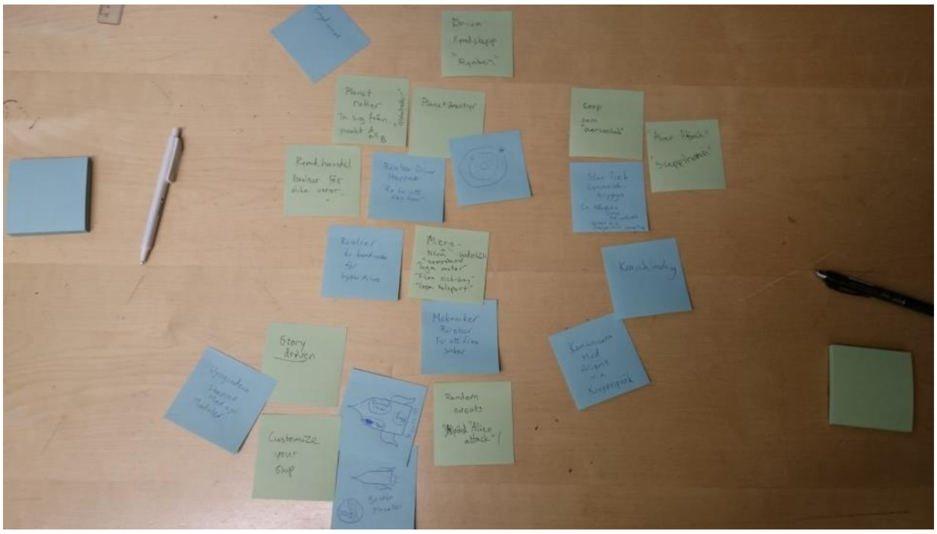

Figure 11. *Discussing ideas for the space concept*

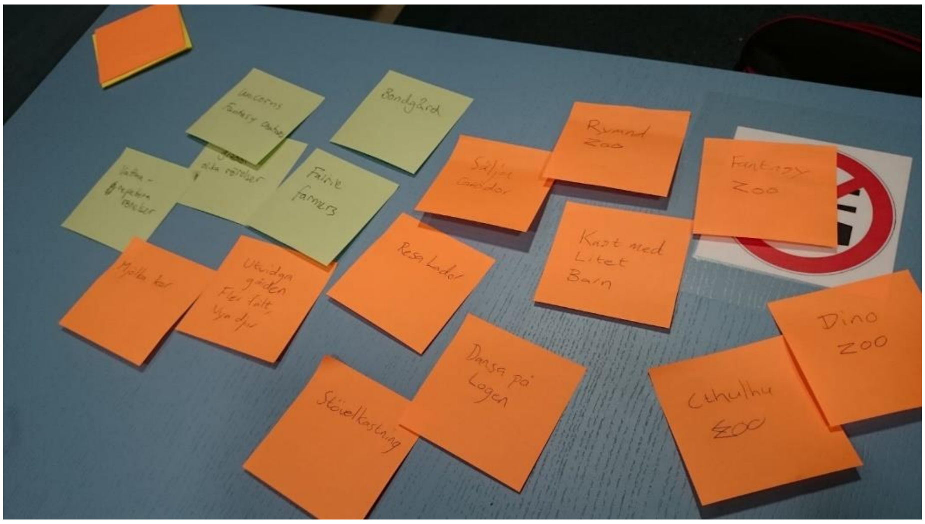

Figure 12. *Ideas and themes for the farm concept*

By the end, we had formed the following game concepts:

- Space: Focus on narrative and exploration for player progress.
- Monsters: Focus on character development where the player trains a pet monster.
- Spellcasting: Throw spells by performing gestures.
- Fairy Farm: Build a farm where you care for fantastical creatures.

Next, we split up to individually draw sketches on the different concepts. Previously we had mostly discussed the ideas in words. By sketching individually, we wanted to visualize what each of us would like to do. After drawing for a while, we met up to show and explain our drawings (Figure 13).

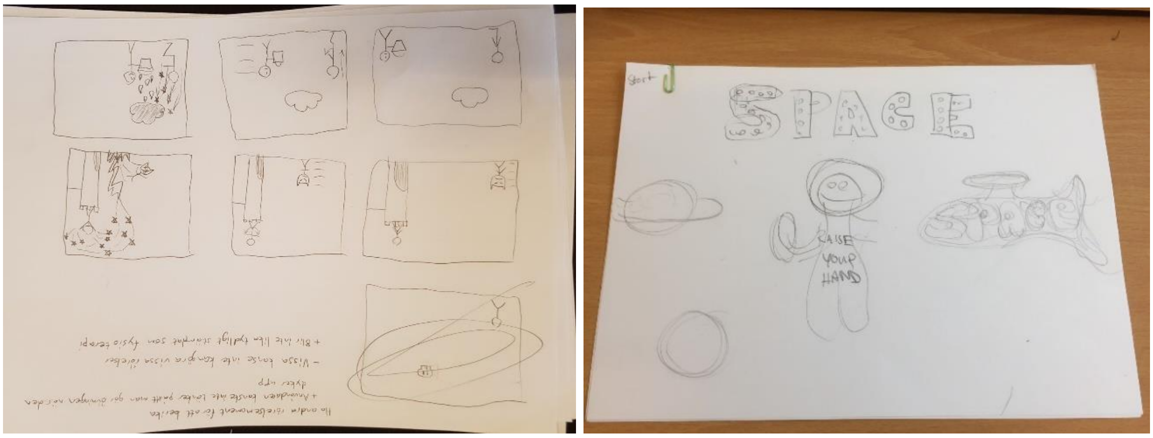

Figure 13. *Examples of individual sketches*

Going through the drawing we agreed upon that we should avoid having unrelated minigames. The game would become more interesting if every task was part of something greater in the whole scope of the game. Likewise, the gestures must also have a reason to exist in the game. Performing gestures only for the sake of performing gestures is not particularly exciting. Therefore, the gestures should not be the game's main focus. Rather, gestures should be a byproduct caused by playing. Another reason to not put focus on the gestures was that we wanted gestures to be interchangeable. This put restraints on gameplay possibilities. Not being able to assume how the player will move reduced our options down to having the gesture as a trigger for in game events. Including other motion elements, beyond regular physiotherapy exercises, was speculated as a possibility for enriching the experience. Potentially, it would lessen the limitations implied by interchangeable exercises and reduce the healthcare label associated with the exercises.

As seen during the planning phase, physiotherapy can focus on either cardio or strength. Cardio requires constant exertion in time spans up to 30 minutes to be effective. We did not want the gestures to be the focus in the game. 30 minutes is a long time and would require movement to be the main attraction. Something commercial dance games does quite well already (Rudella & Butz, 2015). Instead we chose to focus on strength and flexibility exercises. A single strength exercise does not take as much time. Thus, they are easier to place between other gameplay elements which better suited our design. Furthermore, cardio would mean more focus on rhythm and use of music as part of the solution, which we felt were a bit outside our scope.

In the end, we subjectively ranked the concepts based on the potential we saw in them. Ranking was as followed:

1. Space
2. Spellcasting
3. Monster
4. Fairy Farm

Fairy Farm was rejected due to the platform. Every idea we had about caring and expanding a farm seemed better suited on a PC or tablet where you can point and click.

The monster concept fell away since we were unsure on how to convey the game objective to the player. The player is supposed to train the monster by letting the monster follow the player's movement. But the player must be informed on how to do the exercises to convey them to the monster. The whole process seemed too complex.

Spellcasting was a strong candidate. Throwing spells is a good excuse for performing a myriad of different gestures. A fantasy theme was compelling and opened a range of gameplay possibilities. For example, defending a castle by summoning lightning bolts or creating gusts of wind to power windmills. Alas, these gameplay possibilities were falling in the category of unrelated minigames. We were unable to tie them together into a cohesive experience. Furthermore, this concept did not seem scalable as it would rely on a minigame structure.

Our choice fell upon the space concept. Motion could fit into the theme by using movement energy as fuel for the spaceship. Science fiction like holograms in the space ship could also be used to build interfaces that works thematically, but also how a user typically interacts with Kinect. Space exploration was also a scalable since one could introduce new planets, alien species and ship modules. Modules that would allow the player to customize his ship and opening for self-expression. Because of this, we decided to move on with the space concept.

5.2.3 Concept Refinement

We sketched some on the concept individually before discussing together more in detail how different parts of the space concept could work. During this discussion, we sketched even more to explain our thinking to each other as well as clarifying our own thoughts. We also tried out body movements to see what worked and what did not.

A basic system architecture and flow chart was made to illustrate how the different game parts held together. Three different views were discussed, the space view, the spaceship view and the planet view.

The space view could be some sort of space map or planet system where the player chooses what planet to go to. The location of the player could be marked by a spaceship.

When it came to the spaceship view we put more focus in how to design this. Several alternatives were explored, such as:

- Having doors behind the user silhouette that the user could access by hovering a hand over them
- The user could spin a virtual platform via hand movements and drift their silhouette into different rooms
- Interact via a hologram menu
- Having a cross section of the spaceship to navigate, but we felt this might be more suitable for a touchscreen
- A cockpit like view where the available actions are close to the user silhouette so the user does not tire their arms quickly (Figure 14)

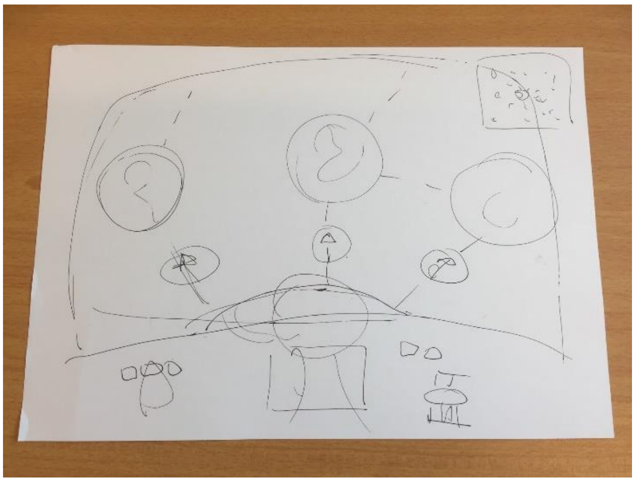

Figure 14. *Cockpit like view*

In the end, we realized that it would be better if we aimed for a minimum viable product showing the command deck of the spaceship, the engine room when doing exercises and a space map when navigating space.

On a more abstract level we discussed desirable features such as the user being able to customize their spaceship, landing on planets, trading, cargo bays, and ship maintenance.

We iterated on the design by sketching on different space views. What interaction did we want? When the user is in space view a certain form of abstraction is possible when the silhouette version of the user is not needed. This allowed us to explore interaction where the user uses hand movements to navigate space and access the spaceship and planets. Other solutions we discussed involved a first-person control panel as well as some solutions where the user silhouette walks around space as if walking around in a hologram. After discussing these solutions, we decided that using a representation of the spaceship is enough to show what planet the user is at in the space view. If the user should be able to customize their spaceship we agreed that showing a correct representation of this in the space view is of importance. The spaceship can be connected to the hand movement of the user. We also explored a mode of interaction where the user could scroll in a chain of planets but realized this would be too linear.

A small 2D minimap of the closest parts of space could be shown in all the user views. We discussed using a fog of war mechanism that hides unexplored parts of space to motivate exploration. We could imagine that traveling to known parts of space could be easier than traveling to unexplored parts of space. A quest system could also enrich the user experience and motivate the user to explore and progress. The use of a main questline could create and guarantee a certain game length.

After agreeing on the space view, we discussed the engine room and how this would work in the concept. One solution was to load up on fuel by doing exercises before deciding where to travel. Different routes could consume different amount of fuel and if the user wants to travel a route that cost more fuel than they have they would need to load up on more fuel. If the user chooses a destination several planets away they might need to only load up on fuel once to get to their destination.

5.2.4 Prototyping Process

With a concept in place, it was time to test it. However, it would be impossible to realize all our ideas in code due to limited time. A decision was therefore made to split the prototype into two parts. One made in PowerPoint and one made with Unity.

PowerPoint was used to create an interactive mockup of the overarching game concept. Showcasing the space exploration and narrative elements that would contribute to the player's long-term goals. The Unity prototype focused the short-term goal of charging the ship engine by completing a physiotherapy exercise.

These two different prototypes were developed in parallel throughout the rest of the development phase. Small informal playtests were done by ourselves and with friends and family to provide some information to help steer the design.

5.2.5 Prototyping in PowerPoint

With the refinement of the concept done we felt that we needed a mockup to be able to show our concept to others. We limited ourselves to only develop the engine room in Unity3D so we needed a way to show the rest of our concept. We used PowerPoint to make a simple interactive mockup to show flow and architecture. When doing mockups, the graphics should not look to developed, so we did a quick sketch of a spaceship that we digitized to act as a mascot for the concept and to use in the mockup (Figure 15). The spaceship's design was influenced by the album *Yellow Submarine* (The Beatles & Martin, 1969) to give the mockup a childish retro touch. For the rest of the mockup we used space background and planet models to show the planet system.

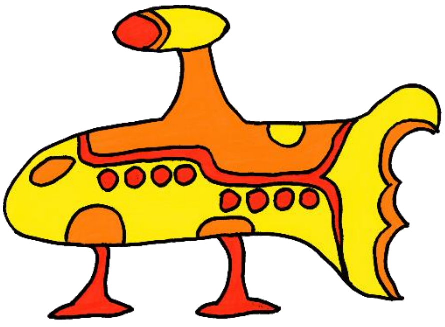

Figure 15. *Retro looking spaceship*

Since we already designed the basic architecture we set up a skeleton of a planet system for the spaceship to navigate and explore. We added some visual cues, such as hand contours, to show the imagined user what to do (Figure 16). When the user chooses to travel between planets they would need to enter the engine room to make more kinetic fuel (Figure 17).

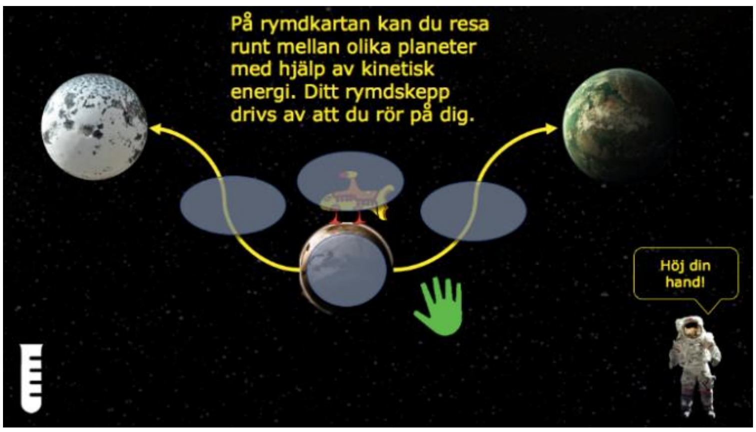

Figure 16. *Visual cues to illustrate interaction on the map*

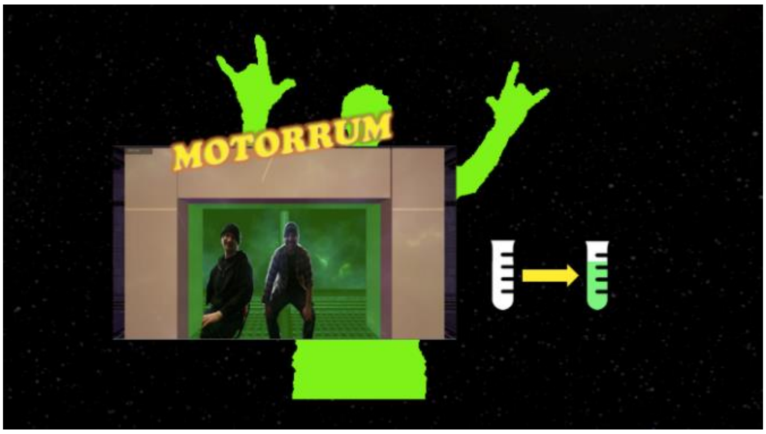

Figure 17. *Enter the engine room to re-fuel*

Internal evaluation

When trying out this mockup, we realized that it is important that the space map is consistent. It was disorienting to navigate in the first version since the space map was not consistent. The mockup shows that fuel is an important resource but we realized that it was disturbing to have to go to the engine room to make fuel for each space travel (Figure 17).

In some parts of the mockup we realized we had too many menu choices. All the buttons the user could hover over made the interface crowded. We decided to cut down on choices in some views since this would make flow easier. We needed to decide on how the user would move between views in the game.

Another thing we discussed was how to show pliancy in the mockup. On the space map, the first iteration had opaque areas to show where the user could hover their hand, but we decided that this was not intuitive enough in combination with it looking unsatisfactory.

All in all, the mockup gave a better picture of the concept and illustrate potential problems that we needed to account for.

Second iteration

We decided to iterate on this mockup design to be able to do an initial game test. In this second iteration, we decided to make a static space map that we could use for all planets (Figure 18).

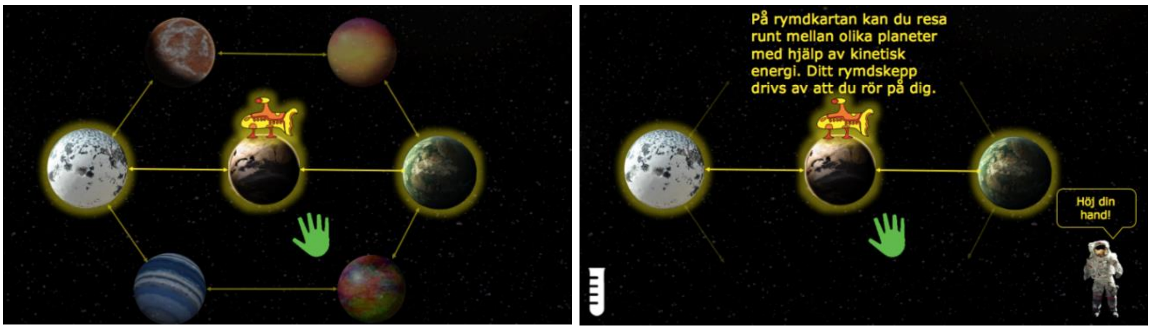

Figure 18. *Space map*

With this in place we could set the basic interactivity in the mockup. The player would always be on a planet with their spaceship and they could access some spaceship functions as well as go down on the planet to trade or explore (Figure 19). When traveling they would still need to go to the engine room to make fuel, but depending on their success, this fuel would last for several trips.

We decided to show pliancy with highlights and halos on the space map as opposed to the opaque areas we used in the first iteration.

Figure 19. *Spaceship view and use of halos and highlights in space view*

We tried to add some flow to the mockup to make a basic scenario, showing some of the possibilities that our concept had. This included a quest system that provided the player with missions to complete.

Figure 20. *Quests*

Third iteration

After the initial playtest (see section 5.3.1) we realized that some visual cues were confusing in the mockup when used as a prototype as opposed to when it is used to explain a concept. One such visual cue was the green hand present on most slides that just confused the test subjects. We removed this before the final playtests.

5.2.6 Unity Prototype

A Unity prototype was made that focused on the engine room. In this part of the game, the player would perform exercises to power the space ship. As the exercises are vital in a physiotherapy, we wanted to prototype this digitally. The exercise was presented as a challenge for the player to refuel the space ship.

Unity was used to shorten the development time. Since it already had fundamental technical components like graphics and audio implemented, focus could be put into prototyping the game. Kinect was used for movement input due to low cost and availability. Kinect Studio was used to record exercises and the clips were processed in Visual Gesture Builder. Data from VGB could then be used in Unity to detect when a player performs an exercise.

Following sections cover the development of the Unity prototype. The sections tackle the major iterations in chronological order with a few exceptions for the sake of readability. Focus is put on the design and the changes made along the way. Technological implementation is outside the scope of this thesis. However, the technology was integral for the design. Therefore, is implementation touched upon in the cases where it affected design choices.

The first exercise

The creation of the first version of the prototype started by setting up the engine room in Unity. Graphical assets were downloaded from the Unity Asset Store to create an engine room with a science fiction theme. The green screen was also quickly modified to be transparent to better blend in with the environment (Figure 21).

Figure 21. *Early version of the engine room*

The VGB code was updated to support continuous gestures. Exercises generally have the user move back and forth in a specific motion and continuous gestures were necessary to monitor this. With the possibility to track the motion we could then implement the logic of an exercise. Which consisted of sets where each set has multiple repetitions of the movement. Initially an exercise consisted of three sets with three repetitions. The current set and repetition was displayed on screen via simple text. A bar on the top of the screen illustrated how far into the movement the player should be and the how well the player timed her motion was graded as perfect, great, good, bad or miss. A text message would pop up temporarily in combination with a particle effect provided feedback to the player on what timing he had (Figure 22).

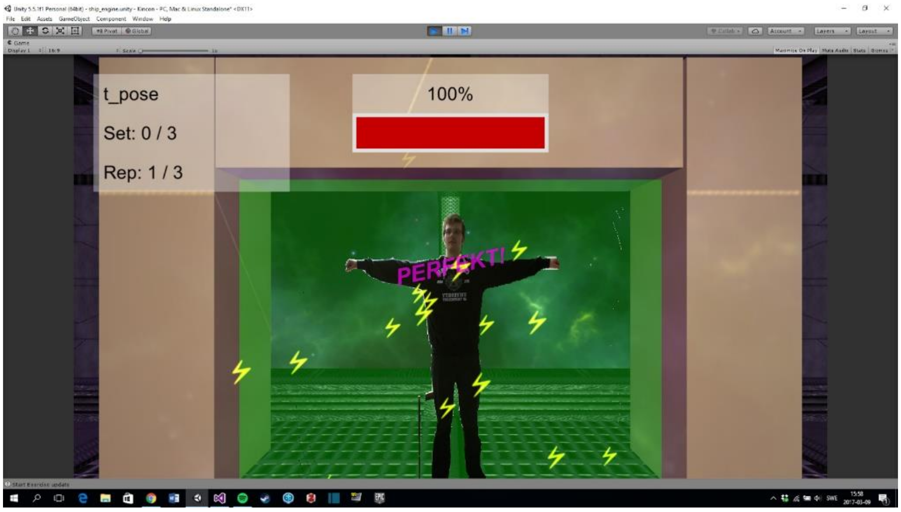

Figure 22. *Early timing feedback*

Between each set there was a short break where the player would rest. The time remaining of the break was indicated by a depleting bar (Figure 23).

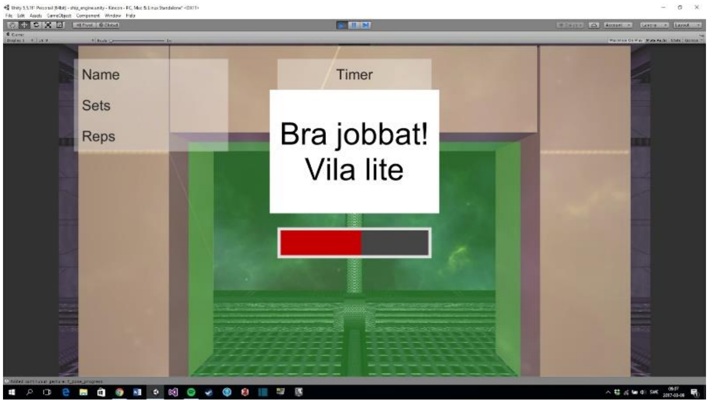

Figure 23. *Depleting red bar illustrated remaining rest time*

Upon completing all sets, the results of the exercise were presented (Figure 24). Not much thought went into the design of this first result screen. The grades from each set was just printed out to see that the gestures were counted correctly.

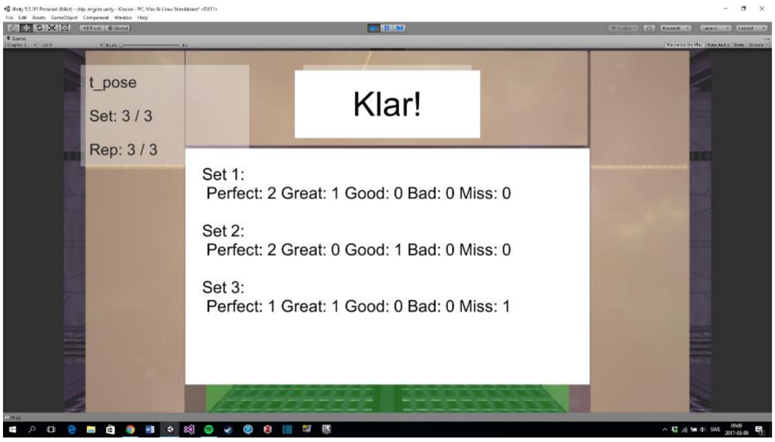

Figure 24. *The first result screen*

Movement energy and the ship engine

Fuel was going to be a key resource in the game. It was going to be generated by the player's movement and used for powering the space ship. There were also thoughts on using it as the in-game currency. During discussion however, we concluded that it might be a bad idea. Having fuel equal currency could cause a snowball effect. Being skilled at trade could make it pointless to complete exercises since fuel could be earned from other sources. And the other way around, repeating exercises constantly would generate more fuel which would make trading obsolete. Separating fuel and money into two different resources would avoid this issue.

A lot of discussion went into the design of the ship engine. It needed to fit the space theme visually. We also wanted it to convey information to the player. For example, which set she is in, how many repetitions are left and how well she timed the repetitions. Thus, it was desired to take this data, at the time only printed out on the screen, and immerse it into the game world.

The big and clunky engine room that was put together in the first iteration was not suited for this as it did not use screen space efficiently. The green screen area covered most of the screen, leaving little room for anything else. Sketches were made to redesign the engine room to better accommodate these issues (Figure 25).

Figure 25. *Engine room sketches*

It was decided to split the engine into two parts. The first part was a smaller platform, the absorber, where the player would be standing. This platform would be connected to the transformer that would convert the energy into fuel. The transformer had three displays. One for each set (Figure 26).

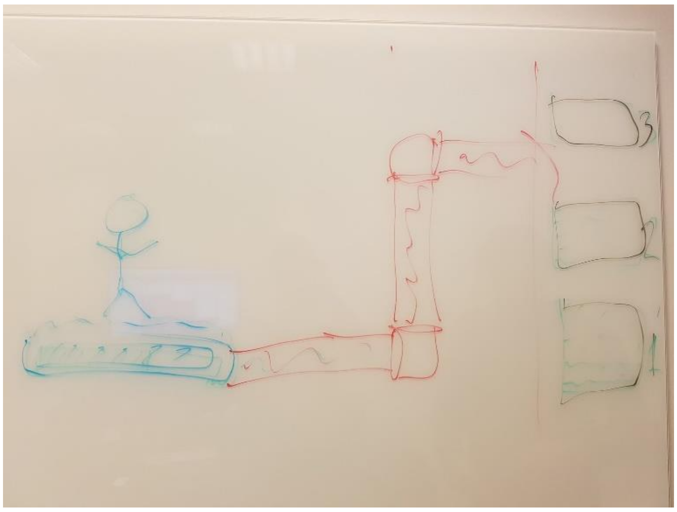

Figure 26. *Whiteboard sketch of the set displays*

Each display was then divided into smaller bars that represented the repetitions. Once a repetition had been executed, one bar would light up in a specific color that represented the timing. To make the end result juicy, we thought it would be interesting to make the machine spit out physical objects after the exercise (Figure 27). These objects became cubes, as it was easy to create cube shapes in Unity, and we called them ‘Kineticubes’. A combination of the term kinetic energy and cubes.

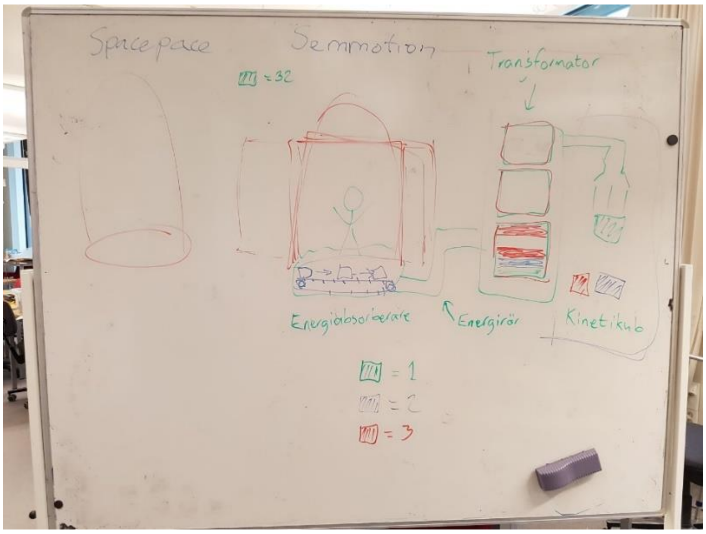

Figure 27. *Whiteboard sketch the transformer spitting out Kineticubes*

Energy design

Our idea of the engine being divided into absorber and transformer was first implemented without the Kineticubes. In this version, the bar that displayed the progress through the motion was also accompanied by two still images. The purpose of the images was to show the player how she was supposed to move (Figure 28).

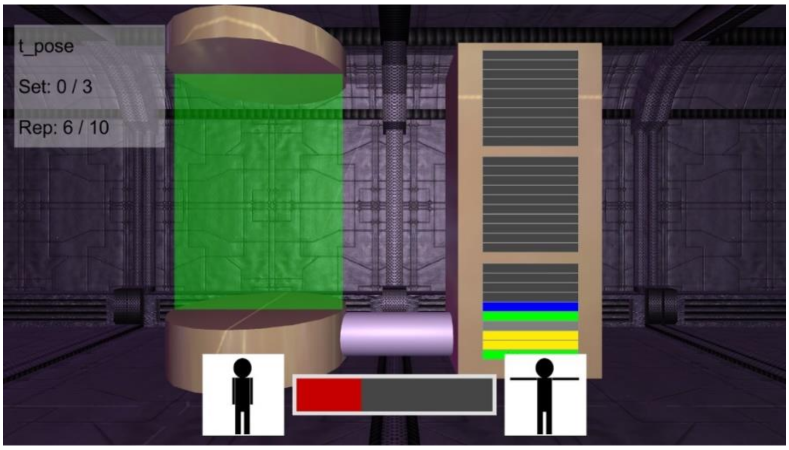

Figure 28. *Ship engine divided into absorber and transformer*

The colors on each bar would lit up in different colors depending on the player's timing. The colors were placeholders and this lead to a discussion on how the energy and the Kineticubes would be designed.

The initial thought was that the player would be rewarded with one Kineticube for each repetition. Each cube would have different colors matching the timing grades. For example, ten 'perfect' and five 'great' would result in ten red and five blue Kineticubes. The cubes would then have different values so a red cube would be worth more energy than blue.

However, it was argued that colors would not be a clear differentiator between values. Using gradients of one hue was considered and tested. Unfortunately, it was hard to distinguish between multiple gradients of one color.

We concluded that the problem was that we were trying to represent two things in one graphical element. Namely repetitions and earned energy. So, we split them up. We made the three displays only show earned energy. Next to the displays we placed small lamps. One for each repetition. When a repetition was completed a lamp would lit up. At the same time the display would fill up by a certain amount depending on timing. This visualization more resembled a fluid that filled up a container. Something we felt would be more associated to a real fuel like gasoline. The repetition lamps were made to lit up in different colors depending on the timing (Figure 29).

Figure 29. *Displays fill up with a green color to visualize earned energy. Lamps on the side of the displays represent repetitions.*

Animation

As seen in Figure 29, the bar and the two images representing the exercise had been replaced by a single image. This image is in fact an animation (Figure 30). Before adding the animation, we had friends playtest the game. While they tested, it became apparent that they had problems with interpreting the two separate images as a single motion. Thus, an animation was deemed necessary. At first, we removed the images but kept the bar and synchronized it with the animation. Our supervisor tested the game and pointed out that it was unclear if the bar was feedback on what the player was doing or instruction on what she should be doing. This point was later confirmed when we let friends play the game. They commented that the animation was good but the bar was confusing. Hence, we dropped the bar completely. The game became easier to play as a result. Even we as designers could hit a perfect timing better with only the animation.

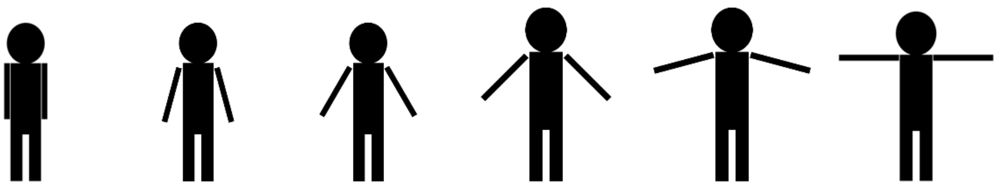

Figure 30. *T-pose animation*

Combos

Combos are “Sets of actions that trigger additional effects than those that occur due to the individual actions” (Björk, 2016) and was brought up by Staffan Björk when he tested *Kinetispace*. In rhythm games, like *Dance Dance Revolution* (Konami, 1999) and *Donkey Konga* (Nintendo, 2004), the player can build a combo by hitting consecutive notes without missing. The length of the combo is then used to modify the end score. As the game already detected the players timing, it was easy to extend this to keep track of combos.

The question was how the combo would work and what it would do. At the time, the game had five levels of timing: miss, bad, good great and perfect. It was argued that the combo should increment if the player hits ‘good’ or better. The reason was to provide more positive feedback to the player. The counter argument was that it would be too easy to increase the combo. Instead it was suggested to only count ‘perfect’ to the combo. ‘Perfect’ has a stricter timing, making it a greater challenge to build a combo. Furthermore, the higher difficulty would add a layer of suspense as the player watches the combo tick up. For this reason, it was decided to only count ‘perfect’ towards a combo. Getting any other rating would reset the counter. The combo count was made to pop up along the timing the timing grade (Figure 31).

We did not want to have a combo count just for the sake of it. The desire was to have the combo affect the number of Kineticubes awarded to the player. We implemented this by adding the highest combo to the amount of Kineticubes awarded from the exercise. Addition was chosen over multiplication since multiplying would give an unreasonably high amount of Kineticubes.

Figure 31. *Combo counter*

Visualizing exercise result

The old end result screen printed out text (Figure 24). The text displayed all the timing grades the player had received in the different sets. How many Kineticubes that had been earned was not displayed. Earning Kineticubes is the main reason to do exercises in the game as they are supposed to power the space ship. Displaying the earned amount was thus identified as the most important piece of information to give the player. To convey this effectively, we put a large number in the center of the screen when the exercise is over. This number counted up as the machine spews out cubes (Figure 32). The timing grades were removed from the end result screen as they were deemed superfluous. On the machine’s interface, repetition lamps already light up in different colors to show the grades. Timing grades were also reduced from five to three to simplify the calculation of the Kineticube amount.

Figure 32. *Counting Kineticubes*

Audio

Audio was supposed to convey feedback via sound effects and set the mood via music. Alas, we did not have the time nor skill to create our own audio. Thus, we had to resort to getting our audio files from the internet.

Sound effects were used for three different things. When the machine spits out Kineticubes, a countdown during the rest period between sets and for timing grades. Each timing grade pop up as a text message when a gesture has been performed. To amplify the text feedback, each timing grade is accompanied by a distinct sound effect. As stated by Cooper et al. (2014), this gives the player a chance to recognize the timing even if she missed the visual feedback.

It was hard to find a good music track. The song had to fit a science fiction theme but also be fit for exercise. Since we did not want to spend money on the music, we were limited to free tracks available on sites like Unity Asset Store and OpenGameArt.Org. The first track we used was from the Synthwave Music Pack (Marma, 2017). A track that several of our friends complained that it sounded like a TV-Shop commercial from the 80s. Instead we opted for a track created by Eric Matyas (2017). A track that at least did not get any complaints for not fitting the game.

Starting the exercise

An issue we had to tackle was how to start the exercise. Throughout most the development phase, the exercise would start when hitting a key on the keyboard. As pointed out by Alkit during the interview, keyboard should be avoided.

The spontaneous solution was to add a button on the screen and the game would start when the player touched it. However, this would probably not have solved another issue. While doing informal playtesting with friends, we noticed that most first time players did not immediately understand what they should do. The exercise would start and then they were confused for one or two repetitions before they understood that they should follow the movement shown on the screen.

How could we remove the need of the keyboard while also seamlessly inform the player on what to do? This sparked the idea of simply starting the exercise by doing a repetition. We set up the initial screen to show the gesture and some text informing the player to follow the movement. This view would idle until the player performed one correct gesture. At that point, the game counts it as the first repetition and the exercise proceeds as normal. This setup lets the player ponder the interface at her own pace. Once acquainted with the interface, she can start moving and initiate the exercise. At this point the player has learned everything she needs to succeed in the exercise.

Timing does not matter in the first repetition. Should the player perform the correct gesture but miss the timing, we give them a ‘good’ timing grade anyway. Positive feedback is given to ensure players understand that their motion was correct.

Final additions

At the end of the development phase we added a second exercise to the game, the squat. This second exercise was necessary to demonstrate the possibility of using any gesture in the game. It was decided to randomize the exercise each play round as this was faster to implement than creating an interface for actively selecting exercises.

Making Kinect recognize a squat proved time consuming. Compared to the t-pose, a squat is a more complex motion. With the t-pose, three recorded clips of the exercise were enough to train VGB to detect the gesture most of the time. Eleven clips were used for the squat to get a somewhat decent accuracy in the gesture detection. An animation was also made for the squat. The animation displayed the exercise from the side. We had a hunch that showing the squat from the side could confuse the player. The player should face the Kinect but the animation could make the player believe that she should face to the side instead. Still, the side perspective was chosen since it was easier for us to animate.

Another exercise was considered over the squat. The exercise had the player stretch his arms straight up into the air and pushing the palms against each other above the head. Alas, Kinect lost track of the shoulder joints while doing this gesture. Making it problematic to implement. Several other types of exercises had also been rejected. Due to occlusion problems with Kinect, it was deemed problematic to implement exercises where the player would have to turn their bodies in extreme angles or lay down on the floor. Another issue with these exercises was that the player would not be able to see the screen while performing them. Audio feedback could potentially be used to solve it but we did not have the time to explore any such solutions.

The pipe between the absorber and the transformer was changed to a glass looking material. When performing a repetition, a lightning bolt would trigger in the pipe (Figure 33). The lightning bolt’s purpose was to make it clearer that the player’s movement is transformed into fuel.

Finally, the number of repetitions in each set were reduced from ten to five. It was done to reduce the time to complete an exercise. We knew that we would have fifteen children playtesting the game at the school. Reducing the repetitions were estimated as necessary to ensure every child would have time to play.

Figure 33. *Lightning bolt effect triggered by repetitions*

5.2.7 Factors from Development Phase

Several factors were touched on during the development phase.

Our experience goal was heavily oriented towards the **time** aspect of physiotherapy, setting **game goals**, providing challenge as a **gameplay aesthetic** and **collecting** could allow for self-expression through ship customization. Social factors like **multiplayer** where deemed important but was not pursued since we limited ourselves to single player. **Collecting** ship modules could allow the user to

When selecting a concept, we rejected some ideas due to **technological limitations** as the interaction would not suit Kinect. Concepts were also rejected because we were unsure on how to provide **clear instructions** and providing a cohesive experience for the game's challenges. The selected concept had a **theme** that invited to exploration and narrative, **gameplay aesthetics** that could provide long term progression. The idea to power the space ship with kinetic energy from the exercises also fit the **theme** in a cohesive way and functioned within Kinect's limitations.

Concept refinement further strived to create a cohesive structure for the game and how exploration as an aesthetic could contribute to goals and progression. Giving quests to the player would also provide **game goals** that encourage exploration and provide a narrative context.

For the prototyping, art style was considered for the PowerPoint mockup. Furthermore, juicy **feedback**, consisting of visual effects and sound provided **audiovisuals**. In the Unity prototype, the value of **clear instructions** became apparent as people struggled with realizing how they should move. A lot of work went into the **feedback** so it naturally fitted the space engine **theme**. Combos were added to provide an extra level of challenge.

Some other factors were also noted that were not directly part of the development. They were more related to the circumstances around the development. Kinect proved to have some **novelty** tied to it. When experimenting with Kinect, it would attract the curiosity in nearby people. Sometimes someone would come forward, ask what we were doing and just watch himself drawn onto the computer screen.

Hassle with **setup** and the **physical environment** also became apparent while developing. There are a lot of cables that needs to be hooked up to run Kinect on a computer. Kinect also requires a few meters of open space so the player has room to move in the **physical environment**. Occasionally we had a hard time finding enough space to work. Resulting in us bumping into walls and furniture.

5.3 Evaluation Phase

The evaluation phase covers the final weeks of the project. At this stage focus shifted towards testing what we had already implemented rather than developing new features. The evaluation phase had three distinct parts. An initial playtest with two children, a follow-up expert evaluation and finally a playtest at a school.

There was a small overlap between the development and evaluation phase. Small changes were made to the prototype after the initial playtest and the follow-up meeting. The changes were mostly related to the code implementation. For example, bug fixes and improving the gesture detection. There were some minor changes to the available exercises and the number of repetitions in each set. These changes are mentioned in each chapter.

The next sections go through each of the three parts. The purpose of doing them and the results they yielded. Most attention is given to the school playtest as it was the largest evaluation session for this thesis.

5.3.1 Initial Playtest

One initial playtest was conducted with the sons of one of the authors. This pilot test was conducted to unearth any potential issues that could arise during the playtest at the school. Only the t-pose exercise was included in the version that was played and had ten repetitions per set.

The boys were of the age eleven and nine and they tried *Kinetispace* separately. During this test, the test subject would explore the PowerPoint mockup on their own. With a little guidance from the facilitator in case they would get stuck. Upon reaching the engine room in the PowerPoint, the children were led over to another computer that had the Kinect game running. After completing one exercise with the Kinect, they were told to go back to the PowerPoint to continue exploring. The intention was to mimic a real game scenario where the player explores space, goes into the engine room to refuel and then continuing exploring space.

During this initial test, it became apparent that the Kinect sensor should be placed directly under or above the screen. For the children, the screen was the natural reference point on what should be forward in the game. However, the Kinect's position is the actual reference point. Due to limited space where we tested, we had placed Kinect to the side of the screen. This caused the younger child to place himself in awkward angle in relation to Kinect. Gesture detection was hampered as a result. Standing at the proper distance was also not apparent. For the game to function, the whole body must be in view. The older boy placed himself at such a position so only his upper body was seen by Kinect. In both cases we had to step in and help the boys to stand at the proper distance and angle.

A green hand was present on slides that was illustrating a user interacting through Kinect. The hand served no real purpose however since the children navigated the mockup via the mouse cursor. Causing the hand to become a distracting visual element. There were also interface elements that did not lead anywhere when clicked which was another cause for confusion.

Jumping back and forth between the Kinect prototype and the PowerPoint mockup was not ideal. Switching between different mediums and computers multiple times caused a choppy flow in the test session. Furthermore, it made it hard for the children to process how these two prototypes should fit together. Especially for the younger boy who believed that the game was meant to be played on two screens.

While playing the Kinect game, the younger boy expressed that it was tiresome. For an exergame, this is potentially a good thing but his tone and facial expression hinted more at boredom. The older boy also seemed mildly amused while playing. He did however understand immediately how to play. He also gave a lot of suggestions on what should be added to the game. For example, vehicles to explore planets, planetary wildlife, building space stations, gathering workers, build alliances and waging war against alien species.

5.3.2 Follow-up with Experts

Jurgen Broeren, at the end of his interview, had suggested a second meeting where we would present our game to him. Giving experts within the healthcare field a chance to see and evaluate our work seemed like a good idea. A follow-up meeting was therefore held at the end of the development phase. The meeting was attended by us, Jurgen Broeren and Martin Rydmark.

We presented both the PowerPoint mockup and the Kinect game. The version of the Kinect game we presented had both the t-pose and the squat implemented with ten repetitions per set. This led to a discussion on what kind of exercises are suitable for the game since Kinect do have its limitations. Rydmark and Broeren stated that it would be of interest to list examples of gestures that are suitable or unsuitable for the game. Such a list would be helpful if someone were to build a library of exercises for the game.

A question we had pondered was the necessity of the exercises repetitive nature. Being told to repeat a gesture three by ten times is not “a series of interesting decisions” (Meier, 2012). Furthermore, every set and every repetition remains the same. According to Werbach and Hunter (2012), this will cause boredom as there is no progression stair. Breaking up the exercise’s forced sequentiality could potentially make the game more interesting. However, Rydmark and Broeren stated that training requires a degree of effectivity and sequentiality. Otherwise, the body’s recovery mechanism will kick in and reduce the effects of the exercise. Short breaks between sets, like the one present in the prototype, on the other hand is good to not completely exhaust the player.

Broeren and Rydmark agreed that social factors are important and should be considered in the future development of *Kinetispace*. Social networks were also suggested to build a community around the game. Which social networks to incorporate depends on the target audience. For example, it was mentioned during the meeting that young people do not “hang on Facebook”.

There was some confusion regarding how the exercise animation was supposed to be interpreted since the squat animation being turned ninety degrees. They did however state that the project displayed potential and that the prototype was a good start. Rydmark once again warned about labeling the game as healthcare. Saying that it is better to promote it as fun game for everyone. Rydmark recommended that we should develop the prototype no further. Only finalize what we currently had and conduct the playtest with the school children. Something which Broeren agreed on.

5.3.3 Preparation for the School Playtest

Extra care must be taken when working with children (Lankoski & Björk, 2015). The child’s guardians must give their consent before the child can participate. Hence the guardians must be properly informed so they can make an educated decision. Therefore, in preparation for the playtest at the school we wrote consent forms (see Appendix I) that we sent to the teacher at the school, whom passed them onto the guardians of the children and the principle.

We wanted a formative evaluation of the prototype and the mockup, where we could see possible improvements but also see if what we had done was appealing for the intended target audience. The aim of the evaluation was to get input on how to improve the concept and the prototype and to explore what parts of the concept seemed motivating. We did not want a summative evaluation, since a summative evaluation would be more to evaluate usability and if the prototype works as a finished product.

We wanted to know what the intended target group thought of the concept and the prototype and how to revise these and the design. We decided that we would make a survey (see Appendix II) for them to fill in about the prototype, but we also wanted to observe them as much as possible as the main way of assessing how they experienced the prototype.

An evaluation plan was made to ensure we would have enough time to test everything. Two to three children would come out in groups, so no child would have to be alone. The test was planned to be conducted in a secluded area away from the rest of the class. Notes would be taken during the test. A maximum of five minutes would be spent on the PowerPoint. It would be presented to the children by the facilitator who would explain the game concept to them. After the PowerPoint, the children would take turns playing the Kinect prototype. We wanted to test the concept and spot possible motivational factors. Not if the prototype was self-explanatory enough to stand on its own. The children would therefore get help with starting the game and we would answer any questions they had.

When every child in the group had played the prototype once, they would be given the survey to fill in. The survey consisted of a question using a Visual Analogue Scale (Markopoulos et al., 2008) and some more open questions (see Appendix II). The procedure would then be repeated with the next group of children.

5.3.4 School Playtest

On March 21, 2017, a playtest was conducted at an elementary school. The school was in Västra Götaland County, Sweden, and the participants were children enrolled in the fourth and fifth grade. Each participating child had written consent from their guardian. The test was conducted in two sessions. The first session was with the fifth graders. The fourth graders attended the second session. Each session was facilitated by us. One took care of the children and provided them with instructions during the test. While the other was the observer and took notes of the children's behavior and comments throughout the test.

The children tested the game in groups of two or three. Each test group first received an introductory walkthrough of the PowerPoint mockup (Figure 34). During this introduction, the test facilitator clicked through the PowerPoint and explained the game concept. After the introduction, the children in the test group took turns to play the Kinect game. Each child played the game once. After all the children in the group had played, they were given the survey to fill in. The survey included questions regarding the children’s opinions on the game, what they liked, disliked and what they would like to see more of. Once a test group had finished, the next group was brought forward.

Figure 34. *Introducing the game concept to the children*

The original plan was to let each test group test the game in a secluded area so they would not be influenced by the rest of the class. Alas, this was not possible since the school could only provide us a spot in the middle of the classroom. Every child in the classroom could therefore see the other children play. Thus, the last child in a session had more knowledge of the game when playing compared to the first child. The children participating in the first session had no influence on the children in the second session since the fourth and fifth graders were not present in the classroom at the same time.

Most of the children expressed a desire to play the Kinect game again. They were allowed to do so at the end of the session after each group had completed the test. During the tests, we moderated the children to ensure they stood in the correct place and that only one child was seen by the Kinect. During replays however, the children could play more freely. Observations were also noted during replays.

5.3.5 School Playtest Results

In total, fifteen children participated in the playtest. Six children (age 10) was in the fifth grade and the other nine (age 11) were in the fourth grade. Gender distribution was five females and ten males. After playing the game, the children got to answer a survey. In this chapter, survey results and observations made during the test are presented. All comments from the children, written and spoken, were given in Swedish. Here, they have been translated to English.

Survey results

The first question was: What did you think about the game? The children were to rate the game on a five-grade scale going from a sad smiley to a happy smiley (Table 3). Overall the children stated that they enjoyed the game. Everybody, except for one child, marked either the happy or the very happy smiley. The single child who did not mark a happy smiley instead chose the neutral one.

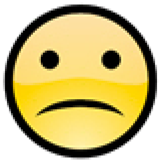	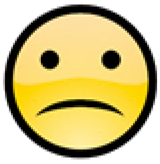			
0	0	1	4	10

Table 3. *The children's rating of the game.*
Number is how many who selected the above rating.

When asked what they taught was best about the game. Every child pointed out either movement or exercise as aspects they liked. One child also added that the aspect of traveling out into space was good. Another child wrote "That I won over [child's name]!!". Referring to that the other child received less Kineticubes by the end of the game. The child had however crossed over this statement in favor for movement. The child who provided the most elaborate answer wrote: "It was easy to understand what to do. That you exercise while playing. It is fun. Not too hard, not to easy".

On the question about what was less good in the game. Six children simply said "nothing". The other children did however identify some problematic elements. Three children felt that the Kinect did not interpret their movement in all situations. Two stated that the game was difficult. Another child complained that "I got the hard one". Most likely referring to the squat exercise since the children often said, while playing, that the squat exercise was much harder. One child did not like the fact that you sometimes would get the same exercise every time you play, which can happen since the two available exercises are randomized. It was also mentioned by one child that the game should have had more exercises.

When asked if there was something they did not understand, most children said "no". Four however were confused about the PowerPoint mockup. Confusing parts were all the buttons, when one would do the different missions, the cargo room and how the PowerPoint mockup was supposed to transition into the Kinect game.

What did the children want to see more of in the game? Six children said "nothing" and one child simply said "yes". Other answers mentioned more of the spaceship, exercises and space travel.

When asked what they want to do in a space game, the children gave a variety of suggestions. Four children wanted to explore space and visit different planets. One of them also wanted to walk on the moon. It was also stated that there should be different levels and places to visit on the planets. Another child specifically wanted to drive the spaceship. More exercises were also desired by four children. One child even wanted to swim. There was also one child who wanted to fight against aliens. Six children did not provide any suggestions.

See Appendix III for a compilation of every answer from the survey.

School playtest observations

The children responded positively to the game. Smile and laughter was often observed and most of them wanted to play again. Conducting the playtest in the classroom attracted the children's attention which caused an audience to build up around the game (Figure 35). Both cheering and heckling sprung from this behavior. It also contributed to a competitive spirit were the children compared each other's results. Mainly they compared collected Kineticubes. However, they also compared their combo count and their timing grades as a tiebreaker. This did however cause some confusion. Some children had the same number of timing grades but had received different number of cubes. The reason was due to them having different long combo strings. How the combo affected the score was not apparent and the children perceived it as an error.

Figure 35. *Audience of children watching each other play*

Two exercises were implemented for the playtest, the t-pose and the squat, and each set had five repetitions. The exercise was randomized before each play through and it was not appreciated. Especially when a child played again and wanted to try the other exercise. Furthermore, there was a difficulty difference between the exercises. The children would often refer to squat as “the hard one”. One child explicitly stated that he would not play if he got the squat. A moment later he was given the squat and he yelled out “You gotta be kidding me!”. Something that caused a burst of laughter in the audience. On the other hand, some enjoyed the squat more due to the added challenge.

A contributing factor to the squat’s higher difficulty was Kinect’s ability to detect the gesture. Some children would perform the correct movement and Kinect would simply not recognize it. This caused frustration and might have contributed why there were a few children who did not want to play again. The timing was also problematic since the children were unsure on how far down they should go in the motion.

The t-pose was generally perceived as “the easy one” since the Kinect could recognize this pose with high accuracy. In one case however, there was an indication that Kinect has problems with smaller children. One child with a tiny stature performed the t-pose exercise. The arms moved up and down but Kinect failed to recognize it.

The children even tried to play together at one point. Two children placed themselves in front of each other and tried to move one arm each like they were a single person. Surprisingly, this worked! Even though we had only intended the game to be played by one at a time. Then, four children tried to play together (Figure 36). This time however, the game crashed and had to be rebooted.

Figure 36. *Four children trying to play together*

Despite some issues, the children were enjoying themselves. They were trying to set new records and high combo counts would trigger a feeling of suspense. Both in the player and the audience. Positive comments like “cool”, “wow” and “this was fun” could be heard from spectating and playing children. Mixed with comments regarding the “super hard” squat. Seeing themselves in the game world was also appreciated. Occasionally a child would just stand in front of Kinect to just fool around.

5.3.6 Factors from Evaluation Phase

During the evaluation phase, we observed several factors. For example, during the initial playtest we could see the importance of **setup**, it was a bit unclear where the camera was and it was obvious that **clear instructions** was of importance. It was also recognized that **theme** and **story** was important to one of the test subjects.

When we showed the prototype to the experts some other factors came up. We had implemented the squat exercise and the animation and instruction was obviously not clear enough. The experts discussed **clinical factors** and what exercises could be supported with the Kinect due to its **technical limitations**. Creating a social context **online** with the use of social media was also discussed.

At the school playtest, we observed some **technical limitations** in the Kinect when it had a hard time recognizing some of the test subjects’ bodies. **Clear instructions**, or the lack of, was once again evident as some of the test subjects had a hard time understanding the squat animation or the timing of the exercises. When it came to **feedback**, the test subjects understood the feedback and even realized some aspects of the game not explained by the facilitator. The **novelty** factor was observed in the test subjects’ reactions to the prototype. Another factor that was observable was the emergence of **multiplayer**. The test subjects compared scores and result with each other and tried to test the limitations of the prototype together.

6 RESULT

Throughout the design process, several results were yielded. A concept for a physiotherapy game, called *Kinetispace,* was created where the player explores different planets. The spaceship in the game is powered by kinetic energy that is generated by performing physiotherapy exercises. This aspect of the game was implemented in a game prototype that utilized Kinect. By working with Kinect, several observations were made regarding the technology. Several factors, that one should consider to maintain player motivation, was observed.

6.1 The Concept

When the game experience goals were discussed the following goal was formulated:

A game where the player strives for short term goals, that builds towards long term goals, by completing challenges where gestures are the tools for success.

This led to the ideation of several concepts but in the end, a decision was made to focus on a space exploration concept called *Kinetispace*. In *Kinetispace*, the user is a space pilot navigating a fictional space with a spaceship. In some game views the users will see a silhouette of themselves representing this pilot. The different views are discussed in more detail in section 5.2.3. The spaceship will be customizable so the user can decide how it looks and how it behaves. To illustrate this concept, a PowerPoint mockup was made showing simple concept art and navigation (Figure 37), as described in the process section. Example images from the mockup can be found in Appendix IV.

The user travel with their spaceship between planets and to load up on fuel the user will have to exercises perform exercises in the ship engine. On the planets, the user will be able to do various activities. By trading the user can make money that they can use to customize their spaceship. If they explore the planet they can discover different things and be able to use gestures to achieve things related to progression and customization. They can also check for available quests. These quests can lead forward to other planets to motivate the user to progress by exploring space, but they could also be to make the user do more exercises or gestures in various ways. To guarantee a certain play lifetime that coincides with the physiotherapy treatment a main questline could be added. Random events will also be added to space travel to surprise the users and keep them motivated.

Figure 37. *The PowerPoint mockup of the concept*

The short-term goals in the game are represented by the gestures the user does for various reasons such as loading up fuel, exploring the planets, doing quests, or reacting to random events. The long-term goals are represented by space exploration, questlines, spaceship customization and an achievement system.

Since a decision was made to limit the game prototype to the engine room as well as just making a basic PowerPoint mockup, concept development was not iterated. Focus lay on showing basic flow and the PowerPoint mockup does this. But it would not show some of the long-term goals, such as customization, in a good way, so this was put outside the scope of the project.

6.2 The Game Prototype

In the concept for *Kinetispace*, the player's travel through space in a space ship. This spaceship is powered by kinetic energy. To generate this energy, the player must perform exercises in the ship's engine room. This aspect is conveyed in the developed game prototype.

The prototype was developed in Unity and uses the Kinect sensor for movement input. Two different exercises are implemented, t-pose and squat, and the game randomizes which exercise to perform in the beginning. On the start screen, the chosen exercise is displayed as a small animation with text that instructs the player to face the screen and follow the movement (Figure 38). All text in the game is in Swedish. Once the player does the movement, the exercise is initiated and continues seamlessly.

Figure 38. *The prototype's start screen*

Once the exercise starts, it then proceeds in in three sets. Each containing five repetitions. The player's task is to time her movements along with the animation. Depending on her timing, the player will be graded with 'miss', 'good' or 'perfect' with the audiovisual feedback changing depending on the grade (Figure 39). The timing also determines the generated kinetic energy which fills up the displays on the ship engine's transformer with a green color. If the player racks up multiple 'perfect' in a row, he builds up a combo. The combo is broken if the player should miss a 'perfect'. In which case the combo count starts over from zero.

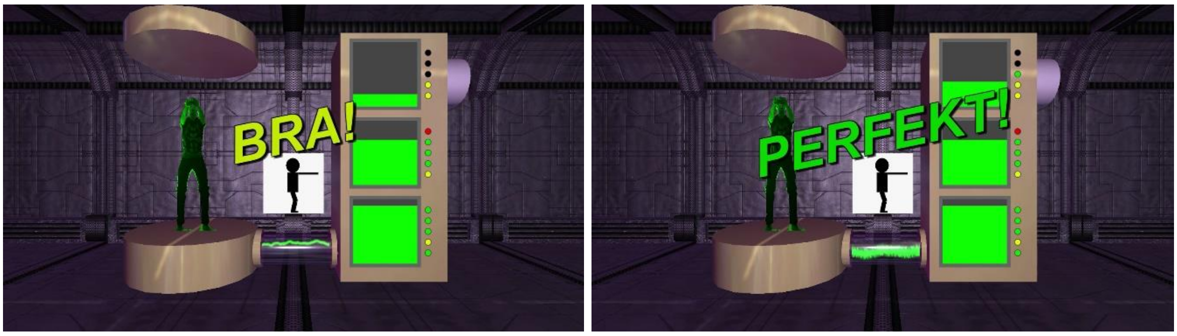

Figure 39. *Good and perfect timing*

Once all the repetitions in a set have been completed, a short break is had before the next set starts. Once the final set has been completed, the result is calculated. The result is based on the number of 'good' and 'perfect' timing the player had during the exercise. Highest combo is also added to the result. The green kinetic energy is transformed into Kineticubes that the machine spits out (Figure 40). For each cube that plops out, a number ticks up. The resulting number is the total amount of fuel generated during the exercise.

Figure 40. *Kinetic energy is turned into Kineticubes at the end of the exercise*

6.3 Kinect Observations

By designing a physiotherapy game and prototyping it with Kinect, we have made several general observations.

Occlusion is indeed a problem as it was pointed out by Alkit and in related work (Bonnechère et al., 2014; Ushaw et al., 2015a). During the development phase this affected which exercises we chose to implement. It caused us to reject exercises that required the user to stand at an angle or lay on the floor. We also had to drop one exercise since Kinect lost tracking of the shoulders when the player stretched her arms up above her head.

Between the exercises we did implement, there were a considerable difference in how well Kinect could detect them. The t-pose gesture was detected with high confidence by the Kinect after just passing three clips through VGB. Squat on the other hand required more clips but still was not detected with the same level of confidence.

Kinect as a platform seems to be dying. The SDK used to develop for Kinect is from 2014 and no major updates has happened since. Furthermore, Kinect was developed to be used with Xbox One. The original version of Xbox One had a dedicated Kinect port to connect the sensor. New Xbox One models however, lacks a dedicated Kinect port. Instead they require the same adapter used to connect a Kinect to a PC. That Microsoft has removed the Kinect port in new Xbox models is an indication that they are dropping their support for Kinect.

6.4 Factors to Consider

What factors should be considered, to maintain user motivation, when designing a physiotherapy game? By consulting theory, interviews and conducting a design process, we could identify 23 different factors during the development of *Kinetispace*. These 23 factors were then divided into eight categories. The categories and their included factors are presented below.

6.4.1 General Factors

Some factors are general since they can affect or be caused by multiple aspects. **Novelty** can be caused by novel technology, art style or gameplay. **Autonomy** should be experienced both in-game but a patient also wants to be able to influence their own rehabilitation. **Feedback** and **clear instructions** can be argued to be needed in any application or regular physiotherapy. Not just in a physiotherapy game.

Novelty

A motivating aspect in games is **novelty**. Novel and new things spark curiosity in people. As mentioned earlier, **novelty** is an important factor in intrinsic motivation (Ryan & Deci, 2000b). New technology can provide that **novelty** factor. For example, displaying the user on the screen via the Kinect can grab the user's attention immediately, but the **novelty** quickly wears off as the player engages with the experience. During the playtest at the school one child went "Wow" when he saw himself on the screen and it was obvious that this motivated him to try out the prototype.

At the physiotherapy ward at Drottning Silvias Barn och Ungdomssjukhus (DSBUS) they try to uphold children motivation by switching out exercises. Also, if a patient regularly skips doing their exercises, the physiotherapist gives them new exercises to motivate them.

In our game, we decided to make the concept modular and this supports the novelty factor when exercises can be replaced and not hard coded to the content.

The **novelty** factor can overshadow other factors though and hide negative factors. If something is new it is initially fun and negative aspect might be harder to spot.

Autonomy

Players should have the **autonomy** to make choices based on what they want to do. As Sid Meier said, "A game is a series of interesting decisions".

In self-determination theory **autonomy** is mentioned as the experience of making a choice (Deci & Ryan, 1985, p. 155) and **autonomy** is generally high in games (Ryan et al., 2006). This experience can be highly motivating since the user feels in control. In a physiotherapy context, you could compare playing a game with watching a video of an exercise. If the game lets you choose what exercises to perform you have some choice, whereas watching the video provides no autonomy.

Alkit mentioned that a patient that can participate in decisions about their own health plan are more motivated as well.

The digital prototype does not have **autonomy** due to its nature, the exercise is even randomized in the current version, but in the PowerPoint mockup we try to make up for this by letting the user be in control of choices and where to travel in the space map.

Feedback

At our meeting with Alkit, we were told that children are motivated by fun games, lots of **feedback**, quality time with parents and weekly pocket money. Jurgen Broeren also agrees that **feedback** is important, the patient needs to know it is doing right. Ryan et al. (2006) back this up, stating that **feedback** nurtures the players need for competence.

In game design, it is argued that **feedback** should be juicy; that the player should get a lot of **feedback** for minimal input (Gray et al., 2005). One example is *Dance Dance Revolution* (Konami, 1999) that uses a combination of flashing lights, text and audio when the player dances (Figure 41).

Figure 41. *Feedback in Dance Dance Revolution (Konami, 1999)*

We tried to put a lot of effort into the digital prototype when it comes to **feedback**. There is **feedback** in text, sound, energy displays, lightning bolts, colored bars showing success rate, and an increasing combo counter when the user succeed perfectly several times in a row. At the end of the exercise, a cascade of Kineticubes are produced by the user depending on success.

In our PowerPoint mockup, we focused on flow but the user gets textual **feedback** when reaching certain places in the space system. We did not explore **feedback** thoroughly in this context since the PowerPoint mockup is limited in what it can show, while being simple enough to prototype with.

When we playtested at the school the kids picked up on the **feedback** and they seemed to understand it. The combo counter made them understand that they should aim for doing several perfect exercises in a row.

Clear instructions

Alkit told us that for each exercise it is important for the user to know when to do it, what the goal or aim with the exercise is, what intensity to use for the exercise and for how long the exercise will go on. In short, it is important with **clear instructions**. Ushaw et al. (2015b) backs this up by, stating that in-game help must be offered.

A virtual coach, like in *Wii Fit* (Nintendo, 2008), can provide instructions on how to perform exercises via 3D animation and audio (Figure 42).

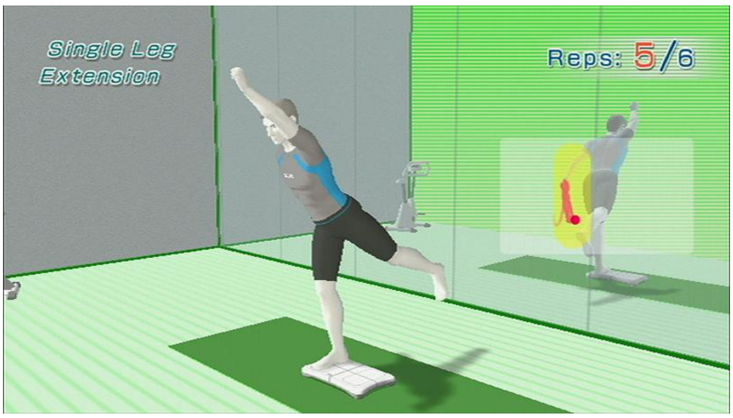

Figure 42. *A virtual coach shows the exercise in Wii Fit (Nintendo, 2008)*

In our digital prototype, text and a simple 2D animation is used to instruct the player. In the PowerPoint mockup, we use text to describe flow and what to do. The mockup also includes buttons, highlights and halos to show pliancy to the user. Pliancy is a term used by Cooper et al. (2014) to describe a screen based object that the user can interact with. And in our context the highlighted objects can be said to have pliancy since they hint at interaction.

6.4.2 Limitational Factors

Limitational factors puts limitations on what you can do with your design. Largely this depends on the target audience since their **culture** and **clinical** state influences what motivates them. The **physical environment** is also a factor since the player will move around in the physical world while performing her exercises.

Culture

Culture was brought up already in initial discussions with Semcon. Specifically, about immigrants who has to adjust to a society with other ruling cultural norms. While the scope of the project was limited to not dive deep into this area. Physiotherapists have stated that cultural background, like religious belief, affects motivation (Maclean et al., 2002). For example, religious norms might present a "disability as a deserved state rather than something to be overcome" (Maclean et al., 2002). One healthcare professional in Maclean's study stated that such norms can be overcome by presenting rehabilitation as God's will. Another healthcare professional also claimed that using gender norms could motivate a female patient through feminine talk (Maclean et al., 2002).

Clinical

Clinical factors are a part of physiotherapy and can impact motivation. Maclean et al (2002) points at several clinical aspects. Age is one factor and physiotherapists has stated that it might be harder to motivate an older patient (Maclean et al., 2002). Severity of the medical condition is another aspect mentioned by Maclean, which is a reason Jurgen Broeren says that some patients might have to sit down. Depression is also mentioned by Maclean, and Martin Rydmark hints at this when he says that having an illness is a life crisis. Rydmark goes on and states that a physiotherapy game should not be promoted as healthcare. A person who needs healthcare does not want to be labeled as ill. Rather, a physiotherapy game should be promoted as a game that can be fun for anyone. Though they should be adaptable to suit the individual's rehabilitation needs.

Physical environment

One should consider where a physiotherapy should be played as the **physical environment** restricts what the player can do. Some open space is required so the player has room to perform the exercises. This became apparent while developing for the Kinect when we occasionally bumped into surrounding objects. Exercise in the home might not be ideal if the patient live in a small apartment. Thus, it was discussed with Semcon that public locations could suit better as they can provide more space but at the expense of accessibility.

6.4.3 Game Design Factors

When designing a physiotherapy game, aim for making a good game. This was discussed during the interviews where it was mentioned that a physiotherapy game should be fun for anyone. To make a good game, one should adopt practices from the game industry (Ushaw et al., 2015b).

Developing a good game is hard and there is a lot to consider. Most of which is covered by Fullerton (2008). However, during this project there were some factors that stood out regarding player motivation. The factors include **gameplay aesthetics**, **game goals** and **unpredictability**.

Gameplay aesthetics

An experience goal should be stated early in the design process (Fullerton, 2008). The MDA framework suggests aesthetics to describe the player's experience (Hunicke et al. 2004). Several different **gameplay aesthetics** have been described. Hunicke et al. (2004) suggests sensation, fantasy, narrative, challenge, fellowship, discovery, expression and submission while more has been described by Lundgren et al. (2009).

An experience goal was set for this thesis that focused on challenge as a **gameplay aesthetic**. The challenge was executing exercises in the ship engine. The challenges were to build toward long term goals. These long-term goals were not explicitly stated during the formulation of the experience goal. However, during the concept selection and concept refinement, these long-term goals took the shape of exploration. This thesis cannot conclude whether it can provide long term motivation. Though, in the results from the school playtest, the children expressed an interest in the space exploration aspect of the game. Indicating that there is potential for long term motivation there.

Game goals

Goal is a common component in game definitions (Salen & Zimmerman, 2003). Goals gives the player something to strive for and completing them gives a sense of accomplishment. **Game goals** are thus a motivating factor. Something we could see during the school playtest. The goal in the prototype was to accumulate as many Kineticubes as possible by performing an exercise. This goal motivated the children to improve their own score as they wanted to play again. The goal also fulfilled the relatedness described in SDT (see section 2.6.1). Which could be observed when the children compared their own results against each other. The result comparison is the players creating their own subgoal, as described by Fullerton (2008), since the system does not rank the player's result.

Both the short and long-term goals should be considered. The player should also feel that she is making progress toward these goals. For progression, one can consider a progression stair (Werbach & Hunter, 2012) with subgoals (Fullerton, 2008) and level structure (Ushaw et al. 2015b). Something that exergame, like *Wii Fit* (Nintendo, 2008) and *Dance Dance Revolution* (Konami, 1999) utilizes to some extent via ranking, points and difficulty levels. Although, any success of completing exercises in these games do not affect any overall in-game progression.

Unpredictability

Unpredictability is a paradoxical factor for motivation. Humans crave for competence and being in control of the situation according to SDT. One would assume that a high level of **unpredictability** would undermine motivation. Yet Werbach and Hunter (2012) claims that a game that always stay the same, or can be described as predictable, will become boring. Furthermore, uncertain outcome has been described as part of a game (Caillois, 1961; Fullerton, 2008) and randomizing a game's content can prolong its lifetime (Elias et al., 2012). This indicates that a game should be unpredictable but not too unpredictable.

How much **unpredictability** there should be is hard to tell and the Unity prototype did not seem to balance this factor. The exercise to perform was randomized. Children that played the game did not appreciate this **unpredictability**.

Complexity and lack of **feedback** also seem to cause **unpredictability**. The algorithm that calculates the awarded amount of Kineticubes is not random. Still, the children were unable to deduce the variables, in particular the combos, that decides the awarded amount. Causing an unpredictable behavior that made the children believe that there was an error in the game's code.

6.4.4 Game World Factors

Games is a form of make-believe (Caillois, 1961). To support make-believe, we argue that a compelling game world should be constructed around, what Parlett (1999) called, formal play. The development of *Kinetispace* had to this point not focused on the game world factors, although it is touched upon briefly in the concept. Factors to consider regarding the game world are **audiovisuals**, **theme** and **story**.

Audiovisuals

Eye-popping art is one ingredient for an engaging game (Lara, 2016b) and audio can set game's mood (Sweet, 2008). A game with poor audio and visuals will feel worse than an equal game where these aspects have been polished (Gray et al. 2005). **Audiovisuals** is the artistic expression that makes the game pleasing for the eye and the ear. However, **audiovisuals** were not given much attention since early prototypes should not be pretty (Salen & Zimmerman, 2003). The PowerPoint was used to provide some indication for what the game may look like. However, the PowerPoint and the prototype is put together with placeholder art and sound. For an example of a game with good **audiovisuals** (Figure 43), have a look at *Ori and the Blind Forest* (Moon Studios, 2015).

Figure 43. *Ori and the Blind Forest (Moon Studios, 2015)*

Theme

A **theme** allows players to connect emotionally to the game (Lara, 2016b). Though, **theme** might only be the initial reason to start play. The engines of play (VandenBerghe, 2016) suggests that people start playing due to their individual tastes but the reason to play shifts towards satisfying psychological needs. Thus, a person might pick up a game due to a science fiction theme, like in *Kinetispace*, but the theme alone is not enough to motivate players to keep on playing. Although, **theme** appeared to spark interest in the school children. It provided them a context for them game and they would give suggestions on what they wanted to see in the game based on **theme**.

Story

Narrative is an aesthetic that means “games as drama” (Hunicke et al., 2004). Narrative could be a main aesthetic goal. Though any game could benefit from having a little **story**. **Story** adds a purpose to the player’s action (Lara, 2016b). Hence, **story** can be beneficial for most games even if narrative is not the focus. However, many exergames, like *Wii Sports* (Nintendo, 2006) and *Dance Dance Revolution* (Konami, 1999), lacks storytelling. In the *Kinetispace* concept, **story** elements are introduced in the form of quests.

6.4.5 Progression Factors

The player needs a sense of progress as physiotherapy can be a long process. **Game goals** certainly relate to progress. Achieving **game goals** can provide a sense of in-game progress. There are however other factors that relates to the progress of the physiotherapy. This includes the **physiological goals** and the **time** of the rehabilitation process.

Physiological goals

Game goals are the in-game objectives that the player strives for while playing. **Physiological goals** are the objective for the actual rehabilitation process which the game tries to help the player achieve through play. It has been stated by professionals that a patient undergoing rehabilitation need goals that are meaningful and achievable for them (Maclean et al., 2002). During the interview with the physiotherapist it was stated that the main goal for a person suffering from obesity is to stop weight gain. It was also stated that progression towards the **physiological goal** could be measured in degrees if the goal is to increase flexibility or pointing out to the patient that the exercises are becoming easier to perform. A game could let the player set a **physiological goal** and help track the progress towards it. Like in *Wii Fit* (Nintendo, 2008) where the player can set a target body weight.

The **physiological goal** determines the exercises that should be used in a physiotherapy game. During the development phase, we chose to focus on strength. Had we chosen cardio instead, we would have had to consider a completely different design. Possibly something more akin to dance games.

Time

The physiotherapist stated that physiotherapy is an individual process. Duration varies and some are in for a long rehabilitation period. **Time** is therefore a factor that should be considered. The player’s motivation to play changes over time. A player starts playing due to individual taste but keeps playing if the game fulfills the psychological needs (VandenBerghe, 2016). Furthermore, the game needs to change over time or the player will lose interest (Werbach & Hunter, 2012). Also, this require setting small **physiological goals** that are achievable for the player (Maclean et al., 2002) so the player feels that the rehabilitation has an effect.

6.4.6 Technological Factors

Technology can be **novel** as indicated by some responses *Kinetispace* has had. Although, a technology should not be used only because it is cool. **Technological limitations** need to be considered as it could harm player motivation and the **setup** required by the hardware could be discouraging.

Technological limitations

Technological limitations can have a negative impact. This was seen during the school playtest when frustration was caused by faulty motion detection. Potentially it could have been avoided by spending more time on improving the gesture detection. Still, Kinect has problems with smaller movements (Galna et al., 2014; Hosseinpour, 2015) and occlusion (Bonnechère et al., 2014). Occlusion also proved problematic when trying to implement gestures in the development phase. The **technological limitations** for this project has been specific for Kinect. However, every technology has its strengths and weaknesses and the choice of technology depends on the kind of movement that needs to be detected (Ushaw et al., 2015b).

Setup

Setup should be easy and fast. Drottning Silvias Barn och Ungdomssjukhus do have a Nintendo Wii. But during the interview at the hospital, it was stated that the game was too complicated to start. A complicated **setup** can thus be diminishing for motivation as it could cause the user to not play at all.

6.4.7 Social Factors

It was decided to not focus on social factors to simplify the development process of *Kinetispace*. However, social factors were often mentioned in related work and the interviews. **External encouragement** that can boost a person's motivation. While **multiplayer**, both **offline** and **online**, allows people to play together and creates a social context.

External encouragement

Other people can provide some **external encouragement** on a person to perform her physiotherapy. This encouragement can come from friends and family. It has been expressed by healthcare professionals that encouragement can boost motivation if done at a moderate level Maclean et al., 2002). **External encouragement** was also backed by the interviews. Especially in the case of children were the physiotherapist stated that the parents are often involved in the child's rehabilitation. Exertion games simulate **external encouragement** to some degree in the form of virtual coaches, for example in Wii Fit (Nintendo, 2008). According to Ryan et al. (2006), this potentially works because artificial intelligence could fulfill the need for relatedness.

Some signs of **external encouragement** could be seen during the school playtest when children were cheering on each other. The exercise animation could be developed further to function as a virtual coach.

Multiplayer

Having more than one player can prolong a game's lifetime (Elias et al., 2012) and can thus be a motivation to play. This is what we refer to as **multiplayer** and it was mentioned in the talks with Alkit and Rydmark. Alkit stated that it is a strong motivator and Rydmark said that it breaks social isolation. This is further backed by Katarina Johansson who explained that they have group sessions at the physiotherapy ward. During group sessions, a patient can meet others in the same situation. Furthermore, Johansson said that younger children have playful exercises that involves their parents. Many exergames also incorporates **multiplayer** in some form. *Wii Sports* (Nintendo, 2006) and *Kinect Sports* (Rare, 2010), for example, allows people to play together in different sports.

The project was limited to single player to simplify the prototype's development. Still, the children at the school playtest tried to play together anyway, even though the game was not designed for it, which is a strong indication of the influence **multiplayer** have on motivation.

Offline

A **multiplayer** experience can take place **offline** with the players in the same room. **Offline** gaming comes with some advantages that an **online** experience might have a hard time replicating. During the playtest, the school children formed an audience around the current player. They would cheer on each other, providing **external encouragement**, but also trying to disrupt to affect the player's result. **Offline** gaming also allows for physical interaction between the players. As seen by the two children who tried to play together as if they were one person.

Online

Thanks to the internet, people can socialize **online**. **Multiplayer** can take place online (Elias et al. 2012). Though the benefits of **online** extends beyond the game. Social media can be used to create a community around the game, as discussed in the follow-up with experts. Community building has also been argued as a key ingredient in games (Lara, 2016b). Elias et al. (2012) writes about guilds and leaderboards in online games. Such features could add another level of social interaction and cater towards the human's need for relatedness.

6.4.8 Gamification Factors

"Gamification is the use of game design elements in non-game contexts" (Deterding et al., 2011). However, physiotherapy games are games that promote health. Hence, best practices from game development should be used according to Ushaw et al. (2015b). Deterding (2014) also agrees, stating that game design is the way to go. Gamification seems to have a bad reputation. Bogost (2011) criticizes gamification to put too much focus on points, badges and leaderboards. However, most game platforms gamify their games by introducing **achievements**. The player collects **achievements** but **collecting** can also be a part of the game.

Achievements

Achievements are usually not part of the core game but rather the platform the game is played on (Hamari & Eranti, 2011). Operant theory (Skinner, 1953) states that eternal rewards is a motivator. Thus, it can be argued that **achievements** bring external motivation to a game. No **achievements** have been created for *Kinetispace* during this project as it is only an early prototype. However, Microsoft requires that games on Xbox Live has **achievements** (Björk, 2015). Since *Kinetispace* uses Microsoft's Kinect sensor, Xbox Live would be a likely target platform. Meaning, **achievements** would have to be considered. However, **achievements** could be implemented into the actual game, like the Wii version of *Mega Man 9* (Capcom & Inti Creates, 2008).

Collecting

Humans like **collecting** both in- and outside of games (Elias et al., 2012). Furthermore, Elias argues that **collecting** can prolong a game's play lifetime. There also exist games that incorporates **collecting** successfully. The *Pokémon* games (Game Freak, 1998) is a notable example of using **collecting** as an essential part of the game. However, **collecting** can also exist outside of the game, like with *Magic: The Gathering* (Garfield, 1993). C**ollecting** is closely related to **achievements** since they typically come with some form of reward for the player to collect.

No **collecting** has been implemented for *Kinetispace*. However, it was discussed already in the preliminary ideation (see section 5.1.2) as a way of motivating the player. When formulating the experience goal (see section 5.2.1) it was mentioned again as a way of promoting self-expression through item **collecting**. Later, during concept selection (see section 5.2.2) it was mentioned that it could be modules for customizing the space ship.

7 DISCUSSION

When trying to motivate users to do something you need to consider why and in what ways. Who is benefitting from the user motivation and how big is the benefit?

In our thesis, we have explored what factors to consider to maintain user motivation when designing physiotherapy games. You could just gamify physiotherapy by adding points, badges, levels and various other rewards to motivate the user, but then again, it would still just be physiotherapy, with some points added to it. When you design a game for physiotherapy you must get ahead of this, you must first and foremost design a game. And if the game is fun and motivating, it will be fun and motivating when doing physiotherapy as well.

What we have seen from our research is that the factors that motivate end user behavior, in our case physiotherapy, can be all kinds of factors. Keeping this in mind it is suboptimal to limit the design of a physiotherapy game to just using game design, because there are so many more factors to consider. This is akin to Deterding's discussion about the limits of Gamification (Deterding, 2014).

Relating to Deterding's discussion about 'eudaimonia', we can see that what we explored can be considered to have a positive outcome if it can help to motivate people doing their physiotherapy. Using games and gameful design to motivate users to do something that is good for them, can be considered as a worthwhile endeavor.

We wanted to explore motivating factors by providing a concept and a context that motivates doing exercises. It is the end users that will benefit, and their benefit is in relation to how motivated they are doing their exercises otherwise. If a game that helps with motivation makes them do exercises they otherwise wouldn't have done, the potential benefit is great.

7.1 Motivational Factors

The suggested factors should be considered as a first draft for an encyclopedia of motivational factors in physiotherapy games. More factors probably exist. The factors presented here is a result of our design process of *Kinetispace*. Other factors might have been found if we had used another target audience, theme or gameplay aesthetic. The list of factors presented in this thesis is therefore not a definitive list.

The factors are based upon theory, interviews, design process and playtests of the prototype. Our observations have led to the factors. It is not definitive proof that they are motivational factors. The school playtest took place during a single day. Observations from there indicates that the children had an initial interest in some of these factors. However, one day is not enough time to draw any conclusions whether these factors have an impact on long term motivation. Longer ethnographic studies would be required to back up such claims.

However, the factors that have been observed in this thesis serves as a starting point. When designing games, we need a precise vocabulary. Hunicke et al. (2004) reasoned that "fun" was too vague and they created their own vocabulary as a result. The same goes for motivation. Claiming that games are good for physiotherapy because they are "fun" or "addictive". More substance is needed to discuss how one can design for motivation. Thus, a vocabulary is needed to discuss what should be considered when designing for motivation. Suggested factors can serve as a basis for such vocabulary.

Once motivational factors have been established, one must consider their potential. They could contribute to good by helping people get through their rehabilitation. But the factors could also be used for less ethical purposes.

With any system designed to motivate users or players to do something that they would not otherwise have done, there is a risk that this is not in their interest. Zagal defined dark patterns in the design of games as “patterns used intentionally by a game creator to cause negative experiences for players which are against their best interests and likely to happen without their consent.” (Zagal et al., 2013).

In the scope of physiotherapy games the risk for misusing motivational factors is probably low. Motivating users or players to do their physiotherapy or exercise more is in their interest, and it should be clear when using the system that this is the intended goal, even if the road towards that goal lies in a game. Compare this to what Deterding (2014) describes as ‘eudaimonic design’. The system will be designed to make a positive impact not only for the user, but also for others. If successful this system will support humanity in some way, and this if something could be considered ethical.

People have different preferences and play games for different reason. The engines of play (VandenBerghe, 2016) tells us this. Hence, different factors will motivate different people. Creating a game that appeals to everyone would be impossible. Rather one should examine their target audience and see what appeals to them.

7.2 Design Process

In a way, our process has been a straightforward, classic design process. It follows the three stages of design and design thinking. In the planning phase, we did research and interviews to get information about the field we were going to design for. The information we got from the inspiration phase gave us the means to diverge enough to come up with ideas that we transformed and converged into a concept in the ideation phase. We then developed this concept and explored motivational factors during the implementation phase.

Throughout the process we constantly evaluated our work and iterated where needed so that we could proceed efficiently and produce results from research and development.

That said, we did some mistakes, and we might have done things in other ways that would have given us other results. One thing we have realized now is that we had an early design bias regarding what technology to use. We suggested using Kinect at our first meeting with Semcon. As Semcon was positive and interested in the technology, we went on ahead with Kinect. Even if we later realized the limitations of this technology.

An immediate implication of this limitation was of course in what desk research we did. We actively searched for related work connected to use of the Kinect and what was done with this technology. Secondly this early choice of technology limited us during ideation and in the choice of concept. In retrospect, it is hard to rule out that we did not try to analyze ideas from a perspective of using the Kinect as the technical solution. If we had not limited ourselves we might have treated ideas more openly and we might have ended up with a better solution. Thirdly we let the limitations of the technology limit us design wise in how we designed some parts of the prototype. In the game prototype, we adapted to what the Kinect can do. Since the Kinect cannot handle obstruction well we needed to design for the user standing turned towards it and facing it. This limited us both in the game prototype and the mockup where we had to design the views for frontal interaction.

We could have designed differently in several ways. One way could have been to be even more specific in our design. If we had limited ourselves even more, we could have focused on making a good game within this narrow context. But in doing this we would probably have had a harder time suggesting factors for our research question. Another way could have been to lessen the focus on physiotherapy and instead design for a holistic solution supporting full body exercise. This solution can be argued as being beneficial for most of the users, but maybe it would have provided limited use as being too general. A third way might have been to focus more on what motivates physiotherapy in general and put less focus on the game aspect, but in doing this it could be argued that it would no longer be in the field of interaction design and technologies, but rather about motivational research.

When doing design and design research there can always be more iteration and given more time we could have iterated more, but when we realized the choice of technology was a limiting factor we felt that more iteration had limited impact.

7.3 Concept and Prototype

Kinetispace is a concept that the target audience found appealing. The children in the initial and the school playtest responded positively to the theme and could provide ideas on how to expand upon it. The children also expressed an interest in the concept's space exploration. The concept is not specified in many areas. Aspects of the game like trading, spaceship customization and different views in the spaceship have only been discussed broadly. Given more time, these aspects of the concept can be elaborated further.

Design deals with wicked problems (Rittel & Webber, 1973). We therefore argue that designing a physiotherapy game is also a wicked. There is no one correct way of designing them and one solution may not work in all cases. Something we saw with *Kinetispace*. Most of the children at the school seemed to enjoy the game. On the other hand, the children in the initial playtest did not seem as engaged when they played. Which could be caused by the environment. In the school, the children could play *Kinetispace* instead of doing their regular school assignments. The initial playtest took place in the boys' home. Which meant taking time from other potential spare time activities. However, it can also be caused by individual tastes. Jason VandenBerghe (2016) argues that the personality type affects which game a person may like. As seen from the school playtest, one child gave *Kinetispace* a neutral ranking (Table 3). This hints at the wickedness in designing physiotherapy games as you cannot satisfy everyone's personal tastes.

The prototyping process was iterative and mixed low fidelity sketches with high fidelity digital prototyping. Splitting the prototyping into two tracks was in hindsight a wise decision. It allowed us to create a robust Unity prototype that focused on the physiotherapy exercises while still visualizing the overall concept in PowerPoint. Making everything in Unity would have required us to basically develop the entire game. A prototype however, should be a model used to test if a concept is achievable. The Unity and PowerPoint prototypes together does that. We know now that we can have interchangeable exercises. Albeit with some restrictions on possible exercises due to Kinect's limitations (see section 7.4).

There were some problems with the way we prototyped. The Unity prototype and the PowerPoint mockup are two different mediums. Some of the children who tested the game did not understand how they fit together. One possible explanation is that the two prototypes does not affect each other. During playtesting, we just switched between them to show both aspects of the game. But the outcome in the Unity prototype would not affect the children's experience with the PowerPoint. Even though the exercises performed in the engine room provides

Kineticubes that are supposed to be used for space travel. Furthermore, just being able to click through the slides created a high tempo where one could just rush through the slides.

A better way might have been to turn the PowerPoint into a board game instead. Salen and Zimmerman (2003) would recommend this approach since they write that video games can be prototyped with pen and paper. Instead of just clicking around in PowerPoint, a board game would put the playtesters in a scenario where they must decide on what to do. Another aspect of this would be to bring down the tempo. When clicking around in the PowerPoint mockup, some aspects of the game goes faster compared to how it would function in a final product with Kinect. Using a board game prototype would mitigate this and slow things down.

Kineticubes would be a resource that would need to be managed. To get more Kineticubes, the players would have to play the Unity prototype. The result from the Kinect game would correspond to how many cubes they could use in the board game.

7.4 Kinect and Gesture Detection

The prototyping process gave first hand impressions of the Kinect's limitations. Occlusion is indeed an issue. Exercises that hides joints from the Kinect's view is hard to track. Furthermore, it is time consuming to train Visual Gesture Builder to achieve accurate results. In turn, this can lead to frustrated players when the Kinect fails to recognize a correctly performed gesture, which is something we observed during playtests.

Gesture detection failures caused us to question our approach. We were focusing on letting the machine detect if the user is performing the correct motion. But perhaps the user is fully capable of realizing this on her own, and maybe even better than the machine. This led us to the concept of heteromation at the end of the project. Heteromation means to "push critical tasks to end users as indispensable mediators" (Ekbia & Nardi, 2014). Unlike automation, which are closed systems that does not allow for human intervention, heteromation let humans handle tasks in a system that is difficult for the machine to handle alone. Judging whether a gesture has been performed would be such a task. Training a machine learning algorithm to recognize a squat is time consuming. A human on the other hand can easily spot it.

A heteromated approach could have the machine focus on instructing the player on how he should move. While it is up to the player to determine whether he does the correct exercise. It puts some responsibility in the player's hands. Not having the machine judge the exercises opens up for cheating. Like in *Wii Sports* (Nintendo, 2006) where the player technically can play tennis by only jerking the wrist instead of performing actual tennis swings. You would have to trust the user that they are responsible enough to not cheat. If not, there may be other people around that can put some external pressure on the patient to not cheat. For example, in the case of children, there are often parents present that can ensure the child does not cheat.

7.5 Other Technologies

Kinect was chosen as the main technology early on. There are of course other technologies that could have been chosen instead. Alas, they did not get any attention in the beginning of the project. Kinect was mentioned in early discussions with Semcon and it stuck because of availability, low cost and Semcon's interest in the sensor. We would however like to briefly point at other technologies that could have been used instead and might be of interest in the future. Party, since we have seen indications that Microsoft's support for Kinect is dwindling.

The following technologies were the ones we discussed after the evaluation phase was over. There may be other technologies that are of interest beyond the ones presented here.

Virtual Reality (VR) has seen a boom in recent years. VR platforms like HTC Vive and Oculus Rift support head tracking and their controllers allow for gesture based input. It would allow for an immersive physiotherapy game. Though the setup could be a hassle and blocking the player's view could cause problems with exercising in the physical environment.

Smartphones is something most people have access to today. Motion input, while limited, is available. Other features present in a smartphone like GPS and camera could also be utilized for augmented reality gameplay.

Nintendo released their latest video game console Switch on March 3, 2017. The console is a hybrid of a home-based game console and handheld device with detachable motion controllers that the player can hold in each hand. The portability gives Switch an edge over Kinect since the physical environment is no longer confined to one spot. The player can easily carry it to a place where there is more room to play.

Desktop computers are not something you can disregard either. During the interviews, it was pointed out that mouse and keyboard are not optimal input devices for a physiotherapy game, but it was also mentioned during the interviews that computers are used for socializing with friends, family and other patients that are going through similar rehabilitation. A game focused on social factors online could be ideal on a computer. The computer could potentially also work together with a smartphone application.

Finally, there is Orbbec Persee. Orbbec is a 3D sensor, like Kinect, but it has a built in Android computer. This simplifies the setup since the Orbbec only needs a power source and a HDMI cable that connects to a screen.

Above technologies are viable options with strengths and weaknesses. Their use can also have ethical implications. A 3D camera could potentially record the player and collect data as she plays. The material could potentially be useful for the physiotherapist to evaluate the patient's progress but should under no circumstance leak to unauthorized parties. Furthermore, the patient must be aware of what data is collected, how it is used and who have access to it.

Care must be taken so any participants does not get hurt (Lankoski & Björk, 2015). The risk of injury must therefore be considered when choosing technology. The movements an exergame requires by the player can be demanding. Especially for someone who has sustained an injury. Also, should the GPS in smartphones be used for location based play, care must be taken so players do not end up in dangerous areas.

7.6 Generalizability

This thesis limited the design to a single player game for children in a home environment. Still, the factors should apply to other contexts and demographics as well, though changes would be needed to the design. If we take the game world factors as an example. *Kinetispace* takes inspiration from science fiction. The children responded positively to it, but had our target audience been elderly people it may not have had the same response. Potentially we would have needed to look elsewhere for inspiration.

An indication that the factors are generalizable can be seen in existing theory. The game design and game world factors exist in game design theory. Thus, they can be applicable to any game. Not just exergames. The same goes for gamification factors. Since they are related to gamification, they could be applied to other systems that are not even games. Then there are the general factors which design theory promotes as fundamental to any form of interactive product.

The technological factors do not only apply to Kinect. During the interview with the physiotherapist, it was mentioned that they did not use their Wii because it was hard to start and Jurgen Broeren spoke warmly of Wii during the interview with him.

7.7 Future Work

Longer ethnographic studies are required to gain a better understanding of the suggested factors. It is of great interest to study their effect on long-term motivation. This could be done by observing people play a game over a longer period. The prototype developed in this project is not suitable for this kind of study. To be used for that purpose, the prototype would have to be developed into a full-fledged game. Instead one could observe people play existing commercial exergames. However, it may be worth considering games from other genres as well to see how they motivate their players.

For the *Kinetispace* concept, it would be interesting to explore heteromation. Do we really need to perfectly detect if the user is performing the correct motion? Other technologies could also be explored more in depth as it has not been done for this project. Turning the PowerPoint mockup into a board game could also be a cost-efficient way to test if the game idea works together with the exercises in the ship's engine room. Furthermore, one should consider how social factors could be introduced to *Kinetispace*.

8 CONCLUSION

The thesis aimed to answer the following question: What factors should be considered, to maintain user motivation, when designing a physiotherapy game?

To find answers a wide range of subjects were explored, including interaction design, game design, motivation theory and physiotherapy. Interviews with experts within healthcare were held and existing games were examined. This provided a theoretical foundation for the factors.

A design process was then conducted to put theory into practice. The design process resulted in a concept for a physiotherapy game called *Kinetispace*. A PowerPoint mockup demonstrated the concept and a prototype, that utilized Kinect for gesture detection, was developed. In *Kinetispace* the player explores space by traveling in a spaceship. The ship is powered by Kinetic energy that the player generates by performing physiotherapy exercises. The game was then playtested with schoolchildren to collect feedback from the intended target audience.

Through this process, a list of factors was compiled. In total, 23 factors were observed during this project and they have been divided into eight categories. So, when designing a physiotherapy game, we recommend considering the following factors to maintain user motivation:

- General Factors
    - **Novelty**
    - **Autonomy**
    - **Feedback**
    - **Clear instructions**
- Limitational Factors
    - **Cultural**
    - **Clinical**
    - **Physical environment**
- Game Design Factors
    - **Gameplay aesthetics**
    - **Game goals**
    - **Unpredictability**
- Game World Factors
    - **Audiovisuals**
    - **Theme**
    - **Story**
- Progression Factors
    - **Physiological goals**
    - **Time**
- Technological Factors
    - **Technological Limitations**
    - **Setup**
- Social Factors
    - **External encouragement**
    - **Multiplayer**
    - **Online**
    - **Offline**
- Gamification
    - **Achievements**
    - **Collecting**

The above list should not be considered definitive. More factors may exist. Furthermore, one cannot draw any conclusions regarding the effect of these factors on long term motivation. Only one playtest session was conducted with the schoolchildren. To study long term effects, multiple playtest over a longer time would be required. Thus, the list should be seen as preliminary results. Although, the factors can serve as a vocabulary to discuss motivation when designing games

All in all, designing a physiotherapy game is not much different from designing any kind of game. Factors observed in this thesis are general. They could be applied to any game that aims to motivate the player's engagement. The game you design should be fun for anyone, not just people in need of physiotherapy. No one wants to play a bad game. Therefore, to design a motivating physiotherapy game, you should design a good game.

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11 APPENDIXES

Appendix I: Consent form

Speltest av sjukgymnastikspel

Till målsman för elev på XXXXX,

Du får detta brev som en förfrågan om ditt barn kan tänka sig att delta i en utvärdering av en spelprototyp som är tänkt att främja sjukgymnastik och rörelser hos unga. Prototypen är framtagen som en del av ett examensarbete på Chalmers Tekniska Högskola inom ramen för masterprogrammet Interaction Design and Technologies (http://www.ixdcth.se/) med ansvarig handledare professor Staffan Björk.
Studenterna är utbildade i hur man arbetar med barn på ett etiskt sätt, och vi är noga med medgivande och hur bilder enbart får tas om man inte kan identifiera barnet. Fokus är såklart på att barnen tycker att utvärderingen är skoj.

Bakgrund/syfte
Ämnet interaktionsdesign handlar om samspelet mellan människa och teknik. Syftet med utvärderingen på Novaskolan är att se hur barnen använder prototypen samt vilka delar av den de tycker är roligast och mest motiverande. Utvärderingen är en så kallat "proof of concept" som innebär att prototypen testas av användare i målgruppen för att undersöka om den lyckas med det den är avsedd att göra, dvs att göra till synes monotona rörelser roliga som en del av ett större koncept.

Spelet använder sig av en Kinect-kamera som har möjlighet att läsa av kroppsrörelser och använda dessa i spelprototypen.

Deltagande
Om något barn inte vill vara med när studenterna är på besök kommer detta att respekteras. Bara de barn som vill vara med och är positiva till det vid besöket kommer att vara med.

Användning av information
Den information och de observationer som samlas in från barnen kommer att vara anonym och förutom projektteamet så kommer ingen annan känna till skolans eller barnens namn, och denna information kommer aldrig att uppges i eventuella rapporter eller artiklar som skrivs om projektet, utan resultaten presenteras alltid anonymiserat. I aktiviteter med barnen där processen eventuellt dokumenteras med foton, ljud eller video för senare analys, kommer barnens ansikten inte att vara synliga eller identifierbara.

För att kunna ta del av skolans och ditt barns aktiviteter behöver vi ert medgivande. Detta medgivande gäller under våren 2017. Om det under tiden uppstår behov för att ändra på planerade aktiviteter, metoder eller dokumentationsformer kommer vi att kontakta er med en särskild medgivandeblankett för detta tillfälle.
Studien utförs i samarbete med Semcon, men Semcon kommer bara att ta del av anonymiserad data från utvärderingen.

Hantering av data och sekretess
Alla svar och alla resultat kommer att behandlas så att inte obehöriga kan ta del av dem. Endast personuppgifter som är relevanta för forskningsprocessen och forskningsfrågan samlas in, som t.ex. kön och ålder. Ingen enskild medverkande kommer att kunna identifieras i de slutliga rapporterna. De som kommer att ha tillgång till data är docent Olof Torgersson, professor Staffan Björk, samt studenterna Jonatan Lind och Andreas Mikko. Det är studenterna som kommer att vara ute på skolan och träffa barnen.
Frivillighet
Att delta är helt frivilligt. Även om ni tackar ja till att delta nu, så kan du som förälder eller ditt barn när som helst avbryta deltagandet utan motivering. Om ni tackar nej till att delta så kommer det inte att påverka elevens skolgång.

Kontakta ansvariga
Om ni har frågor eller funderingar kring projektet så kontakta gärna studenterna:
Jonatan Lind, tel. 0708-161825, email: jonalind@student.chalmers.se eller Andreas Mikko, tel. 0706-469830, email: mikkoa@student.chalmers.se

Medgivande
[ ] Jag ger härmed samtycke till att mitt barn deltar i "Speltest av sjukgymnastikspel" under 2017.

Underskrift

……………..……………..……………..……………..……………..……………..…….

Namnförtydligande

……………..……………..……………..……………..……………..……………..…….

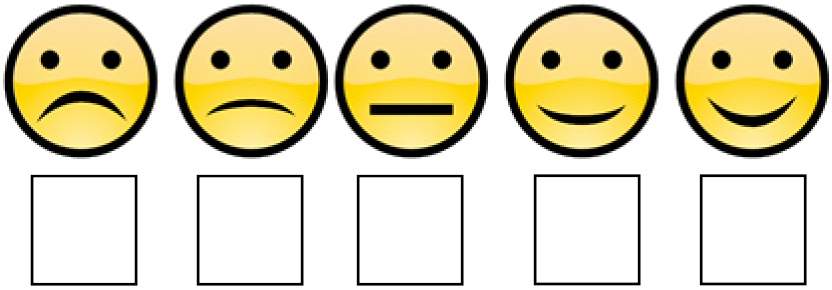
Datum
Mitt barns namn

……………..……………..………… ……………..……………..………………

Appendix II: School Survey

Rymdspelet – Enkät

Vad tyckte du om spelet?



Vad var bäst med spelet?

Vad var mindre bra med spelet?

Var det något du inte förstod?

Är det något du skulle vilja se mer av i spelet?

Vad skulle du vilja göra i ett rymdspel?

Appendix III: School Survey Results

Svar på enkät

[Name of school]

2017-04-05

Session 1 - 5or

Vad tyckte du om spelet? (1 - 5)

1. 5
2. 5
3. 5
4. 4
5. 5
6. 5

Vad var bäst med spelet?

1. Bra träning och att man åker ut i rymden
2. Att röra på sig
3. ~~Att jag vann över [namn på elev]!!~~ [This line was crossed over]
   Att man fick röra på sig
4. Att man rörde på sig
5. Att man fick röra sig
6. Att man får bra träning

Vad var mindre bra med spelet?

1. Samma rörelser ibland
2. Inget
3. Att rörelsedetektorn var väldigt känslig
4. Man fick inte till rörelserna riktigt
5. Svårt att koncentrera sig
6. Inget

Var det något du inte förstod?

1. Nej
2. Alla knappar
3. När man skulle göra uppdragen och det
4. Nej
5. Inget
6. Nej

Är det något du skulle vilja se mer av i spelet?

1. Fler rörelser
2. Mer såna där uppgifter
3. Det du visade när man fick resa i rymden
4. Att göra lite andra rörelser också
5. Mer rörelse

Vad skulle du vilja göra i ett rymdspel?

1. Styra rymdskepp
2. Jag vet inte
3. Kriga mot rymdvarelser [Answer had been underlined]
4. Åka runt och kolla i rymden
5. Ja det ser kul ut
6. Vet ej

Session 2 - 4or

Vad tyckte du om spelet? (1 - 5)

1. 5
2. 5
3. 5
4. 4
5. 3
6. 5
7. 5
8. 4
9. 4

Vad var bäst med spelet?

1. Rörelse
2. Att man rör på sig och att det är jättekul
3. Jag tycker rörelserna
4. Jag gillar iden och jag gillar att röra mig
5. Rörelse
6. Att göra rörelser
7. Det var enkelt att förstå vad man ska göra att man tränar medan man spelar. Det är roligt inte för svårt inte för enkelt
8. Att man kan röra sig
9. Att man kan röra sig

Vad var mindre bra med spelet?

1. Ibland var kameran inte med
2. Inget
3. Ingenting
4. Kanske utveckla med fler rörelser
5. Att jag fick den svåra
6. Inget
7. Inget
8. Att det var så svårt

9. Att det var ganska svårt

Var det något du inte förstod?

1. Det där i lastrummet eller när man byter
2. Ja hur man går in på bränsletävlingen
3. Jag förstod allt
4. Nej
5. Nej
6. Nej
7. Nej
8. Inget jag förstod allt
9. Nej

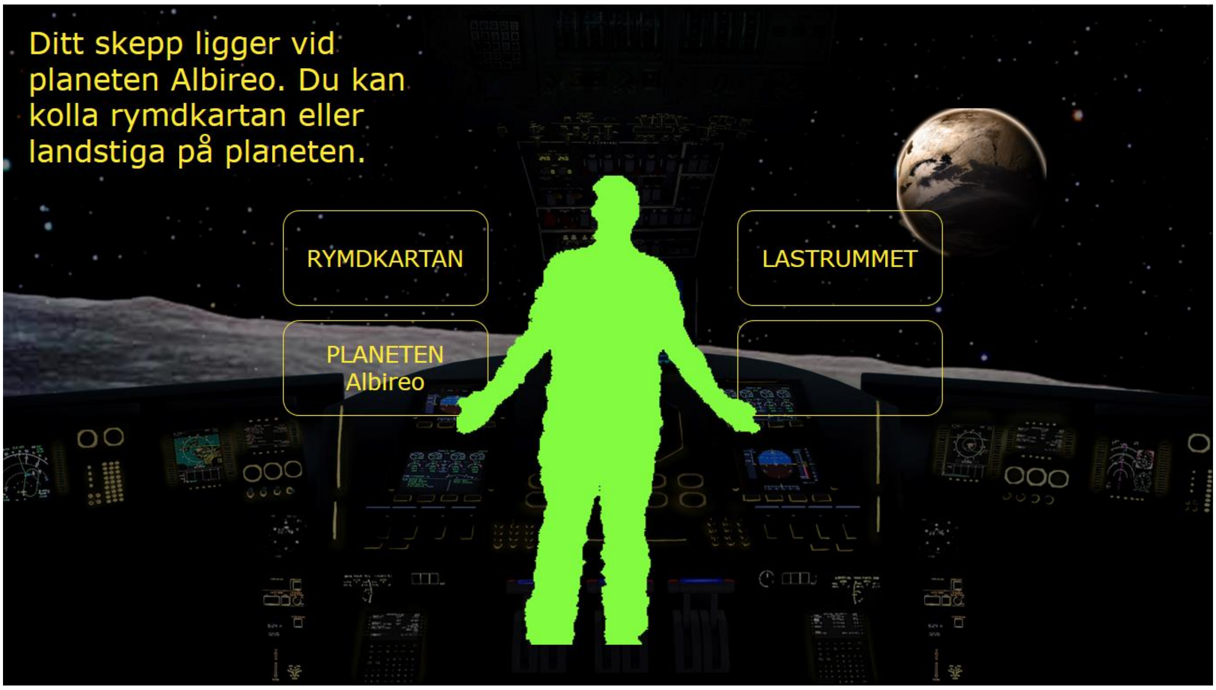
Är det något du skulle vilja se mer av i spelet?

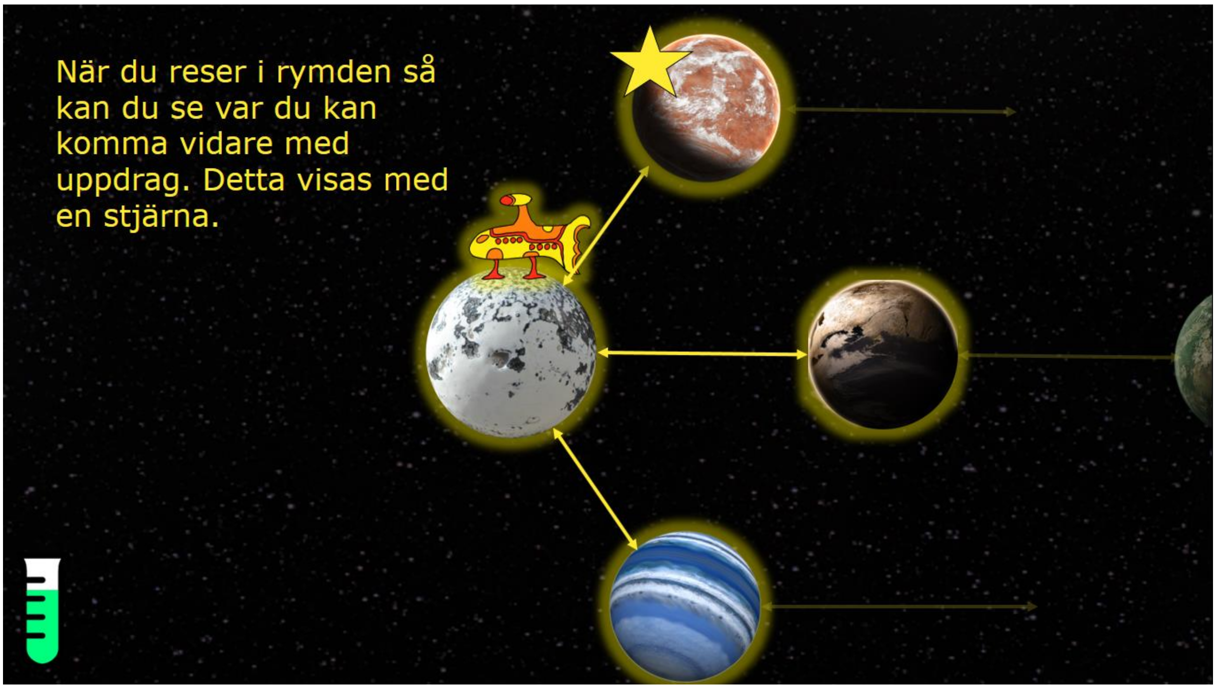
1. Lite mer med rymdskeppet
2. Nej
3. Nej
4. Ja
5. Nja
6. Nej allt var bra
7. Nej det är bra som det är
8. Nej
9. Nej

Vad skulle du vilja göra i ett rymdspel?

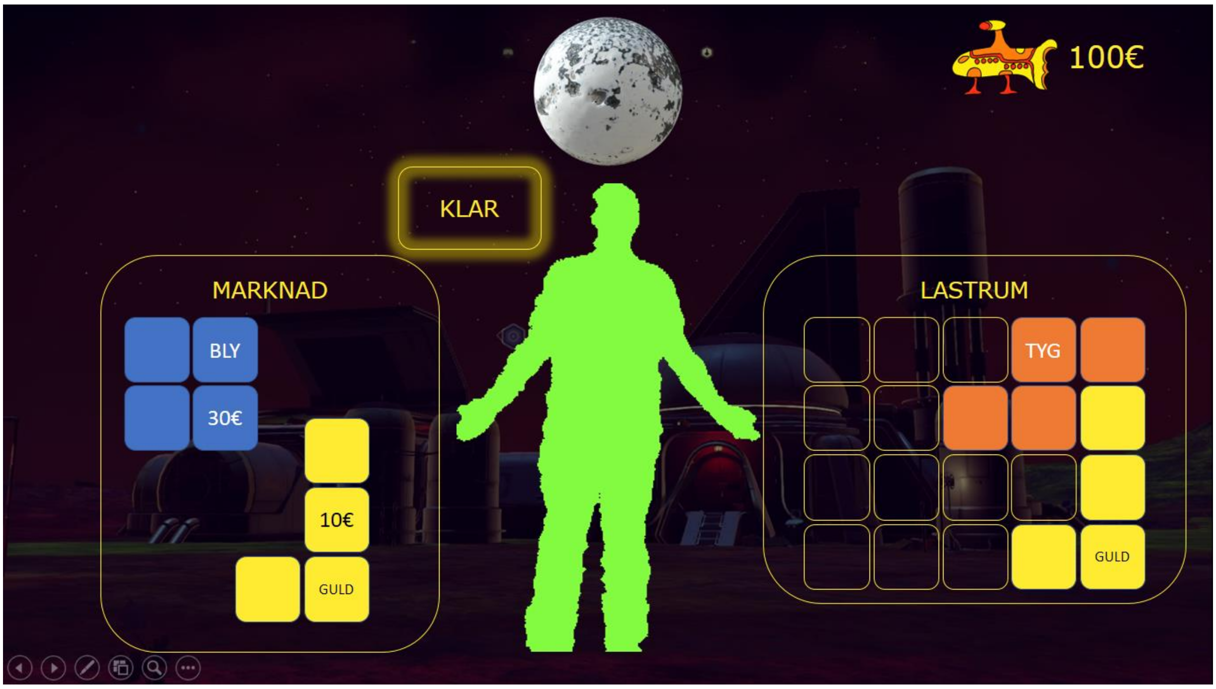
1. Att det finns nivåer och olika ställen på planeterna
2. Jag tyckte allt var bra
3. Utforska planeterna
4. Åka i rymden och utforska planeter
5. Vet ej
6. Göra rörelser som vi gjorde
7. Utforska rymden, kanske gå på månen
8. Simma
9. Vet inte

Appendix IV: PowerPoint Mockup Images






På planeten Capella kan du handla, utforska och leta uppdrag.
RYMDKARTAN
UPPDRAG / UTFORSKA
RYMDSKEPPET
HANDLA


100€
KLAR
MARKNAD
BLY
30€
10€
GULD
LASTRUM
TYG
GULD


I uppdragsvyn kan du se vilka uppdrag du kan välja på planeten Capella.
TILLBAKA
HJÄLPA BONDE
ESKORTERA HANDELSMAN
UTFORSKA


Uppdrag:
Leta efter din syster på planeten Nunki.
NEJ
JA


UPPDRAG
UTFÖRT!
FORTSÄTT