

StepFarm: An Active Video Game to Support the Self-Management of Chronic Diseases in Children.



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February – July 2017

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Abstract

Asthma is the most common chronic disease among children, preventing some children from performing moderate – vigorous physical activity. However, children actually benefit from an increase in physical activity when their asthma is under control. To support the self-management of asthma in children, a project was initiated wherein an interface was to be designed which promotes physical activity. In context of this project, self-management is referred to as providing children with the tools to cope with their chronic disease on a daily basis, by means of education and the promotion of physical activity. The interface took form as an Active Video Game (AVG) concept named StepFarm, which consists of a gathering mechanic to support physical activity and several educational game mechanics to educate the players how to cope with their chronic disease. Literature research and short-term testing of a prototype show possibilities for StepFarm to support the self-management of asthma, and other chronic diseases in the future, in children. But long-term testing and more research is required to examine an actual increase in physical activity and knowledge over a longer time-period.

TABLE OF CONTENT

1	INTRODUCTION.....	4
1.1	MOTIVATION	4
1.2	GOAL	4
1.3	RESEARCH QUESTION.....	5
1.4	PAPER LAYOUT	5
2	STATE OF THE ART	6
2.1	MOTIVATIONS TO PLAY VIDEOGAMES.....	6
2.2	ACTIVE VIDEO GAMES AND PHYSICAL ACTIVITY	7
2.3	STORYTELLING AS A MEANS OF EDUCATION IN VIDEO GAMES	8
2.4	INTERVIEW WITH A GAMIFICATION EXPERT	10
3	RESEARCH APPROACH	12
3.1	IDEATION	12
3.2	REALISATION	12
3.3	EVALUATION.....	12
4	IDEATION.....	13
4.1	MINDMAPPING MECHANICS.....	13
4.2	GAME IDEAS	15
4.3	DECISIONS.....	17
4.4	STEPFARM	19
5	REALISATION	24
5.1	PROTOTYPE: STEPFARM V0.1	24
5.2	DESIGN.....	26
5.3	A WORKING PROTOTYPE.....	27
5.4	ADJUSTMENTS	28
5.5	FITBIT.....	29
6	USABILITY TESTING	30
6.1	TESTING PROTOCOL.....	30
6.2	STEP FARM V0.1 USABILITY TESTING.....	32
6.3	RESULTS	33
7	DISCUSSION	36
8	CONCLUSION	38
	REFERENCES	39
	APPENDIX A: GAMIFICATION EXPERT INTERVIEW QUESTIONS.....	40
	APPENDIX B: STEPFARM QUESTIONNAIRE	41
	APPENDIX C: INFORMED CONSENT	57

1 INTRODUCTION

The first chapter of this report will describe the motivation for the project, as well as some background information. Next, the goal of the project will be explained along with guiding research questions. Finally, a more detailed outline of this remaining report is given.

1.1 MOTIVATION

Asthma is the most common disease in childhood [1], with a large majority of the children being affected by Exercised-Induced Asthma (EIA). Those suffering from this chronic lung disease often have to deal with breathlessness, wheezing and chest-tightening, which can be caused by certain triggers (e.g., dust mites, pollen or tobacco smoke) or physical activity. Because of these symptoms a child might avoid engaging in physical activity in fear of triggering an asthma attack, which ultimately may result in an increase in Body Mass Index (BMI) [2] and frustration because they cannot keep up with their peers [3].

When their asthma is under control, asthmatic children benefit from an increase in physical activity. Mendes et al. [4] show that physical activity, in specific aerobic exercise, reduces airway inflammation, something which is beneficial for managing a disease such as asthma. Therefore, it is suggested that physical exercise might be used as an adjuvant therapy for those who are asthmatic [4].

1.2 GOAL

The Biomedical Signals and System (BSS) group at the University of Twente aims to increase physical activity in children using technology. In order to support self-management of asthma in children, they have started a project wherein an interface is to be designed which stimulates physical activity. This project is a collaboration between the University of Twente and healthcare institutes in the region (Ziekenhuisgroep Twente and Medische Spectrum Twente). In the context of this project, we refer to support in self-management of asthma as providing the children with the tools to cope with their chronic condition on a daily basis, by means of *education* and promotion of *physical activity*. Although the project has a focus on children with asthma, the interface should be designed with varied target groups (e.g., obesity or rehabilitation) in mind.

The interface should be fun for the target group and support physical activity. Active Video Games (AVG's), also known as Exergames, support these criteria. This is a form of game wherein the player needs to perform some kind of physical activity (e.g., dancing, walking, running) in order to proceed with the game. To measure physical activity either a smartphone or step counter device can be used.

1.3 RESEARCH QUESTION

A game concept which supports the self-management of chronic diseases in children should be created if the interface is to take form as an AVG. A game concept, in terms of this project, consists of a topic as well as game mechanics. Mechanics are certain rules that apply to the game allowing for interaction and gameplay (e.g., if the player defeats an opponent he will get gold). Therefore, the following research question served as the main research question throughout this project:

“Which game mechanics would an Active Video Game require in order to support the self-management of chronic diseases in children?”

Different sub-research questions have been formulated to support the main research question. These sub-research questions will guide the research and project to determine which game mechanics an active video game would require in order to support the self-management of chronic diseases in children. The first three sub-research questions will be answered in section 2 *State of the Art*, while the latter three are answered in section 4 *Ideation* and section 6 *Usability Testing*.

- › *What motivates children to play video games?*
- › *What is the effectiveness of an AVG as physical exercise?*
- › *How to incorporate storytelling as a means of educating the target group to support self-management?*
- › *Which game mechanics, implemented in the game concept, motivate children to become more active?*
- › *Which game mechanics, implemented in the game concept, provide educational content?*
- › *Which game mechanics, implemented in the game concept, does the target group like?*

1.4 PAPER LAYOUT

In Section 2 *State of the Art* a literature review and interview with a gamification expert are presented which form the base of this project. Section 3 *Research approach* describes the creative design process of *Ideation*, *Realisation* and *Evaluation*, which are each a section on their own. Next, Section 7 *Discussion* describes and discusses the results of this research and project. Finally, the main research question is answered in Section 8 *Conclusion*.

2 STATE OF THE ART

The State of the Art chapter shows a review of existing relevant literature regarding motivations to play videogames, Active Video Games and physical activity and storytelling as a means of education in video games. Lastly, an interview with a gamification expert regarding game design with a focus on children is given.

2.1 MOTIVATIONS TO PLAY VIDEOGAMES

Intrinsic motivation is considered to be an important factor when playing a video game, especially during a longer period of time. In this section of the state-of-the-art review different motivations as to why children play video games and what game design elements support these motivations are looked at.

The self-determination theory (SDT) is an important part of motivation research [5, 6]. SDT highlights three basic psychological and intrinsic needs in humans [6]:

- *The need for competence* is to feel effective and successful when interacting with the environment.
- *The need for autonomy* is being able to choose any course of action which is in accordance with one's own interests and goals.
- *The need for relatedness* is a sense of belonging in a social environment while caring and being cared for by other people.

These 3 needs are motivational resources that can be enhanced by modifying the environment [5] (e.g., games).

Sailer et al. [5] established a theoretical framework which builds upon SDT and showed that certain game design elements have a specific impact on motivation. These seven game design elements were grouped in the four categories which represented the three basic psychological and intrinsic needs (autonomy was subdivided into decision freedom and task meaningfulness). Results showed that points, performance graphs, badges and leaderboards increase levels of competence as well as autonomy regarding task meaningfulness. Game design elements such as avatars, meaningful stories and teammates increase levels of relatedness. However, autonomy regarding decision freedom was unaffected by any of the tested game design elements. Sailer et al. argue that this might be due a relatively weak 'dose' during the experiments as it did not affect the game process itself. Although the design element meaningful stories was tested on autonomy regarding decision freedom, there is reason to believe that meaningful stories might increase levels of autonomy regarding decision freedom when multiple storylines are introduced which offers choices during gameplay. Table 1 provides an overview of the findings of Sailer et al.

<i>Game design element</i>	<i>Affected basic psychological needs</i>
<i>Points</i>	Competence + autonomy regarding task meaningfulness
<i>Leaderboards</i>	Competence + autonomy regarding task meaningfulness
<i>Badges</i>	Competence + autonomy regarding task meaningfulness
<i>Performance graphs</i>	Competence + autonomy regarding task meaningfulness
<i>Avatars</i>	Relatedness
<i>Meaningful stories</i>	Relatedness
<i>Teammates</i>	Relatedness

Table 1: Findings based on results of Sailer et al. [5]

Instead of building on existing theories, Olson [7] has shown different kinds of motivation (social, emotional and intellectual and expressive) for video game play by drawing on a survey (n = 1254), largely consisting of children aged 12 – 14. Firstly, *social motivations* can consist of spending time with friends, competition, peer-based learning and making friends. The children participating in the experiment saw video games as intensely social wherein they could spend time with their friends and solve obstacles together. Competition was one of the strongest motivations, especially among boys because being good at video games was a desirable trait among their friends. It was also the feeling of achievement and pride that came with winning which were important motivators. Making friends was a higher motivator for children with a mild learning disability than for those who did not have a disability. Because the children with a mild learning disability were more likely to be bullied and excluded by peers, they might put more effort in connecting with peers through video games [7].

Secondly, *emotional motivations* can consist of regulating feelings and creating flow. Using video games to relax and regulate feelings such as anger or frustration was a big motivator for children. Olson defines flow as “a state of being pleasantly and completely absorbed by a goal-driven activity” [7]. Creating flow can be done by matching the difficulty and tempo of a challenge to a player’s skill level.

Lastly, *intellectual and expressive motivations* can consist of challenge & mastery and expressing creativity. Challenge as well as games with multiple storylines were motivators when replaying a video game. The expression of creativity can often be found in games called sandbox games (e.g., Minecraft, Grand Theft Auto, The Elder Scrolls). These games often feature an open world environment, multiple solutions and play options.

Findings suggest children can experience different kinds of motivation (e.g., emotional) and game design elements which promote these motivations (e.g., meaningful stories). Making use of these findings can prove to be worthwhile when designing an AVG to maintain motivation in users to keep playing. However, stimulating motivation is not the only aspect which needs to be present in an AVG to achieve positive results as we will discuss in the next section.

2.2 ACTIVE VIDEO GAMES AND PHYSICAL ACTIVITY

In this section three studies regarding the effectiveness of the use of an AVG to promote physical activity are reviewed. The last part are findings of a review of reviews by some of the many games for health researchers.

The first study argued that an AVG had a positive impact on asthmatic children in improving clinical control and aerobic fitness and in reducing lung inflammation [8]. The energy expenditure measured during the use of the AVG was higher than during regular aerobic training on a treadmill. The author suggests that AVG’s could prove to be an interesting exercise for asthmatic children.

The second study argued that children significantly increased physical activity (2934 steps and 46 minutes exercise more per day) with an AVG during a randomized four week crossover study [9]. The AVG seemed to do better in a school-based environment instead of a community-based environment. The author points out that this might be due to the face-to-face interaction and competition with peers, which is more likely to happen in a school-based environment.

In contrast to the two previous mentioned studies, Howie et al. [10] found no increase in physical activity during a sixteen week intervention with the use of an AVG, but suggested other positive long-term effects. Participants self-reported an improvement in motor functions and attitude towards physical activity which might lead to an actual increase in physical activity over a

longer period of time. Howie, however, points out that these findings were speculative and further research was necessary to verify them.

Baranowski et al. [2] showed that AVG's can promote moderate to vigorous physical activity under certain conditions. However, further research is needed in order to determine what these conditions exactly are. Some of the studies reviewed reported an increase in energy expenditure during the use of an AVG in a home setting, while other studies found no significant differences in such a setting. Schools are considered to be an interesting setting, which was also found by Howie et al. [10]. Baranowski et al. pointed out that the quality of both reviews and studies of AVG's needed to improve to get a better understanding of the conditions which promote physical activity.

The use of an AVG can lead, either direct or indirect, to an increase in physical activity. The exact conditions as to when this increase happens, however, are currently unknown and further research should be done to discover this.

2.3 STORYTELLING AS A MEANS OF EDUCATION IN VIDEO GAMES

Existing studies have shown evidence that storytelling is beneficial in health-care as a tool for diagnostics, therapeutics and education [11]. People remember more when the content is presented in a narrative form because the memory of information might be enhanced. For the target group of the AVG it is important to learn about their asthma (e.g., how to avoid triggers) to support self-management. In this section, therefore, studies are reviewed which provide models on how to use storytelling as an educational means in (educational) video games, which will be used in the AVG.

One way to create a story is by using the Hero's Journey template by Joseph Campbell which consists of three acts and seventeen steps [12, 13]. Others have adapted this concept to create a new template such as Christopher Vogler with his Writer's Journey. Many well-known stories fit within these templates (e.g., Harry Potter, Lord of the Rings). An overview of the original seventeen-step Hero's journey template is shown in table 2.

Motivation increased by making the Hero's Journey interactive and applying this to an educational video game, which in return supports the learning process [12]. There are, however, certain aspects an educational game designer should take into account when adopting this presented interactive version of the Hero's Journey.

The Hero's Journey consists of two worlds. The first world is a normal world in which the player feels familiar and comfortable. In this world the player can explore possibilities, identify with the character and encounter problems which are not solvable at the beginning of the game but will be later on. The other world, the world of adventure, should be based on the knowledge to learn. This world should also have a final test of knowledge (atonement with the father) and non-player characters which take part in the journey. It is important to match the final test of knowledge to the skills the player will gain during the journey.

There are certain characters the player will meet during a Hero's Journey. The characters in the Hero's Journey are based on myths but their symbolism can be used to create similar characters which will intervene during the story. Supernatural aid, for example, can be some sort of mentor which assists the player and helps them to get started with their quest. The figure of the goddess can be a maternal, protective figure (based on myths) who comforts the player and gives them advantages during the quest. The figure of the father can represent personal completion of the player. Rescue from without can be the same as supernatural aid, which is some sort of mentor.

The player should be the centre of every action taken in the game. Any of the important

actions during game should be because of and by the player. Whatever the player decides to do, the outcome should be valid and the story should be able to progress. Good choices might be rewarded by giving the player advantages while bad choices might give the player a penalty.

Because the Hero's Journey has been made interactive, new, but mostly optional, stages were added to accommodate for all possibilities. *Stubborn refusal* and *Compelled to adventure* are in the beginning of the story. The former happens when the player keeps refusing the call to adventure and more incitation events occur the later will draw the player to adventure whether they want it or not. *Interference from without* is the same but happens if the player after refusal of the return when the player keeps refusing. The figure from without can then intervene to not help the player, but push the player to the end of the story.

ACT	Step	Meaning
Departure	Call to adventure	The hero finds themselves in a normal world but something (e.g., an event) pushes them to leave the comfort of their normal world.
	Refusal of the call	The hero first refuses this call because of obligations or fear.
	Supernatural aid	The hero meets some sort of guide/helper who helps the hero get on his way for the journey that lies ahead.
	Crossing the first threshold	The point where the hero enters the unknown world/world of adventure.
	Belly of the whale	The moment when the hero is completely separated from the normal world sometimes paired with a minor danger.
Initiation	The road of trials	A succession of trials which the hero must overcome which will test the courage, the determination, and the virtues relative to the hero's quest.
	Meeting with the goddess	A meeting with a protective, maternal figure.
	Woman as the temptress	A point where the hero is tempted to abandon his quest
	Atonement with the father	The central point of the journey in which the hero must confront an ultimate power.
	Apotheosis	The moment when the hero achieves a greater understanding (e.g., love, knowledge)
	The ultimate boon	The hero gets what they went on a journey for. The quest is complete.
Return	Refusal of the return	The hero might not want to return to their normal world.
	The magic flight	The hero has the boon but might need to escape with it.
	Rescue from without	An entity guides the hero back to their normal world.
	The crossing of the return threshold	The hero returns to the normal world with newfound knowledge and wisdom.
	Master of two worlds	After returning, the hero has mastered both worlds, finding balance between the two.
	Freedom to live	The hero lives his life in the normal world again, but he is changed because of the quest.

Table 2: An overview of Campbell's Hero's Journey

Another model to incorporate storytelling into an educational video game presented by Padilla-Zea et al. [14] lists a few proposals to take into account:

- Making use of cinematographic language allows for an easy and entertaining way to educate children while also placing them into the story without causing too much confusion.
- Characters should be easily recognisable, which means that good characters are easily distinguished from enemies or villains.
- The story should not be interactive as it might confuse the players, especially younger children.
- The final goal of the game, which should be presented at the start, is clear and simple.
- Sub-objectives should also be clear and simple, but should not confuse the player regarding their main quest.
- There should be a balance between fun content and educational content to maintain motivation.
- A system which can adapt and customize to certain user features should be incorporated.
- The world in which the game is set should be interactive, meaning elements can be interacted with and react accordingly to offer breaks from the main quest and promote investigation.
- The integration of educational content into the storyline should be done in a natural way.
- Provide a variety of exercises which progress in difficulty. The performance of the player during these exercises should be evaluated by the game.

While both models present different ways to incorporate storytelling into an educational video game, they do both support each other. The proposals suggested by Padilla-Zea et al. can be combined with the interactive Hero's Journey without any contradictions apart from the interactivity. This, however, is not a concern for the AVG as the target group is older than the target group Padilla-Zea focussed on (3 – 7 years old).

2.4 INTERVIEW WITH A GAMIFICATION EXPERT

An interview with a gamification expert was held in order to get a better understanding of game design with a focus on children. Jäin van Nigtevegt, teacher at Hogeschool voor de Kunsten Utrecht (HKU) and game designer at Flavour in Amsterdam, answered some questions regarding important aspects concerning game design with a focus on children. These interview questions can be found in the Appendix.

During the interview van Nigtevegt explained that children find it hard to distinguish a digital compliment from a real compliment or a digital reward from a real reward. A game designer should take advantage of this by making the game positively stimulating and let players feel rewarded. A game should therefore have a clear and easy to remember set of actions which is followed by a reward, which results in the player knowing when to expect a reward. However, this should preferably be done during the right moment as this will help creating flow. Do this by making use of dynamic elements, movement, colour and sound as children like it.

Another element which would help to create flow is a varying difficulty. The player will have zero skills when they just start the game so the beginning should not be hard. Upon beating the first challenge the player is given a reward (e.g., a magic wand) which will help them during their journeys, however challenges will be more difficult. It will become easier for the player, but at the same time the game will get harder.

The way children experience life is extremely relevant for game designers. A child will have all sorts of activities during the day such as school, sports and friends. Van Nigtevegt elaborated that a game will have to compete with all of these other activities inside the mind of a child.

One way to grab the attention of children is to let them feel very important. The power to have control over what happens inside that game world is attractive to children. For example, a game world in which disaster has struck is in need of saving. The inhabitants of that world ask the player for help because they are the only one who can save the world. If done right, the player should feel motivated and related enough to start playing the game.

There are elements which should be avoided when designing a game for children. A lot of text at once on a screen is not appealing to children. A game designer should also be careful with numbers, information and statistics concerning the behaviour of the player during gameplay. Children often do not understand what the numbers or statistics mean which might result in confusion.

Finally, van Nigtevegt gave a few tips on how to get children walking with the help of a game. Some kind of reward that lies at the end of the journey definitely helps. Pokémon go was taken as an example. Children do not walk to a pokéstop because they need to, but rather because the pokéstop is there. A game designer should give children a reason to walk without having to tell them to actually perform physical activity.

3 RESEARCH APPROACH

In order to be able to answer the research question a research approach had to be created. This project follows three phases of the design process which are ideation, realisation and evaluation. This chapter gives a description of these phases and briefly explains how these relate to this project.

3.1 IDEATION

The ideation phase is the phase in which brainstorming happens, ideas are generated and possibilities are explored. During this phase, designers can make use of tools which will help them in the process of developing new ideas. (e.g., mindmap). While this phase allows for the generation of a great number of ideas, it is good practice to set constraints which will guide the process. By making use of the literature research in section 2 *State of the Art*, it is possible to create criteria which will provide the necessary guidance to create a viable game concept for the AVG. Once the designer has thought of multiple ideas he should compare them and decide on one idea. Finally, the designer should work out the chosen idea so he can progress towards the realisation phase.

3.2 REALISATION

The realisation phase will start once the designer has an idea of what he wants to create. The realisation phase of this project consists of the creation of a prototype which functions as a tutorial for the AVG. This phase explains the design of the prototype as well as how it works, which was done with HTML, CSS and JavaScript during this project.

3.3 EVALUATION

The evaluation phase is the phase in which a working prototype is tested by the target group. This allows for feedback which makes iterations of the prototype possible. This project, however, did not have multiple iterations of its prototype. A testing protocol which describes the preparation of the usability tests, the executions of these usability tests and results are found in this section.

4 IDEATION

The Ideation chapter describes the ideation phase. At the very start of the ideation phase a mindmap was made regarding different game mechanics to get children to walk. With these mechanics different ideas were thought of. At the end of the ideation phase decisions had to be made and a game concept had to be designed in order to move forward to the Realisation phase.

4.1 MINDMAPPING MECHANICS

A mindmap is used to visually display information, ideas and relations. It is possible to set certain criteria while making use of a mindmap, which allowed for a more clear approach regarding the generation of concepts for the AVG. The criteria for this project are a walking mechanic, re-playability, the amount of dedication needed to play the game, educational possibilities as well as fun.

› *Walking mechanic*

Because this project requires the interface to support physical activity, one of the most important elements is the walking mechanic. Mechanics are certain rules that apply to the game allowing for interaction and gameplay. The walking mechanic, also, is a rule which allows for interaction with the AVG. Therefore, this rule should be something that happens when the player starts walking.

› *Re-playability*

Self-management of chronic diseases is a long term process. Therefore, it would not be effective to create an AVG which consists of only one linear storyline, but rather an AVG which offers re-playability. Examples might be minigames or multiple storylines.

› *The amount of dedication*

As the gamification expert explained, there are a lot of activities during a day of a child. Therefore, the game should not require an unrealistic amount of dedication, but rather intertwine with the planning of the player. This would allow the players to play the game at any given time they want to. Examples might be being able to play while walking to school or during a lunch break.

› *Education possibilities*

As previously has been mentioned, in context of this project self-management is referred to as providing tools for children to educate them about their asthma or other health problems and the promotion of physical activity, thus the game should provide possibilities for education. Examples might be non-playable characters (NPC's) or story.

› *Fun*

Although the definition of fun may differ from person to person, it should be considered during the generation of ideas nevertheless. The literature research concerning motivation and the interview with the gamification expert should be taken as guidelines for this criterium.

These criteria produced the following mechanics and mindmap (figure 1).

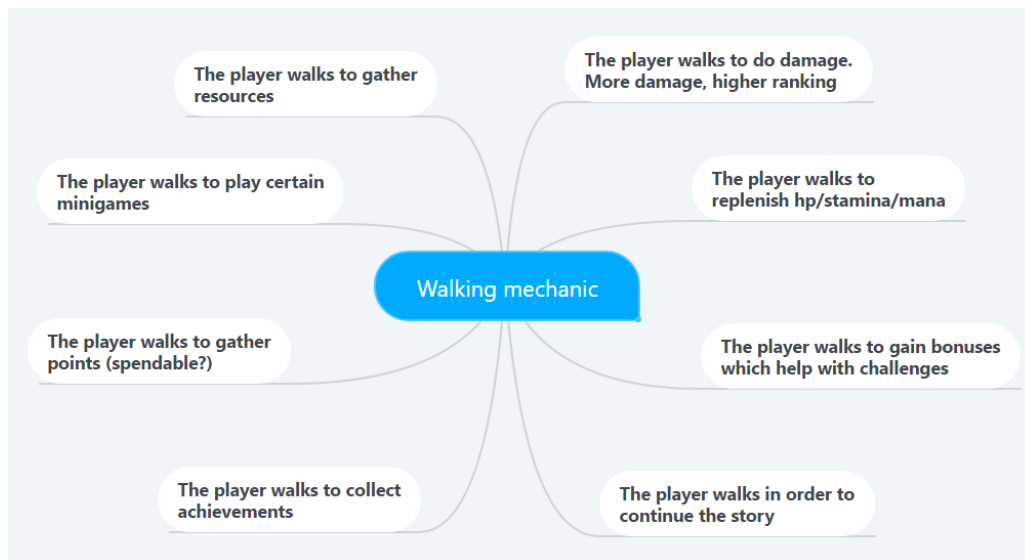


Figure 1: A mindmap of different walking mechanics

› ***The player walks to gather resources***

This mechanic allows the player to gather resources while walking. Resources are items a player can collect (e.g., wood, stone). The player should be able to utilize the gathered resources in some way (e.g., building a house).

› ***The player walks to do damage***

This mechanic requires the game to be in a constant state of combat. The more the player will walk, the more damage the player will do to the enemy. More damage means a higher ranking on the leaderboards.

› ***The player walks to replenish hp/stamina/mana***

With this mechanic the player can regenerate lost points such as health points, stamina points or mana points. This does require a game which contains these points such as a role playing game (RPG).

› ***The player walks to gain bonuses***

This mechanic enhances an existing game by providing bonuses that can be gathered by walking.

› ***The player walks to continue the story***

The player is required to walk in order to advance the storyline. This mechanic requires a well written story.

› ***The player walks to collect achievements***

When walking the player will automatically collect certain achievements

› ***The player walks to gather points***

With this mechanic the player can gather points while walking. These points can then be used to either exchange for something in the game or used as a means of ranking.

› ***The player walks to play certain minigames***

In order to play all sorts of minigames the player has to walk. The player will be able to play these minigames once they have reached a certain amount of steps needed to unlock the next minigame.

These mechanics were rated according to the criteria which produced table 3. A minus was given when the mechanic would not meet the criteria on their own, meaning without using other mechanics. A zero was given if the mechanic could meet the criteria, but it would heavily depend on the game concept. Finally, a plus was given if the mechanic could meet the criteria on their own.

An example, walking to continue the story is not re-playable, unless the story would consist of multiple storylines, making it a limited mechanic for an AVG which supports self-management. The amount of dedication this mechanic requires is high. The player will not be able to walk and play the AVG simultaneously, leading a reduced amount of time to actually play the game. The education possibilities this mechanic provides, however, are endless as educational tips can be hidden throughout the entire story. Lastly, fun which is entirely dependent on the game concept and what the story actually will be about.

<i>Walking mechanics</i>	<i>Re-playable</i>	<i>Dedication</i>	<i>Education</i>	<i>Fun</i>
<i>Gathering resources</i>	+	+	+	0
<i>Dealing damage</i>	+	+	-	0
<i>Replenish</i>	+	0	+	-
<i>Gain bonuses</i>	0	0	+	0
<i>Advancing story</i>	-	-	+	0
<i>Collecting achievements</i>	-	0	0	0
<i>Gathering points</i>	+	-	-	-
<i>Unlocking minigames</i>	0	-	+	-

Table 3: Walking mechanics vs. Criteria

4.2 GAME IDEAS

Table 3 gave a clear overview of the mechanics and their strengths and weaknesses, which allowed for a selective way of idea generation. By combining mechanics which might not be viable on their own one can create concepts which might be more viable. The most notable game concepts are described below.

› *Gathering game*

The player will gather resources during their walks which they can use, either to create objects or trade. Bonuses will be awarded depending on the amount of days the player has played in a row. The player will be able to collect achievements depending on the gathered resources. This game concepts mainly revolves around gathering resources while also incorporating bonuses, story and achievements.

<i>Walking mechanics</i>	<i>Re-playable</i>	<i>Dedication</i>	<i>Education</i>	<i>Fun</i>
<i>Gathering resources</i>	+	+	+	0
<i>Gain bonuses</i>	0	0	+	0
<i>Advancing story</i>	-	-	+	0
<i>Collecting achievements</i>	-	0	0	0

Table 4: Gathering game mechanics

› Collecting stories

A story driven game which requires the player to walk in order to find all sorts of short stories. These short stories tell of different storylines, which sometimes interchange with each other. During the collection of these stories the player must solve story related puzzles which will also require the player to walk.

<i>Walking mechanics</i>	<i>Re-playable</i>	<i>Dedication</i>	<i>Education</i>	<i>Fun</i>
<i>Gathering resources</i>	+	+	+	0
<i>Advancing story</i>	-	-	+	0
<i>Collecting achievements</i>	-	0	0	0
<i>Unlocking minigames</i>	0	-	+	-

Table 5: Collecting stories mechanics

› Clicker game

The objective of clicker games is to click or tap the screen as often as possible, rewarding the player points which they can spend on upgrades. In this game concept the player will be able to collect points while walking. The more the player will walk, the more points the player will get. Achievements are possible.

<i>Walking mechanics</i>	<i>Re-playable</i>	<i>Dedication</i>	<i>Education</i>	<i>Fun</i>
<i>Gain bonuses</i>	0	0	+	0
<i>Advancing story</i>	-	-	+	0
<i>Collecting achievements</i>	-	0	0	0
<i>Gathering points</i>	+	-	-	-

Table 6: Clicker game mechanics

› Dungeon exploring

This game concept offers the player to explore dungeons while walking. The player will be able to choose to either replenish their health, stamina or mana points or deal damage to the boss of the current dungeon floor. Every step the player takes deals a certain amount of damage to that boss. The game will become easier once the player starts to unlock better equipment, which in turn will create stronger opponents.

<i>Walking mechanics</i>	<i>Re-playable</i>	<i>Dedication</i>	<i>Education</i>	<i>Fun</i>
<i>Dealing damage</i>	+	+	-	0
<i>Replenish</i>	+	0	+	-
<i>Gain bonuses</i>	0	0	+	0
<i>Advancing story</i>	-	-	+	0
<i>Collecting achievements</i>	-	0	0	0

Table 7: Dungeon exploring mechanics

4.3 DECISIONS

Decisions had to be made in order to continue with the design of the game concept. After the generation of all game concepts they were each evaluated according to which would serve best as a long-term, easily accessible, educational and fun interface *which supports self-management*. The game concept which fits this description best would be the gathering game. The gathering game has been chosen as this concept heavily revolved around the gathering resources mechanic, which is a very versatile mechanic for this project. Gathering resources satisfies most of the criteria and combines perfectly with gaining bonuses as well as collecting achievements and story.

› *Re-playability*

The re-playability of the gathering resources mechanic is the core of this walking mechanic. The player will always be looking for more resources offered in a game. Especially if these resources have a purpose.

An imaginary player named Bob wants to build a house in his town. However, to do so Bob will need 10 wood and 20 stone. Bob goes on a little walk and acquires the required materials to build a house. If Bob wants to keep growing his village he will have to gather more resources, which means he will have to walk more.

Bob Example 1

› *Dedication*

The amount of dedication this walking mechanic requires from the player is very little. This means the player will be able to play the game whenever they want to *and* have the time to do so. This will be a core feature regarding the support of physical activity.

Bob has a busy day consisting of family visits, homework and guitar lessons. Luckily, Bob knows when he walks he will gather resources for his town, so Bob decides to walk to his guitar lessons instead of taking the usual bus.

Bob Example 2

› *Educational*

The gathering resources mechanic also offers great educational possibilities. All the resources that are gathered during walking can contain educational knowledge. These resources might be traded for other objects which contain educational content. This walking mechanic would benefit greatly from NPC's as they also could be used to convey educational content to the player.

Bob has met a NPC to whom he can give gifts. He learns that the NPC is allergic to certain flowers and decides to give a gem he found instead. This way Bob will learn more about allergies, asthma or other health related problems.

Bob Example 3

› Fun

Lastly, the criteria fun, which was given a 0. The gathering resources mechanic does need a good game concept in order to function well as a walking mechanic. This will be done by making use of the literature research, interview with the gamification expert and combining other mechanics with the gathering resources mechanic such as gaining bonuses, collecting achievements and stories.

› Gaining bonuses

The ability to gain bonuses from walking would be good addition to the gathering resources mechanic. As long as the player keeps gathering resources, they will also gain bonuses. Being able to lose these bonuses gives another level of responsibility to the players.

It has been a week since Bob started playing the gathering game. Every day Bob went searching for resources and because of that he acquired a weekly bonus. Now, every time Bob gathers resources, he will receive 25% extra resources. However, if Bob misses a day gathering, he will lose his weekly streak and he will have to start over getting the bonus.

Bob Example 4

› Stories

Stories are important elements in games, whether they are re-playable or not. Stories will help players to relate to the world in the game and to the characters. A good story should take the player on an adventure, as has been explained in the literature research.

Bob takes a look at his town which has grown a lot. It has 6 houses, 1 chapel, 1 inn and 1 market square. Bob has all the power to change the world as he sees fit.

Bob Example 5

› Collecting achievements

Achievements is one of the motivating game design elements discussed in the literature research. These are collectibles which show your progression in the game. This can thus be used as a competitive element. It is also possible for achievements to contain small rewards or bonuses which are granted to the player once said achievements have been acquired.

2 weeks of playing the gathering game have led to the point of an achievement. Bob has walked over 100km and has been rewarded with a badge and a unique item.

Bob Example 6

4.4 STEPFARM

Even though Bob showed promise, a medieval town building game might not have been equally interesting for everybody in the target group. Therefore, it is important for the AVG to have a topic which is accepted by the general target group. In an effort to make the topic of the AVG as gender equal as possible, a choice has been made for a farming game. StepFarm, the name given to this game concept, incorporates the mechanics of the gathering game in the following ways:

› Seeds

Seeds are the resources a player can gather in StepFarm, allowing for a lot of inspiration since there are many seeds in existence [15]. The seeds in StepFarm will vary in rarity, which will create an extra sense of reward once the player actually manages to obtain a rare seed. These rarities will be indicated by colour, as common practice in videogames. This will also help children better understand the meaning of rarity because of the association with colour (Figure 3).

StepFarm has seasons which add another sense of scarcity and reward. Some seeds can only be planted during spring and summer, while other seeds can be harvested every single season (Figure 2). Then there are seasonal seeds, which can only be obtained during the corresponding season (Figure 4). The season will change every week.



Figure 2: Wheat, Quality, Season and information



Figure 3: Seed rarities (white:common, green:uncommon, blue:rare, purple:legendary)

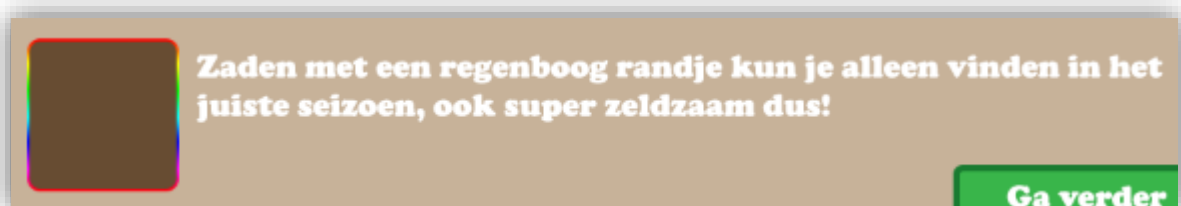


Figure 4: A seasonal seed border

› Gathering seeds

The way to gather seeds is the same way as gathering resources in the gathering game, which is walking. When the player walks the step counter will measure the amount of steps they take. Upon starting StepFarm the game will try to connect with the step counter and refresh the amount of steps the player has taken. The difference can then be calculated by subtracting the old step value and the new step value. With this new value the game will calculate how many seeds the player will get. The amount of steps required to get one seed should be play-tested.

Once the game has fully loaded the player will be able to receive their seeds by going to the forest which is very close to the farm. The story tells of this magical forest which produces all kinds of different seeds.

› Backpack

The Backpack is where the player will be able to view their seeds, crops, achievements, upgrades and a lot more. The entire Backpack consists of four different sections: Seeds & Crops, Inventory, Log and Friends.

In Seeds & Crops the player will be able to view all the seeds they have gathered during their walks. They will be able to plant the seeds via this menu as well as view all the crops that already have been harvested. Finally, the player will be able to view the quality of the seed, the seasons in which the seed will grow and some (educational) information (Figure 7).



Figure 5: The Backpack



Figure 6: The forest where the player collects the seeds they gathered during a walk

In their inventory the player can view all of the upgrades they purchased. When viewing an upgrade the game will give information about the bonus the upgrade gives. For example, a water well gives an extra 5% to growth rate of normal crops. The other feature players can see in their inventory is their streak. The streak gives players bonuses each consecutive day they play StepFarm. Once the player has reached streak 7 they will not be able to get any additional bonus. The player will keep the streak 7 until they miss one day of gameplay, at which moment the streak will reset and the player will have to start over (Figure 8).

The log will show players which seeds they already have discovered and which achievements they have acquired. The player is able to click on either the achievements or a discovered seed to get more information about it. The log will also show players their total amount of steps, total amount of earned money, total amount of harvests and since when the players has joined StepFarm (Figure 9).

The final section of The Backpack is friends. In this menu the player can add their friends which allows them to visit each other's farm. Then they will be able to leave either some kind of message or present behind. Friends will also be able to view each other's log, allowing for a friendly competition. Finally, there are some settings which allows the player to reject those from the farm who are not their friends (Figure 10).



Figure 7: Seeds & Crops



Figure 8: Inventory

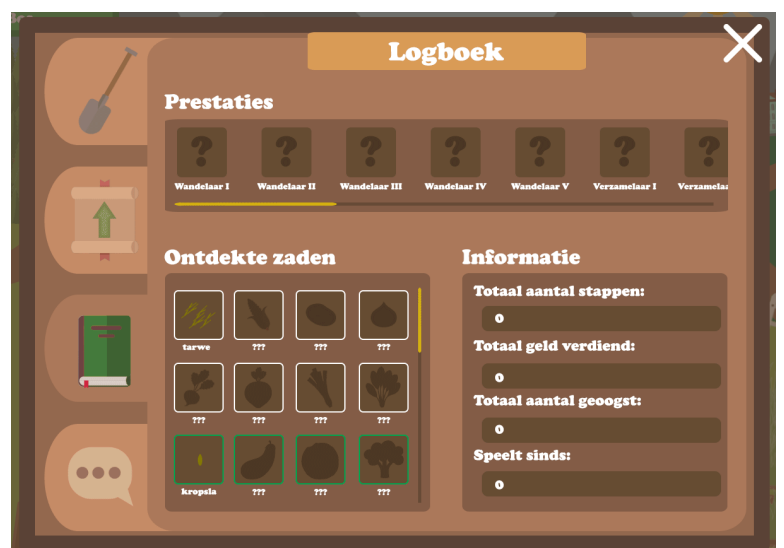


Figure 9: Log

› Planting and harvesting

The player is able to plant all seeds from the Seeds & Crops menu. Once the player has pressed the green 'Plant!' button they will be able to select an empty piece of land. The seed will be planted once they have selected the empty piece of land. Alternatively, the player can select an empty piece of land, which will open up the Seeds & Crops menu. The player will then be able to easily select a seed they wish to plant.



Figure 10: Friends

› City: Store and Requests

The players will also be able to travel to a nearby village from the farm. This village consists of two menus: The shop (Figure 11) and Requests (Figure 12). In the shop the player will be able to purchase upgrades. The shop changes inventory every day. The player may also choose to sell their crops to the shop for a quick injection of money. However, if the player wishes to gain more money, then it would be better to do requests instead. Requests are tasks from the people that live in the village. These requests can give all kinds of rewards such as money, seeds or possibly even an upgrade. These requests, as well as all the purchasable items, are opportunities for educational content.



Figure 11: Shop



Figure 12: Requests

› NPC Grandfather

Finally, there will be an NPC in StepFarm. This NPC plays the role of the player's grandfather and is called 'Opa Boer' ('Farmer Grandpa'). This NPC will motivate the player to walk by giving them notifications (Figure 13). This NPC will offer another opportunity for educational content.



Figure 13: Opa Boer giving the player a hint

5 REALISATION

This chapter explains how StepFarm got developed from game concept to a working prototype. The first section explains the creation of a concept for the first prototype, the StepFarm tutorial. Next, the design as well as the actual realisation of the prototype are described. Finally, this chapter explains how to integrate Fitbit as a step counter.

5.1 PROTOTYPE: STEP FARM V0.1

A prototype was created to test the StepFarm game concept. The prototype should include all the mechanics previously mentioned in the Ideation chapter 4.4 *StepFarm*. Therefore, a tutorial of StepFarm would seem the most logical realisation choice. This is because the purpose of a tutorial is to inform a beginning player about the game's mechanics and the story, which would create the possibility to test whether StepFarm would be a good concept for an AVG or not. The tutorial of StepFarm would therefore consist of the phases as shown in Figure 14. These tutorial phases offer the possibility to include all the mechanics previously mentioned in the Ideation chapter 4.4 *StepFarm*.

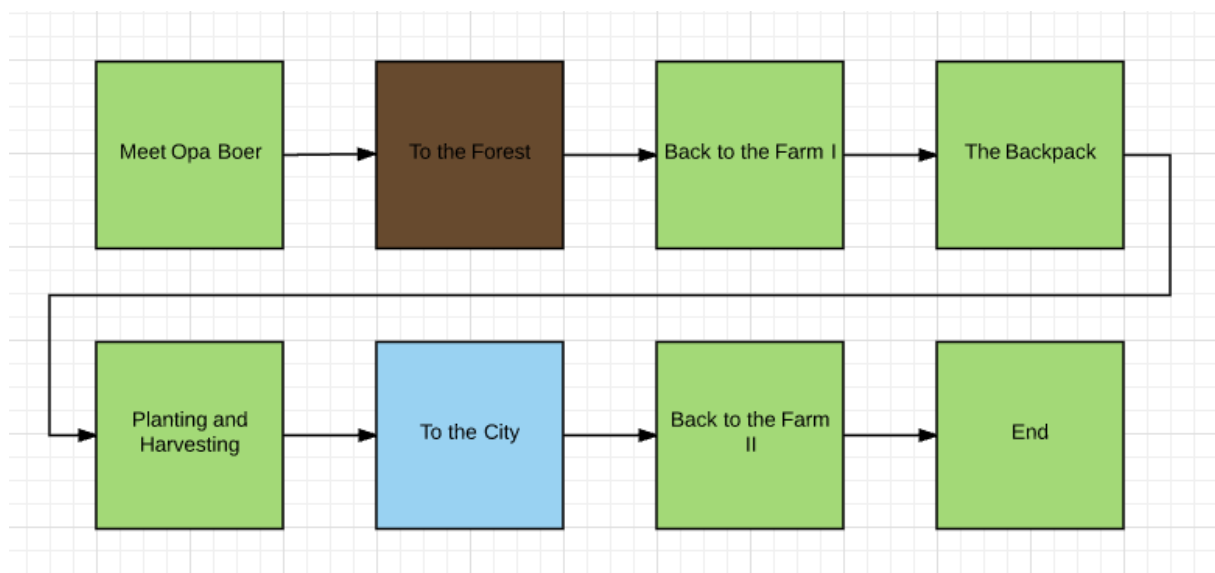


Figure 14: The StepFarm tutorial flowchart. Colour describes the scene (green: farm, brown: forest, blue: city)

› Meet Opa Boer

In Meet Opa Boer the player is introduced to the NPC grandfather who will explain the setting and story of StepFarm. After a short introduction, the player is asked to enter a username which will serve as both the name of the farm as well as the player's username for multiplayer. The NPC grandfather will then explain to the player that they will have to go to the forest in order to find some seeds.

› To the Forest

The NPC grandfather will start to explain about the walking mechanic once the player arrives in the forest. If a step counter device is used rather than the smartphone, the player is asked to make sure that the step counter is connected with the game. Then the player is asked to go on a little walk. When the player comes back from the walk, the game will have reconnected with the step counter,

allowing the game to calculate the amount of seeds the player will get. Each player will get the same amount and types of seeds during the tutorial. NPC grandfather will explain more about seeds once the player returns from the walk. The player is then asked to go back to the farm.

› *Back to the Farm I*

NPC grandfather will give the player The Backpack upon returning to the farm.

› *The Backpack*

During this phase the player will learn all about The Backpack, which means learning where the seeds and crops can be found, learning about achievements and their streak, learning about their log and finally learning about the social interaction features, such as adding friends or sending messages. NPC grandfather will be there to explain everything to the player.

› *Planting and Harvesting*

The player will be able to begin planting the seeds once they are finished with The Backpack phase. NPC grandfather will guide the player through the process of planting and harvesting crops.

› *To the city*

Once the player has harvested their first crops they will go to the city in order to trade. NPC grandfather will explain to the player what they are able to do in the city, which are visiting the shop and completing requests. Once the player has traded their crops they will be taken back to the farm.

› *Back to the Farm II*

NPC grandfather will leave the player on his own now, however, he will stay on the farm if the player needs any help. The player is then presented a final screen which presents some possibilities of playing StepFarm (Figure 15).



Figure 15: Final screen of the StepFarm tutorial

5.2 DESIGN

Adobe Photoshop was used as the main design tool in the realisation phase of StepFarm. Photoshop offers a hierarchal map structure which allowed for a clear process of creation of content for StepFarm (Figure 16). Starting from the bottom there is a background which functions as a skybox followed by 'FarmBG' which is the background of the farm (e.g., all the mountains, hills, forest) and 'Bewerkbare grond' ('Workable soil') which contains the farming plots as well as the images for seeds and crops. The next folders, 'CityBG' and 'ForestBG', are both backgrounds for their corresponding location. 'UI' consists of the user interface of StepFarm, which can be seen in the upper left corner of the game. The 'Bag' folder contains all the menus from The Backpack (Figure 7 - 10).

› Images

StepFarm has been designed with the use of stock images which were modified and adjusted in order to fit the StepFarm game concept [16]. NPC grandfather, certain icons and the background for both the city and the forest are such stock images.

› Colours

In order to create an atmosphere which would stimulate the player to go outside the colours shown in Figure 17 were chosen as the colour scheme for the user interface of StepFarm. These colours represent nature, trees, grass and soil.

› Font

The typeface used in StepFarm is the 'Cooper Black' font, which was chosen because of its readability and playfulness. The colour of the text in StepFarm has been chosen to be white, which increased the readability.

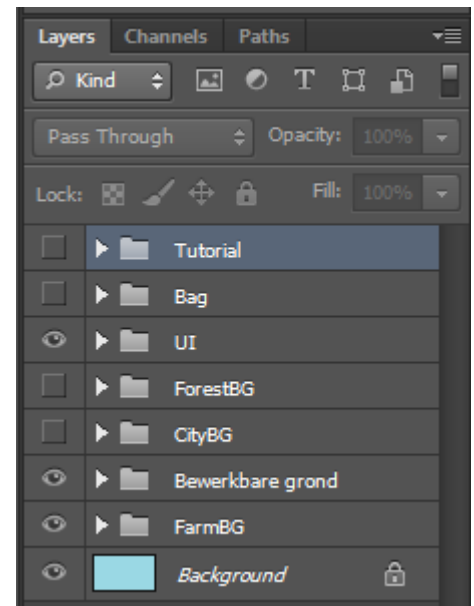


Figure 16: StepFarm content in Photoshop

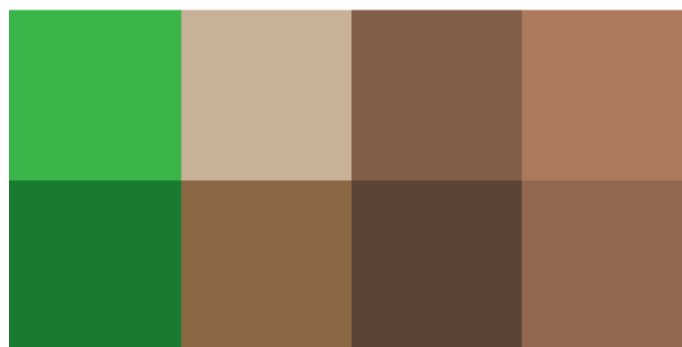


Figure 17: Colour scheme of the StepFarm UI and menus

5.3 A WORKING PROTOTYPE

The creation of a working prototype could start once all the necessary designs for the StepFarm tutorial had been made. This resulted in a total of 44 images which were each a unique scene for the StepFarm tutorial. These unique images were then linked to each other by making use of HTML and CSS.

› HTML and CSS

The linkage of all these unique images to one another resulted in 44 different HTML files. The HTML code, however, is relatively the same for each of these 44 different HTML files (Figure 18).

```
1 <!DOCTYPE HTML>
2 <html>
3 <head>
4 <script type="text/javascript" src="../adjustToScreen.js"></script>
5 <style>
6 body{background-size: 100%;background-repeat: no-repeat;}
7 #go {width:194px; height:50px; position:absolute; left:1363px; top:537px;}
8 </style>
9 </head>
10
11 <body background="Images/1.png" onload="adjust()" >
12 <a href="Tutorial_2.html">
13 <div id="go">
14 </div>
15 </a>
16 </body>
17 </html>
```

Figure 18: HTML code for the StepFarm tutorial

The HTML code for the StepFarm tutorial consists of a unique image as its background which depends on the tutorial scene ('1.png' in Figure 18). A clickable div element exists which takes the player to the next tutorial scene ('Tutorial_2.html' in Figure 18). This clickable div element could easily be created by using the information Photoshop gives about the selected element (Figure 19). Therefore, the only values that had to be changed during the creation of all 44 different HTML files were the background, the link to the next HTML file and the size and position of the clickable div element.

The first version of the StepFarm tutorial was designed to fit a screen of 1920 pixels by 1080 pixels. During a quick test on a tablet it was found that the webpages did not adjust to the screen size of the device. This was solved with JavaScript, which will be explained in the next section 5.4 *Adjustments*.

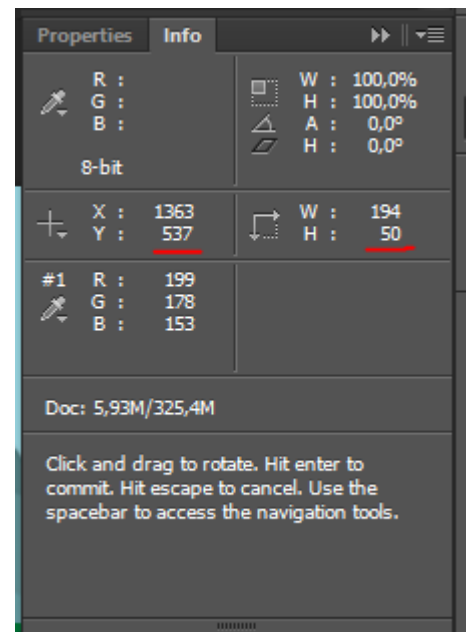


Figure 19: The size and the location of the continue button

5.4 ADJUSTMENTS

In order to fit the webpages to the screen size of the device a function was written (Figure 20). The function takes the height and the width of the screen of the device and divides it by 1080 and 1920 accordingly, which results in a percentage of how much smaller or bigger the screen is than the original design. The function then takes the existing size and location of the div element and multiplies this with the previously found percentage, resulting in a precisely calculated new size and location for the div element. These adjusted values are then given to the clickable div element.

```
1 function adjust()  
2 {  
3     var percWidth = window.screen.width / 1920;  
4     var percHeight = window.screen.height / 1080;  
5     var divX = document.getElementById("go").offsetWidth;  
6     var divY = document.getElementById("go").offsetHeight;  
7     var divLeft = document.getElementById("go").offsetLeft;  
8     var divTop = document.getElementById("go").offsetTop;  
9  
10    var newX = divX * percWidth;  
11    var newY = divY * percHeight;  
12    var newLeft = divLeft * percWidth;  
13    var newTop = divTop * percHeight;  
14  
15    document.getElementById("go").style.width = newX + "px";  
16    document.getElementById("go").style.height = newY + "px";  
17    document.getElementById("go").style.left = newLeft + "px";  
18    document.getElementById("go").style.top = newTop + "px";  
19 }
```

Figure 20: JavaScript to adjust the webpages to the screen of the device

5.5 FITBIT

A vital part of this project is the walking mechanic. This mechanic requires a value (steps) in order to reward the player with the correct amount of seeds. This can be done by making use of a step counter, a device which tracks the amount of steps a person has walked during the day. Fitbit is one of such step counters and provides an API which designers can use to integrate Fitbit into their own application.

Before a person can make use of the Fitbit API they will have to register an application on the Fitbit website. Once completed, an API key is given which allows the retrieval of data. This data comes as a JSON file and thus can be easily read, for example with JavaScript using `JSON.parse()`. The only data StepFarm requires is the amount of steps the player has walked, which can be found in the player's daily activity under "activities". An example of a JSON file from a Fitbit user is shown in Figure 21.

```
{
  "activities": [
    {
      "activityId": 51007,
      "activityParentId": 90019,
      "calories": 230,
      "description": "7mph",
      "distance": 2.04,
      "duration": 1097053,
      "hasStartTime": true,
      "isFavorite": true,
      "logId": 1154701,
      "name": "Treadmill, 0% Incline",
      "startTime": "00:25",
      "steps": 3783
    }
  ],
  "goals": {
    "caloriesOut": 2826,
    "distance": 8.05,
    "floors": 150,
    "steps": 10000
  },
  "summary": {
    "activityCalories": 230,
    "caloriesBMR": 1913,
    "caloriesOut": 2143,
    "distances": [
      {"activity": "tracker", "distance": 1.32},
      {"activity": "loggedActivities", "distance": 0},
      {"activity": "total", "distance": 1.32},
      {"activity": "veryActive", "distance": 0.51},
      {"activity": "moderatelyActive", "distance": 0.51},
      {"activity": "lightlyActive", "distance": 0.51},
      {"activity": "sedentaryActive", "distance": 0.51},
      {"activity": "Treadmill, 0% Incline", "distance": 3.28}
    ],
    "elevation": 48.77,
    "fairlyActiveMinutes": 0,
    "floors": 16,
    "lightlyActiveMinutes": 0,
    "marginalCalories": 200,
    "sedentaryMinutes": 1166,
    "steps": 0,
    "veryActiveMinutes": 0
  }
}
```

Figure 21: Daily activities of a Fitbit user in a JSON file

6 USABILITY TESTING

Testing could start once a working prototype was created. This chapter explains the preparation of the usability tests in the form of a testing protocol. Next, the execution of the usability tests are described, which consisted of testing the prototype and filling in a questionnaire. Finally, the results of the usability tests are presented.

6.1 TESTING PROTOCOL

Before the testing of the prototype could start, a testing protocol was made to ensure the testing sessions would proceed without any difficulties. This testing protocol consists of a goal, a description of the participants, a description of the method and the questionnaire.

› Goal

The following sub-research questions, mentioned in section 1.3 *Research question*, will be answered to support the main research question. The question have been modified to fit the StepFarm game concept.

› Which game mechanics, implemented in the StepFarm game, motivate children to become more active?

› Which game mechanics, implemented in the StepFarm game, provide educational content?

› Which game mechanics, implemented in the StepFarm game, does the target group like?

› Method

The participants (a maximum of two per testing session) or the supervisor will enter the room. A short introduction will be given. Afterwards, an informed consent will be given to the parent to sign, which can be found in Appendix C. Next, participants will take place behind a table separated from each other. Sitting back to back they are given a tablet which has the prototype on it. The participants will enter tutorial part I, which ends when the player is asked to go on a walk. Once this part of the tutorial is concluded, both the supervisor and the participants will go on a short walk of (a minimum of) 500 steps. Then the participants start tutorial part II. Once the participants are finished they will be given a questionnaire. Once both participants are finished they are given a small compensation for their participation (chocolate).

ETA	Duration	Activity
00:00	2 min	Welcome & introduction
00:02	5 min	PART I: Playtest tutorial I
00:07	7 min	PART II: Walking (500 steps)
00:14	10 min	PART III: Playtest tutorial II
00:24	10 min	PART IV: Questionnaire
00:34	1 min	ENDING
00:35		Total

Table 8: Planning testing session

› Questionnaire

The questionnaire that this project used during usability testing is derived from the Fun Toolkit [17]. This toolkit allows researchers to gather opinions about technology from children. This questionnaire consists of the smileyometer, an again-again table and three open questions.

› Smileyometer

The smileyometer is used to gather the opinion of the participant about a technology before or after testing aforementioned technology. It is based on a 1 – 5 Likert scale, but made for children. The smiley on the far left says ‘slecht’ meaning bad. The smiley on the far right says ‘geweldig’ meaning great. The following ten questions make use of the smileyometer:


1	StepFarm vond ik een leuk spel.
	

Figure 22: Smileyometer ("I liked StepFarm")

- Q1.** I liked StepFarm.
- Q2.** I know how to gather seeds in StepFarm.
- Q3.** I would take a short walk to gather more seeds in StepFarm.
- Q4.** I know how to plant seeds in StepFarm.
- Q5.** I know how to harvest crops in StepFarm.
- Q6.** I like the requests in StepFarm.
- Q7.** Opa Boer gives good hints/tips.
- Q8.** I would like to complete every achievement in StepFarm.
- Q9.** I would like to upgrade the entire farm in StepFarm.
- Q10.** I would like to play StepFarm with my friends.

The purpose of this set of questions is to gather the opinion of the participant on each mechanic individually. The first question asks the participant whether StepFarm is a fun game concept in general. Next, Q2, Q4 and Q5 show if the mechanics are clear and easy to understand and remember. Finally, Q3 and Q6 – Q10 gather opinions about each mechanic individually (walking/gathering seeds, requests, Opa Boer, achievements, upgrades and multiplayer).

› Again-again table

The again-again table allows children to compare different kind of technologies or actions by asking whether the participant would like to do something again (Figure 23). In this case it allows the participants to compare the mechanics with each other. A participant can choose from either yes, maybe or no. Nine questions made use of the again-again table:

- Q11.** Collecting seeds.
- Q12.** Planting seeds.
- Q13.** Buy something from the shop.
- Q14.** Fulfil requests.
- Q15.** Discover all the seeds.
- Q16.** Complete all achievements.
- Q17.** Buy every upgrade.
- Q18.** Add friends.
- Q19.** Get more hints from Opa Boer.

Ik zou graag nog een keer

	Ja	Misschien	Nee
 Zaden gaan verzamelen.			
 Zaden planten.			
 Iets kopen in de winkel.			

Figure 23: Again-again table ("I would like to do ... again.")

› Open questions

The open questions provided an opportunity for the participants to share their thoughts on the game concept. The questionnaire contains three open questions:

Q20. What did you like about StepFarm?

Q21. What should be improved in StepFarm?

Q22. Do you have any additions which you think should be in StepFarm?

6.2 STEP FARM V0.1 USABILITY TESTING

Different homes of participants were visited in order to test the prototype. This allowed for the opportunity to test StepFarm in a domestic setting, a setting which would eventually be the goal for this project. After entering the home, the participants and the supervisor were introduced to each other. The supervisor then gave a short introduction about the project and the test. Once both the parent and the participants had been fully informed about the project and the test, a consent form had to be signed by the parent. Afterwards, the test entered PART I: Playtest tutorial I.

The participants were asked to sit down and were each given a tablet with the prototype. The supervisor explained that it is important that the participants test the prototype on their own, so helping each other was not allowed. If the participants had a question, they could raise their hand upon which the supervisor would come to help. Participants could ask for directions during the playtest. In this case their questions would be redirected by questions like: *‘Wat denk jij wat je nu moet doen?’* (What do you think you should do here?) and *‘Kijk eens rond, zie je iets wat je zou helpen?’* (Look around, do you see anything which might be able to help you?). Participants, also, could ask why they cannot click on certain elements during the test. This is explained by telling them that this is the tutorial. Once the game is developed those interactions will be possible, however we need the help of the participant in order to do so.

The supervisor and the participants went on a walk once the participants finished PART I: Playtest tutorial I. The parent was allowed to go with them, but should not interfere. During this walk the supervisor would talk with the participants, usually about school or hobbies. The participants and the supervisor went back once they walked 500 steps or more. Once home, PART III: Playtest tutorial II began. The participants would then finish the StepFarm tutorial.

Once completely finished, the participant was asked to fill in a questionnaire. The supervisor gave the questionnaires after he explained what the participants should do. If there was a question, the participants could raise their hands and the supervisor would come to help. Finally, when the participants have finished the questionnaire, the supervisor thanked everyone and left.

6.3 RESULTS

The results of the questionnaire are divided into three categories, which are the questions asked with the smileyometer, the again-again table and the open questions. The first two categories show both the individual scores the participants gave a StepFarm game mechanic and the collective opinion regarding a StepFarm game mechanic. The participants are children aged 7 – 11. The participants have been contacted via acquaintances. The only requirement for attending a testing session was the ability to read. The participants consisted of both boys (n=2) and girls (n=3). None of the participants were affected by a chronic disease, which is not a problem for this phase of the project as StepFarm needs verification regarding its fun factor and because StepFarm might be used among varied other target groups in the future.

› Questionnaire

The first ten questions were asked to gather the opinion of a participant regarding StepFarm and its game mechanics. Figure 24 shows the results of these ten smileyometer questions. The first question shows how much the participants liked StepFarm as a game concept. StepFarm received three maximum scores out of the five, while the other two scores are moderately high. This shows promise for further development of StepFarm. Next, participants were asked if some of the vital, game mechanics of StepFarm were clear. These vital game mechanics consist of the gathering of seeds, the planting of seeds and the harvesting of crops. In Figure 24 and these are denoted as *Clear? Seeds*, *Clear? Planting* and *Clear? Harvesting*. Nearly every participant gave a moderate-high score regarding these important game mechanics, except for one participant who gave low scores regarding the clearness of these game mechanics. Finally, the participants gave other mechanics moderate-high scores, especially multiplayer which received the maximum score. Achievements, however, received lower scores than initially expected. Higher scores were expected because achievements is considered a motivational game design element by Sailer et al. [5].

Participants were asked nine questions which used the again-again table. These results are shown in Figure 25. Participants could answer whether they would like to do a certain activity again or not. A higher score, therefore, means a game mechanic is more fun and motivating. Collecting and planting seeds received the maximum scores from every participant. Participants, therefore, report liking the walking to get those seeds. Both requests and upgrades received maximum scores, both of which provide possibilities for educational content. The other mechanics received moderate-high scores, while achievements scored lower than expected, again.

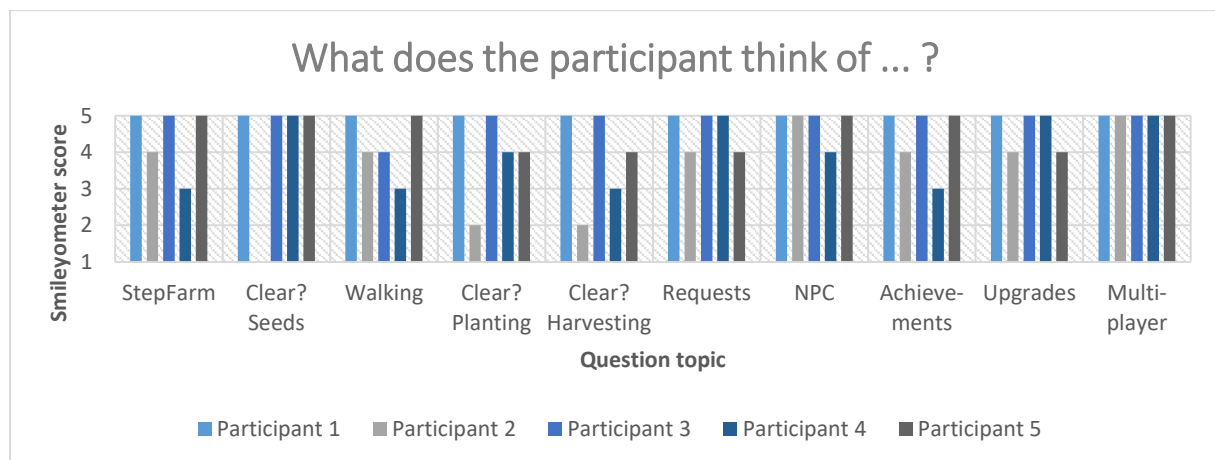


Figure 24: The individual opinions of the participants (n=5) regarding StepFarm game mechanics (bad = 1, not good = 2, good = 3, very good=4, amazing=5)



Figure 25: The individual opinions of the participants (n=5) regarding StepFarm activities (yes=3, maybe=2, no=1)

The last part of the questionnaire consisted of three open questions. The first question asked participants what they liked about StepFarm. Every participant reported liking the walking, which needs to be done in order to gather seeds. Other comments showed the participants liked other activities such as buying upgrades from the shop. One participant also mentioned StepFarm is fun because one has to perform actions in real life, which are required for the game to function.

The second open question asked participants what should be improved in StepFarm. Participants did not actually mention anything which should be improved in this version of StepFarm. Instead, the participants mentioned additions to StepFarm which should have been answered in the last open question.

The final, open, question of the questionnaire asked the participants what should be added to StepFarm. Participants suggested the following additions:

- Planting seeds should require additional steps. For example, the player must click the farm a few times in order to dig a hole for the seed to go in.
- Adding animals to the farm.
- The possibility of multiple farms
- The ability to use different kinds of machines (e.g., tractor)
- The ability to control a character on the farm (e.g., movement)

Finally, the collective scores of the participants are presented in Figure 26 and Figure 27 to summarize results and in an effort to make an observation about the general scores of StepFarm.

StepFarm received high scores and is, therefore, liked by the participants. One participant (participant 2) did not understand important game mechanics, while all other participants did understand. Other mechanics, such as NPC, upgrades and requests, received moderate-high scores with multiplayer receiving the maximum score possible.

Participants would like to walk to gather seeds and plant them afterwards. Requests and upgrades also received maximum scores, which provide opportunities for educational content. All results show achievements receiving lower scores than initially expected. This might be due to the low amount of participants, or the achievements are not motivating enough. Motivation and flow might increase when completing an achievement awards the player a small reward as mentioned by the gamification expert.

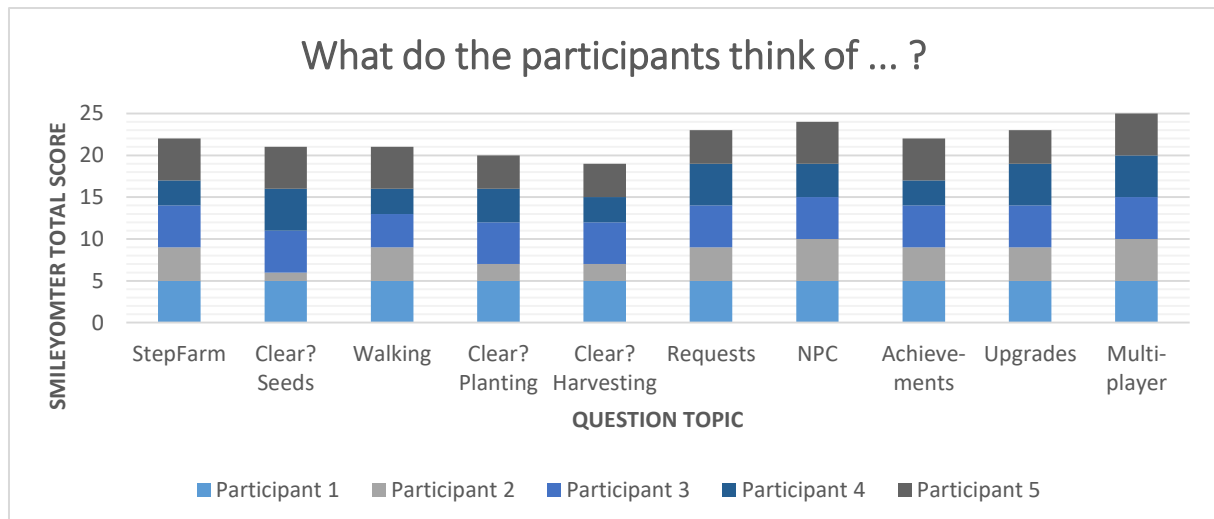


Figure 26: The collective opinions of the participants (n=5) regarding StepFarm game mechanics (bad = 1, not good = 2, good = 3, very good=4, amazing=5)

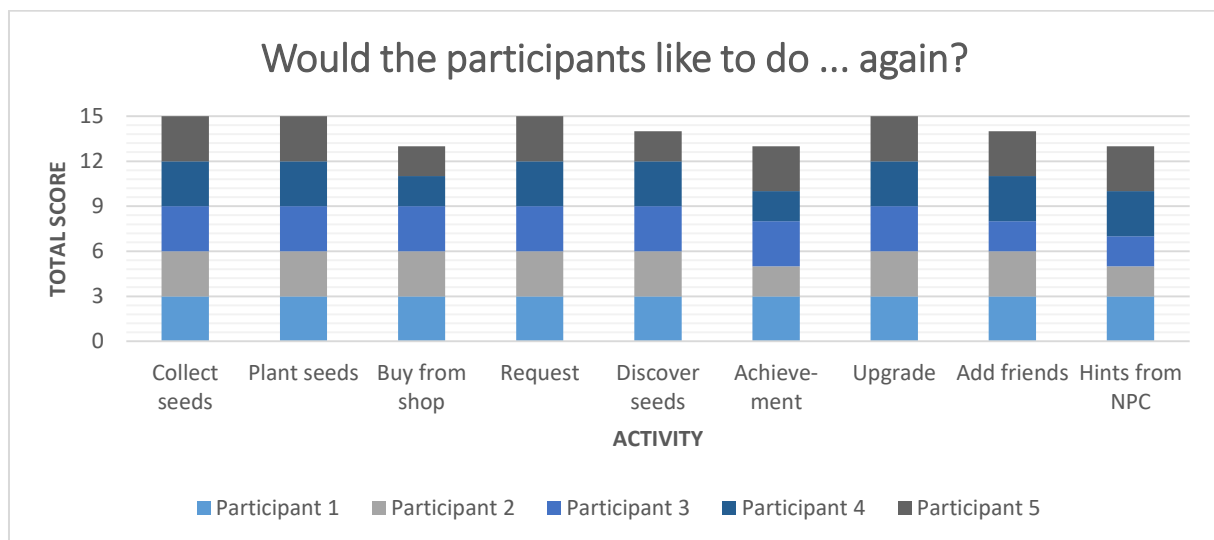


Figure 27: The collective opinions of the participants (n=5) regarding StepFarm activities (yes=3, maybe=2, no=1)

› Observations

The supervisor was tasked with observing the participants as they tested the prototype. The first notable observation made was participants continuously trying to interact with StepFarm. Participants kept trying to press elements which were not implemented in the prototype yet (e.g., selecting different items in the shop), which suggests an intuitive design of StepFarm. The second observation was made when a participant advanced rather fast through the tutorial. This was followed by the participant asking questions such as ‘What do I need to do now?’. The participant was able to continue after being redirected by the supervisor. The final notable observation was made during the walking part of the test. Parents were allowed to join when participants had to go on a walk, but they were asked not to interfere with the test. The participants, however, were enthusiastic about StepFarm and started to talk about it with their parent. This observation showed opportunities for StepFarm to be played co-operatively between child and parent, which will be more discussed in the next Section 7 Discussion.

7 DISCUSSION

The start of Chapter 7 Discussion describes the goal of this project, after which the results of this research are described and discussed. The results describe game mechanics which promote physical activity and provide educational content, multiplayer and the safety of the target group and finally, testing and future research.

The original goal of this project was to design an interface which would stimulate physical activity. This interface took the form of an Active Video Game which was named StepFarm. The goal of StepFarm is to support the self-management of chronic diseases in children, where we refer, in context of this project, to support in self-management of chronic diseases as providing the children with the tools to cope with their chronic condition on a daily basis, by means of *education* and promotion of *physical activity*. StepFarm, therefore, consists of both a game mechanic which promotes physical activity as well as game mechanics which educate the player.

The game mechanic which promotes physical activity in StepFarm is the gathering mechanic. When the player walks in real life he will gather seeds he can use in StepFarm. This mechanic was heavily inspired by the information provided by the gamification expert about the amount of dedication a video game should require. A video game which requires a high amount of dedication from the player will have to compete with all other daily activities the player has on a given day, which might result in a decrease in engagement with the video game. This might be a possible explanation as to why other AVG's have failed to increase any levels of physical activity in a domestic setting, while those same AVG's did show an increase in physical activity in a lab setting. The way the gathering mechanic is currently implemented in StepFarm allows for very little dedication required from the user. All the player has to do, and the only thing the player *can* do, is walk in order to gather seeds, as long as his steps can be measured. Upon starting the game, StepFarm will give the player his gathered seeds. This allows StepFarm to intertwine with the schedule of the player, improving engagement. The gathering mechanic also makes it so that the desired behaviour (children walking) is the only possible behaviour to perform, which prevents StepFarm from any malicious dual-use. Initial pilot tests with children aged 7 – 11 show that the target group likes and understand the gathering mechanic. This is excluding participant 2, who advanced rather fast through the tutorial and missed vital information, which is the explanation for the low scores given to *Clear? Seeds*, *Clear? Planting* and *Clear? Harvesting* in Figure 24. The fast advancement through the tutorial is still a real possibility, though, which should be researched during the future development of StepFarm. For example, highlighting the element which lets the player proceed might prevent confusion, but might at the same time allow players to skip quickly through the tutorial, resulting in a lack of understanding how StepFarm works.

The educational game mechanics of StepFarm consist of *Seeds*, *Requests*, *Achievements*, *Upgrades* and *The NPC*. These mechanics provide opportunities to educate the players about their chronic disease and the promotion of a healthy lifestyle. Examples to educate the player are *Seeds* and *Requests* educating the player about a healthy diet and food, *Achievements* educating the player about physical activity, *Upgrades* educating the players about their chronic disease and *The NPC* which sporadically gives the player persuasive hints to perform physical activity. Initial pilot tests with children aged 7 – 11 show that the target group gives moderate-high scores to aforementioned mechanics. The results also show that the target group would like to play more with these game mechanics. The main purpose of these mechanics is to educate the target group, however, the mechanics also provide additional motivation as was shown by Sailer et al. [5] and the motivational

game design elements. This project made use of the findings of Sailer et al. and also support these by using *avatars, badges, points and performance graphs*. Other inspiration for these mechanics existed of the findings from Olson [7] with different kinds of motivation and the information provided by the gamification expert. Although the current version of StepFarm does not have a rich backstory, possibilities for future development regarding the story of StepFarm are shown in Section 2.3 *Storytelling as a means of education in video games*, which present tips and a Hero's Journey template.

Multiplayer is an element which the target group, unanimously, agrees upon that should be in StepFarm. This would bring certain ethical issues with it, such as the online safety and privacy of the target group. The target group should be able to feel safe from online harassment when playing StepFarm. Ways of preventing online harassment is to either filter messages, remove messages entirely or limit the content of the messages. A possible design choice for StepFarm is the limitation of content of the messages. By allowing the player to choose from a set of specific words (e.g., hi, goodbye, hello there!) and smileys he is able to leave a message on the farm of a friend. This way of messaging prevents players from leaving offensive messages.

To prevent sensitive data from leaking StepFarm should only require the amount of steps the player takes during a day. This is the only data StepFarm requires in order to function, making other data unnecessary.

Mediation theory states that technology is not neutral and influences experience and ethics. Because StepFarm promotes physical activity, it changes and steers behaviour in a certain way. This change in behaviour should be done in such a way that no harm can befall the user. Users should be aware of their surroundings at all times when doing physical exercise, especially when going outside.

Therefore, the design choice has been made to show the player a pop-up each time he starts StepFarm, which warns the player to be aware of his surroundings at all times.

Testing StepFarm proved to be an interesting experience. Testing was not done in a usual lab setting, but rather at the residences of the participants themselves. This did allow for testing in a domestic setting which would be the final goal for StepFarm. For example, during a usability test walk, the participant took her dog with her and reported to the supervisor she would walk more with the dog if it meant she would get more seeds in StepFarm.

StepFarm provides opportunities as a fun parent-child activity. Parent and child might play StepFarm together and have a competition whoever gathers the most seeds. Another opportunity is being able to go on walks together. It is also possible for StepFarm to be used as adjuvant therapy given by healthcare institutes, which might benefit from the data StepFarm provides about the amount of steps the player walks. In combination with the data, healthcare institutes might be able to closer examine the progress of their patient. StepFarm, therefore, also provides a way for parents to support their children during their therapy by going on walks together.

Future research which would benefit StepFarm should be done regarding story, multiplayer and the additions the participants suggested in Section 6.3 *Results*. Finally, more short-term and long-term tests should be done to verify StepFarm as a fun and motivating Active Video Game. Short-term testing can be accomplished by following the testing protocol presented in Section 6.1 *Testing Protocol* and by using the questionnaire which can be found in Appendix B. Because self-management is a long-term process, long-term testing should examine whether StepFarm increases physical activity over a longer time period as well as test the knowledge of players regarding StepFarm educational content.

8 CONCLUSION

Chapter 8 Conclusion concludes the research and answers the main research question.

The main research question of this project was established as follows:

“Which game mechanics would an Active Video Game require in order to support the self-management of chronic diseases in children?”

In context of this project we refer to support in self-management of chronic diseases as providing the children with the tools to cope with their chronic condition on a daily basis, by means of *education* and promotion of *physical activity*. The gathering mechanic of StepFarm promotes physical activity by requiring the player to walk in order to actually play StepFarm. This mechanic is implemented in such a way that it should persuade the player to walk to his guitar lessons instead of taking the bus. Other mechanics such as Requests, The NPC, Achievements, Upgrades and Multiplayer provide educational content and increase the motivation of the target group, which is supported by the findings in Section 2 *State of the Art* and in Section 6.3 *Results*. Testing showed participants liked the game concept StepFarm, which consists of the aforementioned game mechanics and, therefore, shows possibilities for an Active Video Game to support the self-management of chronic diseases in children.

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APPENDIX A: GAMIFICATION EXPERT INTERVIEW QUESTIONS






- Zijn er elementen waar je je echt op moet focussen bij kinderen?
- Hoe zou ik kinderen kunnen laten lopen?
- Hoe belangrijk is de focus op de doelgroep?
- Wat zijn dont's?

StepFarm v.0.1 Vragenlijst

LEEFTIJD: _____






GESLACHT: MAN / VROUW

De volgende vragen kun je beantwoorden door de zin te lezen en daarna de smiley te omcirkelen waarvan jij vindt dat die het beste past bij die zin.






1	StepFarm vond ik een leuk spel.
	<div style="text-align: center;"></div> <div style="text-align: center;"><p>Slecht Niet zo goed Goed Heel goed Geweldig</p></div>






2	Ik weet hoe ik zaden kan verzamelen in StepFarm.
	<div data-bbox="331 349 512 533"></div> <div data-bbox="547 349 727 533"></div> <div data-bbox="762 349 943 533"></div> <div data-bbox="978 349 1158 533"></div> <div data-bbox="1193 349 1374 533"></div> <div data-bbox="367 542 456 582">Slecht</div> <div data-bbox="563 542 724 582">Niet zo goed</div> <div data-bbox="818 542 898 582">Goed</div> <div data-bbox="997 542 1134 582">Heel goed</div> <div data-bbox="1208 542 1337 582">Geweldig</div>






3	Ik zou een stukje gaan lopen om meer zaden te vinden in StepFarm.
	<div><div><p>Slecht</p></div><div><p>Niet zo goed</p></div><div><p>Goed</p></div><div><p>Heel goed</p></div><div><p>Geweldig</p></div></div>






4	Ik weet hoe ik de zaden kan planten in StepFarm.
	<div>      </div> <div> SlechtNiet zo goedGoedHeel goedGeweldig </div>

5	Ik weet hoe ik mijn gewassen moet oogsten in StepFarm.
	<div><div><p>Slecht</p></div><div><p>Niet zo goed</p></div><div><p>Goed</p></div><div><p>Heel goed</p></div><div><p>Geweldig</p></div></div>

6	Ik vind de verzoeken/opdrachten in StepFarm leuk.
	<div style="text-align: center;">      </div> <div style="text-align: center;"> Slecht Niet zo goed Goed Heel goed Geweldig </div>

7	Opa Boer geeft handige tips.
	<div data-bbox="341 349 521 533"></div> <div data-bbox="376 542 466 580">Slecht</div> <div data-bbox="557 349 737 533"></div> <div data-bbox="571 542 735 582">Niet zo goed</div> <div data-bbox="772 349 952 533"></div> <div data-bbox="826 542 908 580">Goed</div> <div data-bbox="979 349 1160 533"></div> <div data-bbox="1005 542 1144 582">Heel goed</div> <div data-bbox="1192 349 1372 533"></div> <div data-bbox="1217 542 1347 582">Geweldig</div>

8	Ik zou alle prestaties in StepFarm willen voltooien.
	<div><div><p>Slecht</p></div><div><p>Niet zo goed</p></div><div><p>Goed</p></div><div><p>Heel goed</p></div><div><p>Geweldig</p></div></div>

9	Ik zou graag de boerderij in StepFarm helemaal willen upgraden.
	<div><div><p>Slecht</p></div><div><p>Niet zo goed</p></div><div><p>Goed</p></div><div><p>Heel goed</p></div><div><p>Geweldig</p></div></div>




10	Ik zou graag StepFarm met vrienden willen spelen.
	<div><div><p>Slecht</p></div><div><p>Niet zo goed</p></div><div><p>Goed</p></div><div><p>Heel goed</p></div><div><p>Geweldig</p></div></div>

De volgende vragen kun je beantwoorden door een kruisje te zetten in het hokje waarvan jij denkt dat er het beste bij past.

Ik zou graag nog een keer

	Ja	Misschien	Nee
 <p>Zaden gaan verzamelen.</p>			
 <p>Zaden planten.</p>			
 <p>Iets kopen in de winkel.</p>			

Ik zou graag nog een keer

	Ja	Misschien	Nee
 <p>Verzoeken voltooien.</p>			
 <p>Alle zaden ontdekken.</p>			
 <p>Alle prestaties voltooien.</p>			
 <p>Alle upgrades kopen.</p>			

Ik zou graag nog een keer

	Ja	Misschien	Nee
 <p>Vrienden toevoegen.</p>			
 <p>Meer tips van Boer Opa krijgen.</p>			

Dit zijn de laatste vragen. Deze vragen zijn open vragen, dus hier mag jij invullen wat je denkt/vindt.

	Wat vond je leuk of goed aan StepFarm?

	Wat moet verbeterd worden aan StepFarm?

	Heb jij nog toevoegingen waarvan jij vindt dat die in StepFarm moeten zitten?

Dit is het einde van de vragenlijst.

Bedankt voor alle hulp!

APPENDIX C: INFORMED CONSENT

Toestemmingsverklaring

Hierbij geef ik toestemming om mijn kind mee te laten doen aan de usability test die wordt afgenomen namens een student van de Universiteit Twente.

Ik begrijp dat deelname aan deze usability test vrijwillig is en ga akkoord dat ik enige zorgen of onwenselijke situaties rondom mijn kind of mijzelf betreft de surveillant of de usability test direct zal aan geven.

Gelieve hieronder tekenen om aan te geven dat u de voorafgaande informatie zojuist heeft gelezen en begrijpt en dat enige vragen betreft de usability test zijn beantwoord.

Datum: _____

Naam van deelnemer: _____

Naam: _____

Handtekening: _____

Hartelijk dank!

Uw medewerking wordt gewaardeerd.