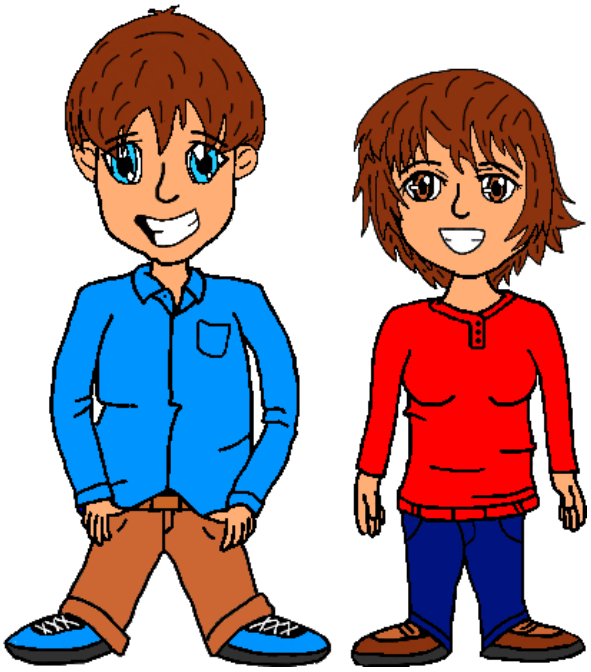
BACHELOR THESIS

Healthy Weight Game!

Lose weight together



Author

S. J. Lentelink

FACULTY OF SCIENCE AND TECHNOLOGY/BSS
TELEMEDICINE GROUP

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Abstract

Motivation

Overweight and obesity is an extremely problematic increasing healthcare problem in the Netherlands as well as worldwide. Being overweight or obese gives higher risks on cardiovascular diseases, diabetes, musculoskeletal disorders and various types of cancer. Current methods for treating overweight and obesity can result in weight loss in the short term but often fail in sustaining the new weight in the longer term. It seems that improving the adherence to such methods and achieving sustainable behavioral lifestyle changes are key factors in the struggle against overweight and obesity. People nowadays live a more sedentary lifestyle which highly contributes to the overweight problem at hand. To counter this problem the physical activity of these people has to be increased and their lifestyles need to be changed. Behavioral changes, include doing opportunistic exercises as well as structural exercise programs, are believed to be of great importance to achieve a healthier lifestyle. Physical activity is an integral part of many weight loss methods, but lack of adherence, which can sometimes be related to the influence of emotional (or 'affective') state, often hinders progress. Feeling comfortable and enjoying following health stimulating methods will improve the motivation to follow up. One way to improve the affective state of people (i.e. to promote positive emotions) is to make them aware of their condition in a playful manner, possibly with interaction of fellow patients. Serious gaming is envisioned as one way to achieve this. In 1970 the term 'serious game' was defined by Clark Abt as: '*serious games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.'[5]* Serious gaming is not new, but may be promising when implemented in overweight and obesity treating methods.

Objectives

Goal

The goal will be to design a serious game for the prevention and treatment of overweight and obesity. By doing first a literature study on 'overweight, obesity and weight management', 'behavioral change', 'serious gaming' and conducting a 'game comparison' a research based serious game will be designed.
The game must be able to:

- Make people with overweight or obesity aware of their condition in a playful manner.
- Stimulate physical health in a playful way.
- Encourage people to adhere to a health increasing program in a playful way.

Research question

In this thesis the research question is**:** How can a 'serious game' be designed which improves the physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods?

Approach

This thesis starts with literature studies on 'overweight, obesity and weight management', 'behavioral change' and 'serious gaming' to obtain (in-depth) information useable for designing a serious game for the treatment and prevention of overweight and obesity. Then a comparison will be made of developed research-based serious games which are designed for treating or preventing overweight and obesity. Then an overview of the literature outcome of the previous literature studies and game comparison will be given to establish useful information for the design of the serious game. On the basis of all this information and using own insights and creativity a serious game will be designed with use of the computer program 'Paint.NET' for additional drawings. It should be noted that in this thesis the game will only be designed and will not be developed. To research how the game design is received among potential users with view on future improvement of the game, an online survey will then be held using the online web survey host 'Thesistools'. The survey will be distributed using the international social networking service 'Facebook'.

In the survey participants will be shown a 9:01 minutes long tutorial video, which is made with use of 'Windows Live Movie Maker', after which open and closed questions will be asked. The survey results will then be analyzed and processed. And finally the discussion, conclusion and recommendation will be conducted using all of the previous information and outcomes.

Results

With use of the outcome of the literature studies on 'overweight, obesity and weight management', 'behavioral change' and 'serious gaming' and with the outcome of the research-based serious game comparison, the serious game 'Healthy Weight Game' was conceived and designed. The survey was held among 53 respondents, 20 male and 33 female, and gave overall good results. The game was well understood and seen as a good method to help people lose weight and induce positive behavioral changes. It was seen as a good addition to own initiatives for being physically active, but could also be an addition to dieting and physical therapy. The design of the game, as well the appearance as the content, was positively well received by the participants of the survey. Of these participants 30.19% thought the 'Healthy Weight Game' could help them become more physically active and 18.78% thought it would maybe. Losing weight with help of this game was thought to work by 16.98% while 22.64% thought it would maybe work. As for the endurance of playing the game, the results were excellent as the main goal was to let people become more physically active with the idea to induce a positive behavioral change, even when this is only minimal. From the participants, 5.66% would play it less than a week, 7.55% a week, 9.43% 2 weeks, 7.55% 3 weeks, 18.87% 1 month, 9.43% 2 months, 1.89% 3 months, 5.66% more than 3 months and 33.96% did not know it. This means that 60.38% would play the game for more than a week of which 35.85% would play it more than a month. If the game would be developed and launched, 79.25% would download it of which 13.73% even would pay for it. The final overall grade given for the 'Healthy Weight Game' was 7.57 out 10.

Conclusion

The designed serious game, 'Healthy Weight Game´, includes most of the valuable additions found in literature and research-based games and is well evaluated by potential users. Therefore can be concluded that the 'Healthy Weight Game' lives up to the research question, meaning that it is a game that shows potential for improving physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods.

1 Contents

List of Figures

List of Tables

1 Introduction

In this section the framework of the research is given starting with the motivation, followed by the objectives, research question, approach and finally the structure of this thesis.

1.1 Motivation

According to the World Health Organization more than 1.4 billion adults were overweight worldwide in 2008. Of these adults over 200 million men and nearly 300 million women were obese. These are astonishing numbers of the global situation on overweight and obesity. In the Netherlands, according to the CBS in 2009, 47.2% of the adult population was overweight of which 11.8% was obese.[6] The fundamental cause of overweight and obesity is an energy imbalance between the consumed and expended energy. Combined with a decrease in physical activity makes weight increase almost inevitable, resulting in serious health problems. Being overweight or obese gives higher risks on cardiovascular diseases, diabetes, musculoskeletal disorders and various types of cancer. Each year overweight and obesity cause at least 2.8 million deaths worldwide, making overweight the fifth leading risk of global deaths. Therefore research on new or better treatment for overweight and obesity is highly important.

Since the increasing prevalence all kinds of treatment have been used, from diets to physical exercises to psychological-, lifestyle-, pharmacologic- and surgical interventions. Most of these treatments can result in weight loss in the short term but often fail in sustaining the new weight in the longer term. For diets, research showed that in long-term-interventions the percentage of people who could not comply with their diet varies up to 40%. For the short-term-intervention diets the non-compliance varies up to 50%. People who actually did comply with their diet often had problems sustaining their achieved weight resulting in following a new diet after some time. This means that the adherence to weight loss methods and achieving sustainable behavioral lifestyle changes are key factors in the struggle against overweight.

In the case of physical activity people nowadays live a more sedentary lifestyle. With the increasing automation, computerization and comfort stimulation (e.g. facilitating escalators), people become less physical active resulting in less energy expenditure. Also the modern form of leisure as watching television contributes to a more inactive lifestyle. Longitudinal research showed that the youth became less active in and around the house as of the increased importance of computing and/or watching television. To counter this lifestyle people need to become more active and start changing their lifestyle. Behavioral changes, include doing opportunistic exercises as well as structural exercise programs, are believed to be of great importance to achieve a healthier lifestyle. Physical activity is an integral part of many weight loss methods but as with dieting adherence remains a major problem showing in people often quitting their program or doing it only partially. By improving the adherence and positively change the behavior, losing and sustaining weight becomes realistic.

With a view to adherence the healthcare condition of people is highly influenced by their emotional (or 'affective') state. Feeling comfortable and enjoying following health stimulating methods will improve the motivation to follow up. One way to improve the affective state of people (i.e. to promote positive emotions) is to make them aware of their condition in a playful manner, possibly with interaction of fellow patients. Serious gaming is envisioned as one way to achieve this. In 1970 the term 'serious game' was defined by Clark Abt as: '*serious games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.'[5]* Serious gaming is not new, but may be promising when implemented into overweight or obesity treating methods. [7, 8]

1.2 Objectives

1.2.1 Problem definition

Many people suffer from overweight and even from obesity. For these people is losing weight and/or sustaining to it often very difficult as their emotional state, among others, highly influences the adherence to their therapeutic advice. By not adhering to the advice there will be insufficient or no improvement in their weight and thus also not in their health condition.

1.2.2 Goal

According to the given problem the goal will be to design a serious game for the prevention and treatment of overweight and obesity. By doing first a literature study on 'overweight, obesity and weight management', 'behavioral change', 'serious gaming' and conducting a 'game comparison' a research based serious game will be designed. The game must be able to:

- Make people with overweight or obesity aware of their condition in a playful manner.
- Stimulate physical health in a playful way.
- Encourage people to adhere to a health increasing program in a playful way.

1.3 Research question

In this thesis the research question is**:** How can a 'serious game' be designed which improves the physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods?

To answer this question, the following sub-questions have to be answered:

- What are effective methods for treating and preventing overweight and obesity to contribute to a healthier lifestyle with view on implementation in serious gaming?
- What are effective methods to cause positive behavioral changes in the lives of overweight and obese people to contribute to a healthier lifestyle with view on implementation in serious gaming?
- What defines a serious game and is of importance to improve the adherence and to achieve positive behavioral changes when designing a health improving serious game to treat and prevent overweight and obesity?
- What research-based serious games are currently available for treating and preventing overweight and obesity and what can be used from these games to design a health improving serious game to treat and prevent overweight and obesity?

1.4 Approach

This thesis starts with literature studies on 'overweight, obesity and weight management', 'behavioral change' and 'serious gaming' to obtain (in-depth) information useable for designing a serious game for the treatment and prevention of overweight and obesity. Then a comparison will be made of developed research-based serious games which are designed for treating or preventing overweight and obesity. The choice for comparing research-based games above other games related to this subject is the usability of the results from the research outcomes. Then an overview of the literature outcome of the previous literature studies and game comparison will be given to establish useful information for the design of the serious game. On the basis of all this information and using own insights and creativity a serious game will be designed. It should be noted that in this thesis the game will only be designed and will not be developed. The design of the game will be created with 'Paint.NET' which is a proprietary freeware raster graphics editor program for Microsoft Windows. To research how the game design is received among potential users with view on future improvement of the game, an online survey will be held. The reason for using an online survey instead of other methods to receive feedback is based on multiple factors. First is the advantage of obtaining a large number of respondents in a limited time interval which gives the advantage of receiving feasible statistically significant results. The survey also will contain standardized questions which give more precise measuring, more reliability, enables group-comparison and makes analyzing the results easier. The survey will be created using 'Thesistools' on www.thesistools.com which is a website that allows users to create and host free of charge online surveys. The survey then will be distributed using 'Facebook' on www.Facebook.com which is an international social networking service. The survey will be uploaded on a personal Facebook page with a demand to other Facebook users to fill in the survey and distribute it on their turn to their social contacts with the effect that this becomes an unsolicited survey. In the online survey the participants will be shown a tutorial video of 9:01 minutes of the designed serious

game after which game related open and closed questions will be asked. The video will be made with 'Windows Live Movie Maker', a video editing software that part is of the Microsoft's Windows Essentials software suite. The video will be comprised of screenshots of a HTC Sensation Smartphone screen supplemented with images of the game design containing additional explanations to form a thriving tutorial video. The results of the survey will then be analyzed and processed. And finally the discussion, conclusion and recommendation will be conducted using all of the previous information and outcomes.

1.5 Structure

The first part of this thesis consists of a literature study to answer to the first three sub questions. The literature study starts in chapter 2 with a study on overweight, obesity and weight management. Here will be given some general information, the diagnostics in healthcare and the treatment of obesity. In chapter three a literature study on behavioral change is conducted giving some general information, behavioral change theories and models. In chapter four a literature study on serious gaming is conducted where general information, definitions, classifications and development of serious games will be given. In chapter five a game comparison is conducted among existing research-based serious games to find weak and strong points of serious gaming which are useable for the design of the serious game in this thesis. In chapter six the literature outcome of the previous chapters is conducted for the use of the design of the serious game. In chapter seven the serious game design is shown along with design-images and detailed explanation. In chapter eight the survey and evaluation of the designed serious game is conducted. And finally in chapter nine the discussion, conclusions and recommendations are given.

Summarized in an overview:

- Literature study on:
  - Overweight, obesity and weight management
  - Behavioral change
  - Serious gaming
- Game comparison on research-based serious games
- Literature outcome overview
- Design of the serious game
- Survey and evaluation
- Discussion, conclusion and recommendations

2 Literature; Overweight, Obesity and Weight Management

2.1 Introduction

2.1.1 General information

Over the years many reports were published on the subjects overweight and obesity. In this literature study the guideline for overweight and obesity in the Netherlands will be mostly used.[8] This guideline is a quite extended report based on existing international guidelines of which the guideline of the National Institute on Clinical Excellence (NICE) is one of them. In addition to these existing guidelines, information from the Dutch healthcare is processed within this guideline. In this literature study the focus lies on adults, because children (0-19 year) are much more difficult to diagnose and treat as their bodies are in different stages of development. First will be discussed what being overweight or obese means, how it can be defined, what the prevalence in the Netherlands is, how the morbidity is and what the determinants of overweight and obesity are. Secondly the diagnostics on adults and children will be discussed and thirdly there will be discussed how to treat overweight and obesity with use of diets, physical activity, psychological interventions and combined lifestyle interventions.

2.1.2 Definitions

Adults

Overweight and obesity are terms that give an estimation of the weight level of a person. Both indicate weight that is higher than what is considered to be healthy for a given person and it has been proven that the likelihood of certain diseases and other health problems increases for people whose weight is outside the healthy range. In definition obesity is called a chronic disease in which chronic indicates that obesity is a lifetime problem in need of continuous attention. Being recognized as a disease it is in need of medical prevention, diagnostics and treatment as long as the fatty degeneration leads to health problems with a view to the total body fat on one end and the distribution of fat on the other end. The location of fat in the body is proven to be important for the risk of chronic diseases. Fat in the abdomen cavity for example gives higher risks than fat in the buttocks or hips. By using the body mass index a quite reasonable indication of the fat storage can be given. But this is not applicable on everyone as being overweight does not necessarily mean there is abdominal cavity fat or that having a healthy weight means people do not have abdominal cavity fat. It is possible to do exact measurements in order to get definite answers, but that will require training and advanced technology. Therefore is decided to use the body mass index, possibly together with abdominal girth or waist circumference as an additional criterion, to measure the level of overweight or obesity. The abdominal girth can be measured with a measuring tape around the abdomen between the lowest ribs and the hipbone. The reason for the extra criterion is that in general both of these measurements can be associated with more stored fat. For example when someone with a given height has an increased body weight and abdominal girth, it is associated with more stored fat.[8]

Body mass index

The body mass index (BMI) is an easy way to measure the level of weight of a person. To determine the BMI score the height and weight of a person is needed which then gives the BMI score by dividing the weight by the squared height. [9] The higher the BMI score, the higher the overweight and risk of co-morbidity will be. However, the fatty degeneration of a person depends on the gender, age and ethnicity.[8] Table 1 shows the international classification of adult underweight, overweight and obesity.

Table 1; The International Classification of adult underweight, overweight and obesity according to BMI (WHO 2004) [9]

Classification	BMI(kg/m²)	
	Principal cut-off points	Additional cut-off points
Underweight	<18.50	<18.50
Severe thinness	<16.00	<16.00
Moderate thinness	16.00 - 16.99	16.00 - 16.99
Mild thinness	17.00 - 18.49	17.00 - 18.49
Normal range	18.50 - 24.99	18.50 - 22.99
		23.00 - 24.99
Overweight	≥25.00	≥25.00
Pre-obese	25.00 - 29.99	25.00 - 27.49
		27.50 - 29.99
Obese	≥30.00	≥30.00
Obese class I	30.00 - 34.99	30.00 - 32.49
		32.50 - 34.99
Obese class II	35.00 - 39.99	35.00 - 37.49
		37.50 - 39.99
Obese class III	≥40.00	≥40.00

Waist/hip ratio

The waist/hip ratio is quite a good predictor for diabetes mellitus type 2 and cardiovascular diseases but unfortunate it will not be used in this literature study. This is because of the complexity of the use of the ratio between waist and hip and because there is no national or international accepted classification criteria for the diagnostic. [8]

Waist circumference

Screening the waist circumference gives a good indication of the amount of abdominal and total body fat and it predicts cardiovascular risks better than the BMI. For men the limit is set on ≥ 102 cm for an increased risk of metabolic complications; for women the limit lies on ≥ 88 cm (WHO 2000) [8]. The waist circumference is strongly correlated with the amount of abdominal fat and less with the amount of muscle. The amount of visceral abdomen fat is the most important risk factor for diabetes mellitus type 2 and cardiovascular diseases. [8]

Conclusion

BMI is an excellent predictor on population level for increased risk of chronic conditions and the increase of mortality, especially for a BMI of 30 kg/m² or higher. Independent of the BMI, the waist circumference can give additional information on the risk for disorders. This information is in different international guidelines summarized as shown in Table 2. Here the BMI score in combination with a normal or large waist circumference shows the risk on disorders. [8]

Table 2; Classification of overweight and obesity with the corresponding health risks (translated table). [8]

	BMI	**Normal waist circumference**	**Large waist circumference (≤ 102 cm for men; ≤ 88 cm for women)**
Underweight	<18,5	-	-
Normal'	18,5-24,9	-	-
Overweight	25,0-29,9	Increased	High
Obesity I	30,0-34,9	High	Very high
Obesity II	35,0-39,9	Very high	Very high
Extreme Obesity	40 or higher	Extreme high	Extreme high

As shown in Table 2 the 'high risk' criteria can be ascribed to the adults with obesity I (30.0-34.9 km/m^3) and a normal waist circumference and to adults with a BMI between 25.0 and 29.9 km/m^3 and a large waist circumference.

Children

To define if a child is overweight or obese the growth and development has to be taken into account. This makes the age and gender criteria inevitable. The most valid and reliable way to measure the fat percentage is to use a DEXA (dual energy X-ray absorptiometry) measurement and radiological image forming techniques. These measurements are for scientific research perfect, but is in practice not feasible because of the costs, time and child friendliness. Using the BMI, skin fold thickness and waist circumference n indirect measurement of the percentage of fat can be given. But this has to be done by well-trained people with calibrated equipment in order to give a good approximation. Research from Ellis (1999) [8] showed that the BMI, especially with adolescents, is not correlating well with the fat percentage. In order to compensate this and thus minimize the false negatives, the youth health care in the Netherlands came up with 'the clinical eye'.[8] This 'clinical eye' means basically that the knowledge and experience of the professional is used to decide what the diagnostic of the child is. The professional should use four types of criteria when assessing, namely the child's physique, ethnicity, puberty and fat distribution. These criteria are important because a child could for example have a high BMI without being overweight, caused by short legs, a muscled body of for example a broadly build body. Children in puberty can also experience a physiological grow spurt which then leads to a lower BMI than expected. As for the ethnicity it shows that the origin has influence on the physique and therefore the BMI. For healthcare professionals it is therefore important to keep an eye on the child his growing curves. In practice a lightly increasing BMI is much less alarming than a rapid increasing BMI for example.[8, 10] The professional needs to use all four criteria in order to make measuring overweight and obesity more explicit, which in the daily practice seems to be well applicable. [8]

2.1.3 Prevalence

Adults

In the Netherlands, over 50% of the population is overweight or obese which means their Body Mass Index is 25 kg/m^2 or higher. From those overweight people 14% is obese. Between 1991 and 2001 there was a growing number of overweight or obese people but the last years it seems to be stabilized.[8] This is shown in Table 3.

Table 3; Overweight and obesity percentage (20 years and older) based on the 'Permanent Onderzoek Leefsituatie' of the CBS (self-reported data) (translated table) [8]

Year	**1981** (%)	**1991** (%)	**2001** (%)	**2004** (%)	**2005** (%)	**2006** (%)
Overweight en obesity *(BMI ≥ 25 kg/m2)*						
Men	37,1	39,3	50,0	51,1	50,4	51,1
Women	29,6	31,1	39,6	41,9	39,6	41,9
Obesity *(BMI ≥ 30 kg/m2)*						
Men	4,0	5,0	8,3	9,6	9,9	9,8
Women	6,2	6,6	10,3	12,1	11,4	12,7

Because Table 3 is made of self-reported data it has to be taken into account that this could not always be correct, according to Visscher et al. (2006)[8]. Visscher found a difference of 6% in the prevalence of overweight between the measured and self-reported data. The overweight prevalence was higher when the measured data was used which in case of obesity was 3%.[8]

Children

From before 1980 here is no prevalence data of children which uses the international BMI criteria. Between 1980 and 1997 the percentage of overweight children has been more than doubled. Recent numbers of 4-15 year olds show that the overweight and obesity prevalence after 1997 increased even further. According to Van den Hurk (2008)[8] the average prevalence of girls in that age increased from 11.4% in 1997 to 16.8% in 2002-2004. For boys it went from 8.0% to 13.6% since 1997. When observing obese children those numbers went for girls from 0.5% in 1980 to 3.3% in 2002-2004. And for boys it went from 0.2% in 1980 to 2.6% in 2002-2004. But it has to be taken into account that the diagnosing of overweight and obesity was done with different methods so these numbers could be incomparable.[8]

Predicting overweight from childhood to adulthood

Being overweight as a child gives a relatively higher chance of having overweight as an adult. This chance increases with the age of the child and is called 'tracking'. According to Whitacker (1997)[8] people have a 70% chance of being obese as an adult if they were obese as a child. For adolescents this percentage is 80%. Different researches showed that being overweight at an age of 6 or 7 is quite a good predictor of overweight after puberty. [8]

2.1.4 Morbidity

Adults

Being overweight or obese gives higher risks on diseases. Common diseases are cardiovascular diseases, various types of cancer, biliary disease, osteoarthritis, respiratory problems, gout, infertility, menstrual disorders and fetal defects. As the overweight increases, the risk of these diseases will also increase but there will also be an increased mortality risk. Peeters et al (2003)[8] concluded that obese people will lose seven years of their lives because of the overweight in comparison to people with normal weight. Flegal et al. (2005)[8] showed that the increased mortality was true for obesity but that overweight wasn't associated with this increase. On the other side, Adams et al. (2006)[8] showed with over 40.000 man and almost 200.000 women that even moderate overweight most certainly increased the risk of mortality. Besides the mortality and the physical aspect, an important problem of overweight and obesity is the psychological and social problems that it brings. Mostly these problems can be ascribed to discrimination and stigmatizing of overweight and obese people and to the related low self-esteem. All these problems combined will result, when looking at the financial aspect, to more incapacity to work and an increase in healthcare costs. [8]

In a research done by Bogers (2006)[8] it was shown that people with moderate overweight are associated with an increased risk of death by cardiovascular diseases. And besides directly focusing on the decreasing life years, a large-scale Finnish research by Visscher et al (2004)[8] found that people with obesity go through more unhealthy life years, besides the shortened life years. These unhealthy life years were defined as suffering from cardiovascular diseases, using medicine for chronic diseases or disabled to work. For warning people about overweight pointing at the unhealthy life years would then be the best way to do it. [8]

Children

With children, overweight but especially obesity is accompanied with risks on multiple serious complications like diabetes mellitus type 2, hypertension, increased cholesterol and musculoskeletal and respiratory complaints. Especially diabetes mellitus type 2 is at young age concerning because it comes together with cardiovascular diseases, eye-, kidney- and nerve conditions. But also with NAFLD, which is the non-alcoholic-fatty-liver disease (Hannon 2005, Mager 2006)[8]. These problems come with increased mortality and less quality of life. Besides the physical problems there are also the mental problems as overweight or obese children often have a negative self-image and experience social problems. [8]

2.1.5 Determinants of overweight

Adults

Increase of weight arises through a, mostly subtle, imbalance in the energy balance caused by genetic, biologic and environment factors (Parsons 1999)[8]. Obesity occurs often in families which can be explained by these factors as families share habits, live in the same environment and share genetic information. Therefore children with obese parents have more chance of becoming overweight. The environment and individual behavior are seen as the most important factors of overweight and obesity because human DNA has not changed that much over the years. At the moment there is scientific evidence that a sedentary lifestyle with high energy and micronutrient poor food promotes weight increase leading to overweight and obesity. On the other side is proven that regular physical activity and a high fiber intake reduce the risk of overweight. [8] In Table 4 is shown how convincing the evidence is for certain activities and if it is decreasing or increasing the risk on increasing weight.

Table 4; Summary of evidence based factors that increase the risk of increasing weight and increasing or decreasing obesity (WHO 2003 translated table). [8]

Evidence	Decrease risk	Increase risk
Convincing	* Regular physical activity * High intake of fiber foods	* Sedetary lifestyle * High intake of food with high energy density and low micronutrients
Probably	* Families and schools that promote health food * Breastfeeding	* Intensitve marketing for energie density food and fastfood * High intake of drinks with a high sugar level * Unfavorable social economic circumstances
Possible	* Food with a low glycemic index	* Large portions * Eating outdoor
Insufficient	* Increase meal times	* High intake alcoholic drinks

Environmental factors

Environmental factors are crucial as determent of food and physicalactivity. The environment can be divided in a physical, social, economic and political environment. In the physical environment can be thought of playgrounds and similar things. Socially can be thought of how people are influenced by other people. What will people think when others are dieting? Economically can be thought of the price paid to eat healthy compared to the price of junk food for example. And for the political aspect the role of the government in living a healthy lifestyle is of importance. [8]

Outcome measures

Adults

In the Netherlands treatment exists of following the guideline 'Goede voeding' (Gezondheidsraad 2007) and the norm: 'Nederlandse Norm Gezond Bewegen'. These guidelines are evidence based and include all Dutch people. Treating obesity is influencing the body weight by downsizing the energy intake and increasing the energy consumption. According to earlier international guidelines (National Institutes of Health 1989) and the 'Gezondheidsraad (2003)' a weight loss of 10-15% will be seen as a successful treatment for people with obesity. In the United Kingdom the 2006 NICE-guideline called a weight loss of 5% clinical relevant. [8]

The following classification is proposed by the Dutch Institute for Healthcare Improvement CBO in 2008: [8]

- Weight loss and conservation 0 - 4.9%: limited successful*
- Weight loss and conservation 5 - 9.9%: moderate successful
- Weight loss and conservation 10 - 14.9%: successful
- Weight loss and conservation ≥ 15%; very successful

* With limited successful is meant that when someone with obesity accomplishes to exercise more and eat healthier while weight loss is just limited there are favorable changes and therefore can be spoken of clinical relevance. For example decrease of the waist circumference, increase of physical fitness or lower cardiovascular risks. Here is spoken of weight loss achieved on short term (one year after initial therapy) and kept on the long term (at least 4 years). It is also important that these are individual results. For example, a treatment with an average weight loss of 4% can give individual patients different levels of success. [8]

Children

Because children are still growing, weight loss is not always necessary. If a child can achieve to keep the same weight while growing in height, then the BMI will lower. Losing weight also can counter the growth of a child which makes it's important to let a professional do the treatment. [8]

Prevention

Because of the increasing prevalence, the increased risk of morbidity associated with overweight and the absence of effective prevention, the expectation is that in the future overweight and obesity will be a strong growing and costly healthcare problem. During the whole lifecycle, attention is needed towards prevention and treatment of overweight and obesity, because changing and maintaining health is not easy in an environment where food is readily easy to get and the need to exercise is almost disappeared. [8]

Social impacts and measures

The increasing prevalence of overweight and obesity leads beside disease and decrease of quality of life also to increased expenses in healthcare, increase in medically incapacity and absence of work. When there will be no intervention, the number of adults over the age of 20 years with moderate overweight will increase to 5,5 million (41%) and with obesity to 2,5 million (18%). The consequence will be that in the year 2024 the total mortality will be increased with 1% and the prevalence of cardiovascular will be 1.8% to 4.3% higher. The prevalence of diabetes mellitus type 2 will even be increased with 40%. [8] At this moment 10% of the overall disease burden in DALY's (disability-adjusted life year) is due to overweight of which prevalence of diabetes mellitus type 2 is not even taken in account. The medical costs for treatment of the consequences of overweight can be divided in direct and indirect costs. The ratio between direct and indirect is roughly said 1:4. In the Netherlands for serious overweight, the costs are respectively €500 million and €2 billion (VTV-rapport 2006)[8]. In the future this amount will increase and an effective intervention is needed to stop this increase. All together makes prevention and treatment of overweight and obesity of great social and economic importance and needs to be continued lifelong. [8]

2.2 Diagnostics in healthcare

2.2.1 Adults

In the conclusion of paragraph 2.1.2 was stated that the BMI is an excellent predictor on population level for increased risk of chronic conditions and increased mortality. In order to diagnose overweight and obesity in practice, the BMI is a useful tool which can be extended by measuring the waist circumference and risk factors for cardiovascular diseases and diabetes mellitus type 2. In the guideline 'Diagnostiek en behandeling van obesitas bij volwassenen en kinderen (2008)'[8] was stated that the diagnosing will be limited by these tools. According to evidence it is enough to only use the BMI to diagnose obesity. A consensus panel in the United States (Klein 2007)[8] showed that adding the waist circumference to the diagnostics adds little to the criteria of the BMI. That is because most people with obesity have a large

waist circumference anyway. It could be found useful in case of dyslipidemia or hyperglycemia, but that is not of any importance for this research. What is important and also found in this research, is that using the waist circumference is useful for evaluation of the effect of the intervention. Because when people are more physical active the BMI may stay unchanged, but abdominal fat may be exchanged for muscle tissue. This is not noticeable in the BMI, but is certainly important as it will lower the risk of getting cardiovascular diseases and diabetes mellitus type 2. [8]

In the Dutch healthcare, screening the population on overweight and obesity is not applicable. This is also supported by Wilson and McAlpine (2006)[8] who determined that screening of all adults is not useful in the first line practice. Therefore diagnosing overweight and obesity will be done when opportunities occur. For example when patients have a question about it, have related disorders or when a general practitioner makes an estimation.[8]

2.2.2 Children

In the Netherlands, 95% of the children get a routine check from the child health care. In the first four life years this is frequently, but after that it decreases. In most cases an overweight or obese child will be diagnosed by a worker from child health care. [8]

2.3 Treatment of obesity

In this part of the literature study an overview will be given of the different ways to treat overweight and obesity. Literature studies on diets, physical activity, psychological interventions and combined lifestyle interventions will be discussed. For this serious game will almost solely be focused on the physical activity because this is the best method to use for this short-term assignment and the limitations of knowledge and experience. Diets for example are quit comprehensive and patients are in need of a long-term treatment lead by a professional. For that reason only a small amount of information about diets is given.

2.3.1 Diet

General

According to the CBO (Centraal Begeleidings Orgaan) (2008)[8], a treatment is successful when a weight loss of 5 - 15% or a decreased waist circumference of 10% is achieved. There are two sides of a diet intervention of which one is the weight loss itself. The other side is that the diet should lead to permanent improvement of the eating habits and additional lifestyle so that relapse is prevented as much as possible. By this is meant an optimal level of physical activity and behavior. A secondary goal of diet intervention is a real improvement in health, fitness and wellbeing.[8] In Table 5 are some main types of diets given, recognized by the CBO (2008):

Table 5; Overview of diets (CBO 2008) (translated table) [8]

Name diet	Calories/day	Other features	Examples	Other
Energy-restrict diet	600 calories less than usual intake	Restriction of carbohydrates (40-50 energy percent) fat (25-30 energy percent) and alcohol	Is the common energy-restricted diet in the Netherlands	In the Netherlands based on the guideline 'Goede Voeding'
Calorific Diet (LCD)	1.000-1.200 calories (4,2-5,0 MJ)	Diet with meal replacements	Different manufacturers bring shakes, bars and meal-replacements on the market	Variant: diet with two meal replacements and one warm meal

Low-fat Diet	Variable: only restriction on fat	10-25 energy percent fat	Ornish, Zone	No restriction on carbohydrates and alcohol
Very calorific	400-800 calories (1,6-3,4 MJ)	Based on meal replacements: high protein, low carbohydrate, very low fat	Modifast	Amounts about half of the basal metabolism
High protein, low-carbohydrate diet	Less than 1.600 calories (6,7MJ)	20 energy percent protein, <40 gram carbohydrate	Atkins, South Beach, Montignac	Used in researches with meal replacements

In the guideline 'Diagnostiek en behandeling van obesitas' were the following conclusions drawn:[8]

- An energy limited diet with a caloric value of 600 kilocalories (2.5 MJ) lower than de usual daily intake can lead to a weight loss of 300-500 gram a week. In a year the average lies around 5 kg weight loss and applies on man and women with a BMI of 28 kg/m² to 40 kg/m² (Anderson 2001, Avenell 2004 and NICE guideline of 2005)[8].
- After four to five years of following an energy restricted diet, a weight loss of 3.5 kg is maintained. If the weight maintenance is more than 20kg, then after four to five years the weight loss is still 7 kg. This applies for energy restricted and very calorific diets and applies on man and women with a BMI of 28 kg/m² to 40 kg/m² (Anderson 2001, Avanell 2004)[8].
- It was shown that using a very calorific diet in comparison to an energy restricted diet achieves more weight loss, but the outfall of this diet is 50%. This wasn't just for the very calorific diet but also applies on other extreme diets. With the energy restricted diet the outfall was between 20% and 30%. (Anderson 2001, Dansinger, 2005)[8].
- Although the diets from table 5 lead to more weight loss on the short term comparing to the energy restricted diet, this difference will be gone in about 60 months (Anderson 2001, Astrup 2002, Avenell 2004, Pirozzo 2002/2006, Nordmann 2006) [8].
- The number of consults in a treatment is more important than the weight goal or the duration of the treatment. (Anderson 2004, Dansinger 2005, Lantz 2003)[8]
- 59% of the people who did lose 10% or more of their weight are able to restrict their relapse with circa 2kg in 24 months (Phelan 2003)[8]

Outfall

Many diets are only successful on the short term and lead also to outfall (people who quit their treatment). According to the CBO (2008)[8] the outfall results percentages of different diets are: after four to five years 55.4% sustained a very-low-caloric diet. For an energy-restricted diet this was 79.9%. The Atkins diet leads after a year to 47% of outfall and a strong-fat-restricted diet with 10% fat (Ornish)[8] gives 50% outfall. The Weight Watchers-diet and a diet based on glycemic index lead to 35.5% outfall. [8]

Weight control

After the diet intervention comes the weight control phase. Can people stay in the weight class they are in at the moment or will they fall back. According to research weight control is doable for big groups of people, but almost always there will be a small weight increase. In a research by Phelan (2003)[8] 2400 people were researched. They lost an average 32.1 ± 17.8 kg and kept this weight during 6.5 ± 8.1 years. 96.4% of the total group remained 10% under their maximum weight and the average weight loss was 26.6 ± 10.7%. 80% of them were women and 20% were men. In the research of Ryttig (1997)[8] was shown that a very-low-caloric diet which after 12 weeks was converted to an energy-restricted diet with 1.600 kcal including two meal replacements was more effective in weight control than an normal energy-restricted diet. [8]

Other considerations

Energy need

The energy need of a person is for 75% decided by the basal metabolic rate (BMR). The total energy need consists of the basal metabolic rate multiplied with the induced thermo genesis of the diet and the physical activity level (PAL) value. The PAL-value is always somewhere between 5 and 15% of the basal metabolism. After being on a diet the basal metabolism decreases in comparison to the start. That is one of the reasons weight increase occurs after ending a diet, because the body gets used to the reduced amount of energy it got with the diet but is now given more. 15.3% of the people of a meta-analysis group, who had been obese and had achieved a normal weight, have a lower basal metabolism. Of the control group 3.3% had a lowered basal metabolism (Astrup 1999)[8]. A calorie-restricted diet leads to a decrease of basal metabolism after a year compared to no diet or activity program (Frey-Hewitt 1990). [8]

Costs

The costs of a diet are often an obstacle for people with low income. In the Netherlands a dietary intervention with a dietician costs around 250 euro a year. This provision however is included in the basic health insurance.[8]

2.3.2 Physical activity

General

In the previous chapter is discussed that dieting is a way to lose weight and become healthier. Another way to become healthier or maintaining healthy is by being physically active. This can stand alone but is often used in combination with a diet or combined with dieting and psychological interventions. This last option is called combined lifestyle interventions and will be discussed short after. In this literature part the importance of physical activity will be discussed, how the physical activity nationwide is in the Netherlands, which effects it has on the health and what is recommended.

Physical activity in the Netherlands

For years the Dutch government is active in stimulating the Dutch population in becoming more physical active. There are projects like 'Tijd voor Sport, Bewegen, Meedoen, Presteren' and 'Nationaal Actieplan Sport en Bewegen' which all have the goal to increase physical activity among the Dutch population. This is done with view on a more healthy and vital population so the costs of healthcare will decrease and the productivity will increase. According to Harbers et al. (2008)[11] the Netherlands have relatively favorable numbers on physical activity and overweight compared to the rest of Europe. To monitor the sport and exercise policy the TNO developed the 'Monitor Bewegen en Gezondheid' which will measure continually the exercise behavior of the Dutch population compared to the health norm. This health norm consists of the 'Nederlandse Norm Gezond Bewegen (NNGB)' which defines the minimum level of activity to gain health profit and the 'Fitnorm' which gives the level which is needed to maintain the cardiovascular condition. [11]

To get an overview of the physical activity in the Netherlands 'TNO Monitor Bewegen en Gezondheid' questioned in 2000-2005 over 8000 Dutch people a year about their activity and from 2006-2009 they questioned over 2000 people a year. The outcome of these questionnaires led to different tables showing if the NNGB, fitnorm or combi-norm is achieved during the year.[11]

Nederlandse Norm Gezond Bewegen (NNGB)

The 'NNGB' is achieved when someone is at least 30 minutes moderately strenuous physical active for five days a week. The percentages of adults that meet this criterion are shown in Table 6 with the added 95% confidence intervals.[11]

Table 6; Percentage adults (18 years or older) that meet the NNGB (2000-2009) and the 95% confidence intervals (CI) (Trendrapport Bewegen en Gezondheid 2008-2009, translated table). [11]

Years	% norm-active	CI
2000	44,2	43,1 - 45,3
2001	43,6	42,5 - 44,6
2002	44,1	43,0 - 45,2
2003	47,4	46,3 - 48,5
2004	50,7	49,6 - 51,7
2005	56,1	55,0 - 57,1
2006	59,5	56,9 - 62,0
2007	58,7	56,1 - 61,3
2008	60,3	57,8 - 62,7
2009	60,9	58,2 - 63,6

The tables show that over the years the activity among Dutch people is increasing. Especially between 2002 and 2006, while the last four years this growth is stabilizing.

Fitnorm

The 'fitnorm' means that someone has to be strenuous active in their free time for at least 20 minutes for three days a week. The percentages of adults that meet this criterion are shown in Table 7 with the added 95% confidence intervals.[11]

Table 7; Percentage adults (18 years or older) that meet the 'fitnorm' (2000-2009) and the 95% confidence intervals (CI) (Trendrapport Bewegen en Gezondheid 2008-2009, translated table). [11]

Years	% fitnorm-active	CI
2000	18,8	18,0 - 19,7
2001	19,4	18,5 - 20,3
2002	20,1	19,2 - 21,0
2003	21,2	20,3 - 22,1
2004	23,9	23,0 - 24,8
2005	22,4	21,5 - 23,2
2006	20,0	18,0 - 22,2
2007	16,3	14,4 - 18,3
2008	20,8	18,8 - 22,9
2009	23,5	21,2 - 25,9

In the years 200-2004 the Dutch population that meet the 'fitnorm' is gradually increasing, but after that there is a slightly decrease till 2007 after which it started increasing again.

Combinorm

The 'combinorm' shows the distribution of het percentage Dutch adults that meet the 'NNGB' and/or the 'fitnorm'. This distribution together with the 95% confidence intervals is shown in Table 8. [11]

Table 8; Percentage adults (18 years or older) that meet the 'combinorm' (2000-2009) and the 95% confidence intervals (CI) (Trendrapport Bewegen en Gezondheid 2008-2009, translated table). [11]

Years	% combinorm-active	CI
2000	52,1	51,0 - 53,2
2001	51,4	50,3 - 52,5
2002	52,1	51,0 - 53,2
2003	55,1	54,0 - 56,2
2004	59,6	58,5 - 60,7
2005	63,1	62,1 - 64,1
2006	67,7	65,2 - 70,1
2007	64,0	61,4 - 66,5
2008	67,9	65,5 - 70,2
2009	68,2	65,6 - 70,7

Being a combination of the 'NNGB' and 'fitnorm' this table gives the same trend line as described in the past two tables. It should be noted that in the summer more people meet the 'NNGB', 'fitnorm' and 'combinorm' than in the winter.

Summarizing the three norms over the years and plotted in a graph gives Figure 1. The rising but flattening tendencies are clearly visible here.

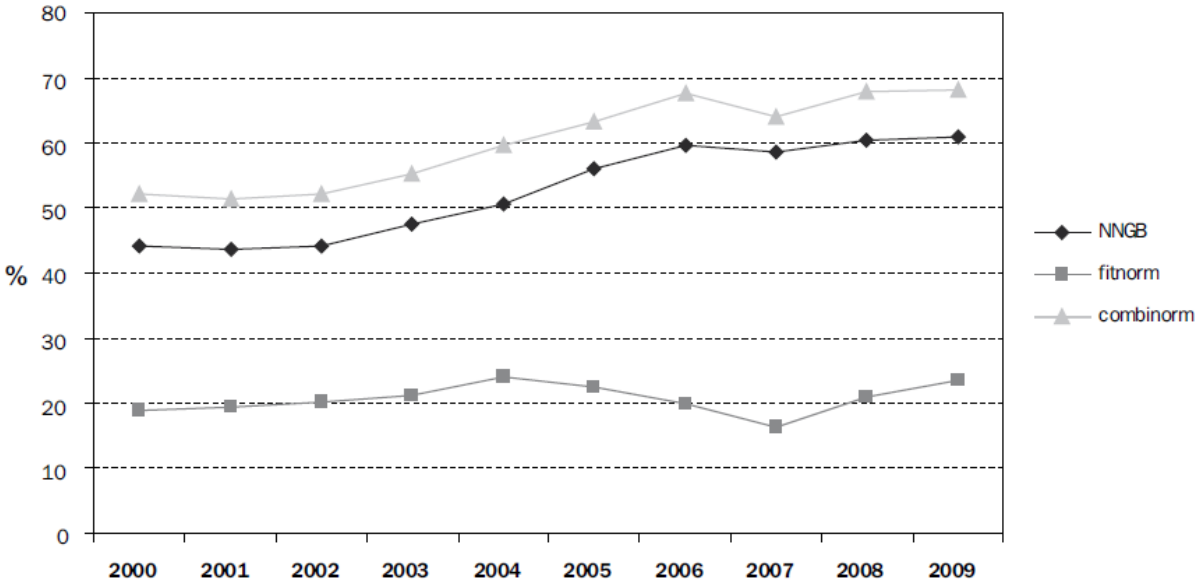


Figure 1; Percentage adults (18 years or older) that meet the NNGB, 'fitnorm' and 'combinorm' (2000-2009) (Trendrapport Bewegen en Gezondheid 2008-2009, translated table). [11]

There has also been research into the activity pattern in the daily life of the Dutch population. The results are given in Table 9 and are divided in type and intensity of the activities.

Table 9; Physical activity pattern of the Dutch adult population: average time in minutes a day per defined activity (200-2009) (Trendrapport Bewegen en Gezondheid 2008-2009, translated table). [11]

	Work/ school	Travel (home - work/ school)	Household chores	Gardening/ tasks	Sport	Cycling	Walking	Other activities	Total*
Light/moderate/heavy									
2000-2001	57	5	41	18	9	9	22	8	169
2002-2003	56	4	41	20	12	10	24	10	177
2004-2005	56	5	39	24	12	11	26	10	183
2006-2007	63	5	46	20	9	11	24	6	184
2008-2009	56	4	48	20	9	11	24	6	178
Moderate/heavy									
2000-2001	35	3	23	13	7	6	11	4	102
2002-2003	34	2	23	14	10	7	12	6	108
2004-2005	34	3	21	17	10	8	14	6	113
2006-2007	43	4	25	14	7	8	11	3	115
2008-2009	41	3	25	13	7	8	13	3	113
Heavy									
2000-2001	11	1	6	5	5	2	2	1	33
2002-2003	11	1	6	6	6	2	2	1	35
2004-2005	11	1	6	7	6	2	2	1	36
2006-2007	12	1	5	5	4	2	2	2	33
2008-2009	10	1	6	4	4	2	2	1	30

* Because of rounding the totals cannot be summed exactly to 100.

Dutch people who are not norm-active, which does not mean they are completely not active, are still in three-quarter of the time positive minded about physical activity and two-third finds it enjoyable to be physically active. Inactive people are less positive about physical activity and the majority does not enjoy it. In both groups is noted that the environment is not physical active or very stimulating to be physical active. Almost half of the people that do not meet the 'combi-norm' feel like being able to be more physically active if the stimulus is there. In the group of inactive people this is just one-fifth to a quarter. [11]

The activity among the Dutch population increased the past years which is a positive development, but in the past years (2007-2009) this trend line is flattening. In order to keep this activity pattern increasing a significant effort has to be made. It seems appropriate to aim this effort at the groups that fell behind. This can be elderly people, unemployed people, foreigners, chronically ill people, people with poor movement tasks and overweight people. Observing Table 9 shows it's wise to pay attention to the most important sources for everyday activities like work/school and the household. Especially work, with the increasing automation, computerization and comfort stimulation has to be paid attention to prevent a decrease in physical activity. In particular work with poor movement tasks like policy- and administrative functions. According to Jans et al. (2007)[11] these people are struggling to compensate this sedentary lifestyle with more active leisure. But also physical household tasks are important because according to Stamataksis et al. (2009)[11] this can decrease the risk of premature deaths. And what in this research is important is to stimulate people with overweight to become more physically active. [11]

The above stated results of the physical activity among the Dutch population do not show the amount of fluctuation in the movement participation in the past decennia (Abe01, Bre03, Hil99a, Ooij02, Poe98)[12]. However, other evidence shows that inactivity most certainly increased instead of decreased. The trend reports have the disadvantage of using questionnaires based on the more intensive physical activities like sports. Daily physical activities like stated in Table 9 aren't registered in the 'NNGB', 'fitnorm' and 'combinorm' tables. Indications for increased inactivity among people are the modern form of leisure, like

the increased average time people spend a day watching television. Also the mechanization and automation of work and transport, which results in a sedentary lifestyle increased. As for the youth, the time children play outside decreased with the years. Watching television and playing on the computer became more important and received more leisure time. Longitudinal research (Amsterdamse Groei- en Gezondheidsonderzoek[12]) showed that the highest decrease in physical activity occurs in the teenage period. Between the age of 13 and 17 years the energy balance decreased with 42% and 17% for respectively boys and girls. This decrease is not caused by less sport, but by less activity in and around the house. The activity pattern does not change after that and remains low. When these teenagers become independent they often get a more sedentary lifestyle and therefore a more inactive lifestyle. [12]

Metabolic Equivalent (MET)

In order to lose weight the energy consumption has to be less than the energy expenditure. Everyday exercises can help burning energy and according to Ooijendijk (2002)[8] these exercises are very important because sport only contributes to 5% of the total energy expenditure. To label everyday exercises in terms of energy expenditure the 'Metabolic Equivalent (MET)' is conceived which gives these exercises a value. Measuring in calories means that 1 MET equals about 1 kcal/kg/h (kilocalories per kilogram bodyweight per hour) (Fletcher 2001)[8]. But keep in mind that this is average because people differ from each other (Byrne 2005)[8]. To give an example of how MET can be used for counting burned calories can be thought of someone who weighs 70 kg. If he exercises moderately intensive for about half an hour with 5 MET five times a week, he will burn about 875 kcal a week. Walking 6km/h is about 3 MET and jogging with 10 km/h is about 10 MET. MET values for different types of activities are given in table 6. Jogging three times a week for half an hour gives about 1.050 kcal per week on calorie-loss. [8] In Table 10 is shown with which activity what metabolic equivalency is reached.

Table 10; Energy consumption in MET with different activities (Ainsworth et al. 2000, Fletcher 2001) (translated table) [8]

Activity	MET
Billiards	2,5
Watering plants	2,5
Household	3,5
Gardening	4,4
Walking (6 km/h)	5,0
Aerobics or ballet dancing	6,0
Skiing (alpine)	6,8
Jogging (10 km/h)	10,0
Squashing	12,1

Advantages of physical activity for overweight and obese people

In this literature research it was stated before that being obese results in a higher risk on diseases. To give another overview of health risks to which obese adults are exposed Table 11 is set up. The strength of correlation between obesity and the noted disease is given by the relative risk ratios (RR). The other column containing the population attributive risks (PAR) shows the percentage of other diseases which could occur due to obesity. [13] In Table 11 is shown what the estimated risk on diseases is for the obese population.

Table 11; Estimated disease risk for the obese adult population, taken from international studies (The prevention and treatment of overweight and obesity. Summary of the advisory report by the Health Council of the Netherlands) [13]

	WOMEN PREVALENCE 9.6 %		MEN PREVALENCE 8.5 %	
	RR	PAR (%)	RR	PAR (%)
Type 2 diabetes mellitus	12.7	52.9	5.2	26.3
Hypertension	4.2	23.5	2.6	12.0
Myocardial infarction	3.2	17.4	1.5	4.1
Cancer of the colon	2.7	14.0	3.0	14.5
Angina pectoris	1.8	7.1	1.8	6.4
Gall-bladder diseases	1.8	7.1	1.8	6.4
Ovarian cancer	1.7	6.3	-	-
Osteoarthritis	1.4	3.7	1.9	7.1
Stroke	1.3	2.8	1.3	2.5

Table 11 shows the severity of diabetes mellitus type 2, which in this table shows the highest RRs and PARs for both sexes. But the risk on all of these diseases can be lowered when people with overweight and obesity lose weight. Physical activity is one way to increase the expenditure of energy and thus help restoring the balance between energy consumption and expenditure. And when the expenditure dominates people lose weight. So has being moderately intensive active preventive effects on chronic diseases as cardiovascular diseases, COPD and diabetes mellitus type 2 and shows that those people have three to five times less chance on those diseases than inactive people. It also helps losing weight and lowers the blood pressure (Bassuk and Manso 2005, Bouchard et al. 2006, Bijnen et al. 1994, Pate 1995, VWS 2001, Coumans 2001)[8, 13, 14] Physical activity also increases the HDL-cholesterol amount in the blood, lowers the heartbeat, platelet aggregation and triacyl glycerol amount in the blood and it improves the insulin sensibility. [15] Besides that is has also some positive general effects which is of great importance, and that is the increased energy, improved sleep and enhanced mobility that a person is experiencing. [14] International guidelines show that even a relatively small weight loss produce significant health gains and that therefore the primary aim of obesity treatment should be achieving a long-lasting weight loss of about 10% of the total weight. [13]

Prevention and treatment of overweight and obesity

Some examples are just given of national projects in order to increase physical activity among the Dutch population. The 'NNGB', 'fitnorm' and 'combinorm' are of great importance to help people with overweight and obesity. Kemper (2004)[8] advises, just like the NNGB, at least 30 minutes of moderately intensive exercise a day for five days a week, but for overweight and obese people this should be at least 60 minutes a day (Gezondheidsraad 2006)[8]. Fletcher (2001)[8] supports this last advice and adds that the intensity load must consist of 55-70% of the maximum heart frequency. These daily exercises are very important because as stated before sports only contribute to 5% of the total energy consumption (Ooijendijk 2002)[8] According to the clinical review 'Management of overweight and obese adults'[14] daily exercises of moderate intensity are more important in order to prevent the increase of weight than very high intensive exercises which leads to exertion. Activities of moderate degree of exertion are nonetheless useful for sustaining for longer periods of time. This results in a relatively high degree of fat oxidation over time and an increasing energy expenditure by activities that are weight-bearing. People that are obese have the same energy expenditure as non-obese people but have to be less physical active. In this clinical review they refer to the Dutch standard for healthy levels of exercise. This means for overweight and obese people a daily moderate exertion of 60 minutes for at least five days a week. And

for obese people even 90 minutes if possible. These exercises are also possible sufficient to keep people that are moderately overweight from becoming obese.[14] According to the guideline 'goede voeding 2006' these activities should be 4 to 6,5 times the resting metabolic (4-6,5 MET). Examples of activities that apply are brisk walking with 5 km/h, cycling (16 km/h) or for example gardening. But this is in general for the population not enough to prohibit overweight, says the advice 'Overgewicht en obesitas'. According to this advice it ten should be at least one hour a day of moderately strenuous activity. Physical activity should become built in into the daily life like taking the stares or be physically active after work. Also was given that sports could stimulate this behavior and so prevent a positive energy balance. [15]

When counseling and supporting obese and overweight patients the clinical review 'management of overweight and obese adults' have set up a list with recommendations. In this assignment there is no counseling for patients but supporting behavior that has to do with being physical active is of importance. The list of recommendations is given in Table 12.

Table 12; Specific recommendations for counseling and supporting obese and overweight patients (clinical review 'management of overweight and obese adults'). [14]

Box 2: Specific recommendations for counselling and supporting obese and overweight patients

- Educate patients about the hazards of obesity and the overall health benefits of modest weight loss (5-10% of body weight)
- Assess readiness to change with the following questions[27]:
  Are you currently involved in any effort to lose weight?
  (If not currently involved in any effort to lose weight) Are you considering trying to lose weight?
  Have you made any attempts to lose weight? If so, what happened?
- For patients who are ready to change, help patients set realistic goals for change in behaviour
- Emphasise gradual change in behaviour over time
- Encourage patients to give up the short term "diet mentality" and stress the need for long term lifestyle change
- Recommend increased physical activity, both planned exercise (for example, walking 30 minutes three times a week) and incorporating activity into daily routine (for example, using stairs instead of lifts or escalators)
- Recommend some level of caloric restriction
- Provide self help materials or referrals
- Help patients overcome barriers (see box B on bmj.com)
- Acknowledge the difficulty of losing weight, given the easy availability and widespread marketing of large amounts of high fat, high caloric food, but emphasise that behavioural change is possible
- Praise success in changing behaviour as well as in losing weight
- Be aware of professional cynicism and prejudice against obese individuals that might compromise support for patients and disrupt their efforts at changing their lifestyle

Conclusions gathered from research

- For healthy inactive people who exercise at least 30 minutes 3 times a week, with a follow up of 3-12 months, it shows that it's more effective than no treatment to lose weight (Shaw 2006, NICE 2006)[8].
- Three different researches show that doing exercises give a weight loss of 3.1 kg after 12 months for healthy inactive people (Wood 1988, Anderson 1996, Prichard 1997)[8].

- Following a diet is after 12 months more effective than exercise moderately intensive for at least 30 minutes three times a week.
- Three different researches show that the diet (previous point) has an advantage of 3.3 kg more weight loss after 12 months (Wood 1988, Anderssen 1996, Pritchard 1997)[16]. Two researches showed no difference between training and diet (CBO 2008). [16]
- 12 months of moderately intensive exercising for at least 60 minutes three times a week showed to be more effective than just stimulating an active lifestyle with a difference of 2,4 kg in advance of the exercise group (Messier 2004)[8].
- Exercising plus dieting versus only dieting is much more effective. According to NICE (2006)[8] the difference is after a 12 months treatment about 2,0 kg and after 18 months 7,6 kg in advance of the exercise plus diet. [8]

Important facts to take into account in these conclusions is that only one research (Thong 2000)[8] included people with a BMI greater than 30 kg/m² (obesity). In the other researches there was minimum overweight. The persons used in these researches were also relatively healthy, so people with conditions like diabetes mellitus, cardiovascular conditions etc. need adjusted exercise programs supervised and guided by professionals. [8]

2.3.3 Psychological interventions

General

In different international guidelines, manuals and reviews, cognitive behavioral therapy is the only accredited psycho therapeutic intervention for treating obesity (Cooper 2003, NIH 1998, NICE 2006)[8]. Cognitive therapy is mainly changing the dysfunctional thoughts someone has. The idea is that someone gives a situation or happening a meaning which determines this person his behavior and feeling (Beck 1995). Not the situation or happening itself, but the interpretation is causing the feeling someone gets. This therapy tries in a systematic way to analyze and modify the different variables which influences the undesired eating behavior (Bosch 2004)[8]. For obesity, the most important cognitive behavioral therapeutic interventions are (NIH 1998) [8]:

- Self-monitoring the eating habits and physical activity. This can be done by using a eating or activity diary.
- Self-control measures: dealing in a different way with arising stimuli that triggers excessive eating.
- Cognitive restructuring: adjusting inadequate beliefs or unrealistic goals of weight loss, self-image or above called stimuli.
- Problem solving: dealing with difficult situations by pre-fabricated solutions. And by evaluating these solutions afterwards.
- Social support: the direct environment can stimulate the behavioral change.

Conclusions gathered from research

- A treatment using cognitive behavioral therapy combined with a diet is more efficient for losing weight than general weight consultation (Munsch 2003, Stahre 2005)[8].
- One research showed that a cognitive behavioral therapy combined with a diet is more effective than just information on improving the lifestyle.
- Active treatment interventions are more effective than self-help via written information (Cousins 1992, Wing 1998)[8].
- Interventions with partner support are more effective than individual treatment (Cousins et al. (1992)[8].
- Combining cognitive behavioral therapy and diet is more effective than only a diet or cognitive behavioral therapy (Wadden 1986, Wadden 1989, Jones 1986)[8].

2.3.4 Combined lifestyle interventions

General

A combined lifestyle is an intervention that includes diet, physical activity and behavioral change. In general it is assumed that combining these three is more effective for losing weight and morbidity than other interventions. There are not many researches that give a clear image of the effect of combined lifestyle interventions. The effect on obese people is insufficient demonstrated, hard to extrapolate to the population and therefore insufficient clear. Even when these people have morbidity it is not well demonstrated if there are any significant effects. [8]

Conclusions gathered from research

- In the NICE guideline of 2006[8] it was concluded out of six RCT's with obese people, which uses combined lifestyle interventions against a control group, that there was a weight difference of 4,2kg in 12 months in advance of the combined lifestyle intervention.
- Combined interventions with obese people compared to a control group show a weight reduction of 2.0 kg over 3 years (Norris 2006, NICE 2006)[8].
- Combined interventions with obese people compared to a group which was given written information showed a weight difference of 3.8 kg in advance of the combined intervention group (NICE 2006)[8].
- If the obese people in the previous point had morbidity then over 24 months there was no difference with the written information group (Wing 1998). [8]

3 Literature; Behavioral Change

3.1 Introduction

Becoming overweight or obese is often due to unhealthy lifestyles which makes managing the weight quite difficult. People these days have a more sedentary lifestyle which means they are less physical active. This is also work-related, because more and more people end up doing deskwork or other physical inactive work. Besides that, people their diet often include energy-dense foods which contain high-fats, concentrated-sugars and low-fibers.[17] To improve this lifestyle, following healthy diets and doing exercises are effective ways for losing weight, but much more important is changing the behavior. If people keep behaving the same way, dieting or exercising is only effective on the short-term. To understand how people behave and how that behavior can be changed, numerous theories and models have been created. Some of them were just guides to understand behavior while others were also used to develop interventions or applied in intervention research. In this chapter will some of the most important theories and models due to promote physical activity be shown.

3.2 Behavioral change theories and models

In order to change the inactive lifestyle of people with overweight or obesity there are multiple theories and models to achieve this. In this part the most common ones will be discussed with the intention to use this for the design of the serious game. The theories and models that are going to be discussed are the Transtheoretical Model, the Social Cognitive Theory, the Theory of Planned Behavior, the Theory of Meaning Behavior and the Health Belief Model.

3.2.1 Transtheoretical Model (TTM)

The Transtheoretical model, also called the stages of change, is often used in the health literature. It evaluates a person his readiness to act on a new behavior and guides the individual through the stages of change with additional strategies. Prochaska and Diclemente emerged the TTM out of the leading psychotherapy and behavior change theories by doing a comparative analysis. [18] After refining the model it now consists out of several major dimensions, namely the '*stages of change*' (central organizing construct of the TTM), '*processes of change*' (the transition between the stages of change by independent variables), '*decisional balance*' (balance sheet showing the pros and cons, depending on the stage) and '*self-efficacy*' (being confident in having the ability to change). [19]

Changes of stage

The Transtheoretical model describes how people intentionally change a problem behavior or acquires a positive behavior by focusing on the decisions made by the individual. It construes change through a series of five stages called the stages of change which will now be discussed. [19]

1. **Precontemplation**; in this stage are people who are not intending to change their behavior in the near future (approximately six months). The reason why they do not do any effort varies. They can be uninformed or under informed about what consequences their behavior bring or earlier attempts to behavioral change failed and they have given up hope. People who are in this stage are most often not suitable for traditional health programs as they still tend to avoid reading, talking or thinking about the high risks their behavior is bringing them. [19]
2. **Contemplation**; in this stage people are intending to change their behavior (approximately in six months). People in this stage are balancing the pros and cons of which they became more aware, but this can also result in a profound ambivalence which can keep people stuck in this stage for quite some time. That is why these people often are not ready for traditional action oriented programs. [19]
3. **Preparation**; in this stage people are intending to take action quite soon (next month). They have a plan of action in order to achieve behavioral change and most of these people already took

some serious significant actions in the past year. Examples of actions are consulting a dietician, buying a self-help book, joining health education classes etc. People who are in this stage are the ones that should be recruited for weight loss or exercise programs. [19]

4. **Action**; in this stage people have made changes in their life-styles in the past six months to improve their behavior. When the behavioral modification is proven to be sufficient in reducing the risks for disease it counts as an action. For example the consensus that of the consumed calories, only 30% or less may come from fat. Another critical thing is that people in the Action stage should be really aware of relapse, as people get mentally pressed. [19]
5. **Maintenance**; in this stage people are working on preventing relapse, while being more confident about continuing their change and therefore lowering the chance of relapse. Compared to the action stage, these people do not apply change processes as often. [19]

An oversight of these steps is shown in Figure 2. It shows how the temporal dimension is represented in the model. In the beginning this is conceptualized as behavioral intention but changes into duration of behavior after behavior change occurs. [19]

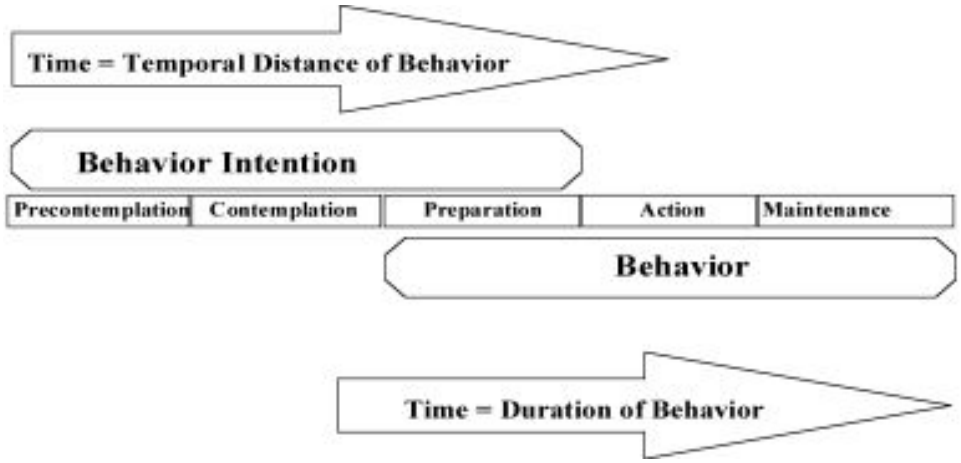


Figure 2; Temporal Dimension as the basis for the Stages of Change. [19]

Regression

In stage four there is spoken about being aware of relapse. But in fact regression can take place from any stage to an earlier stage. In the Action stage most people relapse when changing their health behavior problem, and sadly this tends to be the rule. But for exercising only 15% of the people will regress all the way to the precontemplation stage, while others regress to the contemplation or preparation stage. [19]

Intermediate/dependent measures: determining when change occurs

Most typical theories only have a single univariate outcome measure of success and therefore cannot measure through the stages of change. The TTM in contrast can measure through all stages by using a set of constructs and can so determine when change occurs. These constructs are the pros and cons, the decisional balance scale, self-efficacy or temptation and the target behavior. [19]

- **Decisional balance scale**; in this construct the pros and cons of changing are weighed by the individual. In the acquisition of healthy behaviors a pattern for exercising was illustrated showing the pros and cons over time. This is shown in Figure 3.The reason why the pros remain high over time can be related to the continuously decision making of maintaining the program of regular exercise. [19]

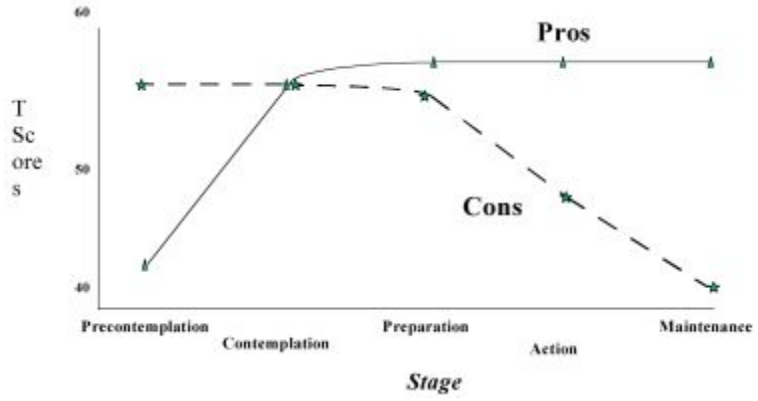


Figure 3; The relationship between the stage and the decisional balance for a healthy behavior. [19]

- **Self-efficacy/Temptations**; in this construct is represented how individuals cope with situations that have a high-risk on relapsing into their unhealthy or high-risk habit. This construct is represented by a temptation measure or a self-efficacy construct. The situational temptation measure shows in certain difficult situations how intense the urge of a specific behavior is. It is the converse of self-efficacy and can use the same set of items to measure, but in different response formats. Tempting situations that are most common are negative affect or emotional distress, positive social situations and craving. The measures of this construct are sensitive to change and therefore can be good predictors of relapse in future stages. In Figure 4 the temptation and self-efficacy is shown over time. It shows that the temptation over the stages will decrease and the self-efficacy will increase. [19]

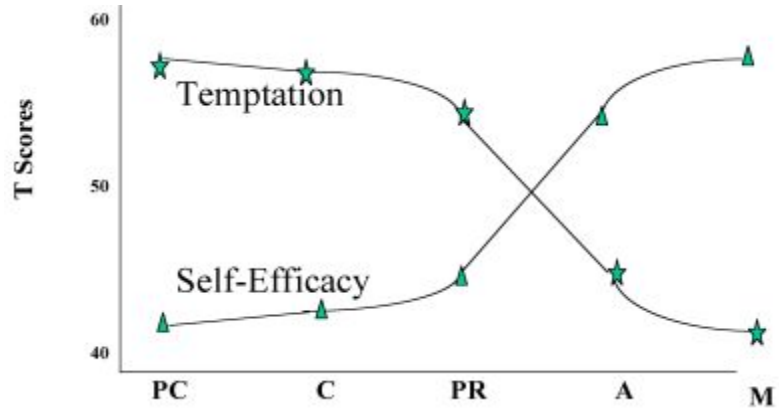


Figure 4; The relationship between the stage and both self-efficacy and temptation. [19]

Independent measures: how change occurs

Processes of change are the activities (covert of overt) used by people to progress through the stages. These processes are very important for intervention programs as they need it as a guidance to help people move to the next stage. There are ten processes used for guidance of which the first five are primarily for the early stage transitions (called Experiential Processes). The other five are primarily used for the later stage transitions (called Behavioral Processes). [19]

I. Processes of Change: Experiential [19]

1. **Consciousness raising** (Increasing awareness); people are more aware of the causes, consequences and cures for their problem behavior. As for interventions, feedback, education, interpretation, biotherapy and media campaigns can increase awareness. [19]

2. **Dramatic relief** (Emotional arousal); people get more emotional when confronted which is reduced when appropriate action is taken. Techniques to move people emotionally are psychodrama, role playing, grieving etc. [19]
3. **Environmental Reevaluation** (Social reappraisal); people think about how their behavior impacts their social environment. Like smoking also affects other people. But it could also be realizing you've been a bad role model. Such reassessments can be made by empathy training, documentaries, family interventions etc. [19]
4. **Social Liberation** (Environmental opportunities); this is when there are environmental changes which helps people change their behavior more easily. Advocacy, empowerment procedures, appropriate policies etc. can help increase opportunities for these people. For overweight people, think of salad bars in canteens. [19]
5. **Self-Reevaluation** (Self-reappraisal); this is where people take a look at themselves. It combines cognitive and affective assessments of one's self-image with and without their unhealthy habit. Value clarification, healthy role models and imagery can help these people evaluative. [19]

II. Processes of Change: Behavioral

6. **Stimulus Control** (Re-engineering); this is where people remove things in their environment that makes them think about their unhealthy behavior. For overweight people this could be removing fatty foods and replace them by fruits. Supporting change and preventing relapse can be achieved by self-help groups, avoidance and environmental re-engineering. Examples of this are planning to park a few minutes away from the office in order to increase movement. [19]
7. **Helping Relationships** (Supporting); people need support in achieving behavioral change. Also caring, trust, openness and acceptance is important. Therapists, counselors, buddy systems etc. can help as social support. [19]
8. **Counter Conditioning** (Substituting); learning other healthier behaviors to replace the problem behavior. For example use fat free foods as a substitute. [19]
9. **Reinforcement Management** (Rewarding); reward yourself for going the right direction. It's found that rewards are more effective than punishments for self-changers. To increase reinforcements and sustain healthy responses, contingency contracts, overt and covert reinforcements, positive self-statements and group recognitions can be used. [19]
10. **Self-Liberation** (Committing); this combines the belief of change and the commitment to act on that belief. This can be New Year's resolutions, public testimonies and multiple rather than single choices. The more choices, the greater will the commitment be with an increasing max at three choices. [19]

3.2.2 Social Cognitive Theory

The Social Cognitive Theory (SCT) explains how an individual obtains and maintains certain behavioral patterns and it also deals with cognitive and emotional aspects and behavior aspects for understanding behavioral change. It forms the basis for intervention strategies where environment, people and behavior are the key factors. The SCT can be used for designing, implementing and evaluating programs that are relevant for health education and health behavior. The environmental factor, which can be divided into social and physical environments, refers to the factors that can affect an individual's behavior. With the social environment family, friends and colleagues are meant, as for the physical environment the room-size, ambient temperature of certain food availability is meant. The environment and the situation provide the framework for understanding behavior, where the situation refers to the cognitive or mental representations of the environment that may affect a person's behavior. The three named factors are constantly influencing each other and a factor cannot be seen as the result of the other factors. The environment is providing models for behavior, and observational learning occurs when the individual watches the actions of others and the received reinforcements of that person. [20]

The concepts and model (Figure 5) of the Social Cognitive Model are stated below.

Concepts of the Social Cognitive Model (Quoted from [20])

- ***Environment:*** Factors physically external to the person; Provides opportunities and social support.
- ***Situation:*** Perception of the environment; correct misperceptions and promote healthful forms.
- ***Behavioral capability:*** Knowledge and skill to perform a given behavior; promote mastery learning through skills training.
- ***Expectations:*** Anticipatory outcomes of a behavior; Model positive outcomes of healthful behavior.
- ***Expectancies:*** The values that the person places on a given outcome, incentives; Present outcomes of change that have functional meaning.
- ***Self-control:*** Personal regulation of goal-directed behavior or performance; Provide opportunities for self-monitoring, goal setting, problem solving, and self-reward.
- ***Observational learning:*** Behavioral acquisition that occurs by watching the actions and outcomes of others' behavior; Include credible role models of the targeted behavior
- ***Reinforcements:*** Responses to a person's behavior that increase or decrease the likelihood of reoccurrence; Promote self-initiated rewards and incentives.
- ***Self-efficacy:*** The person's confidence in performing a particular behavior; Approach behavioral change in small steps to ensure success.
- ***Emotional coping responses:*** Strategies or tactics that are used by a person to deal with emotional stimuli; provide training in problem solving and stress management.
- ***Reciprocal determinism:*** The dynamic interaction of the person, the behavior, and the environment in which the behavior is performed; consider multiple avenues to behavioral change, including environmental, skill, and personal change.

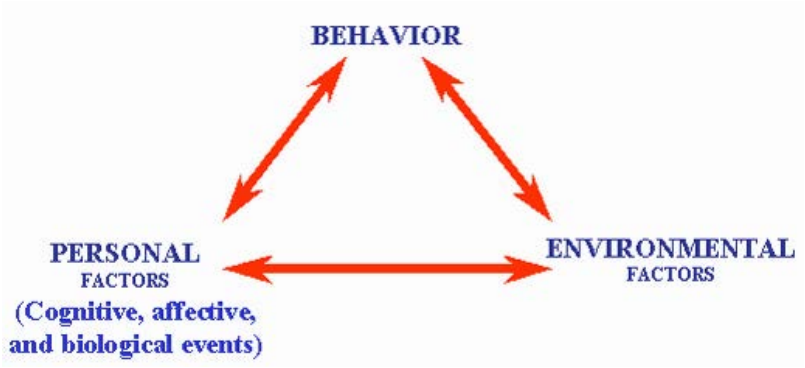


Figure 5; Social Cognitive Theory Model. [20]

3.2.3 Theory of Planned Behavior

The theory of planned behavior (TPB) is used for the prediction and explanation of deliberate behavioral intentions and behavioral adoptions. This is shown in Figure 6. It says that behavior is affected and depends on the following:

1. **Behavioral Beliefs**; this refers to that people believe that by conducting the behavior and the attitudes towards this behavior it will result in a perceived outcome.
2. **Normative Beliefs**; this refers to what people who are close to the individual will think of the behavior.

3. **Control Beliefs**; this refers to the ease or alleged obstacles of performing the behavior and their perceived capabilities and abilities to perform the behavior.
4. **Behavioral Intention**; this refers to the willingness to do the behavior. [21]

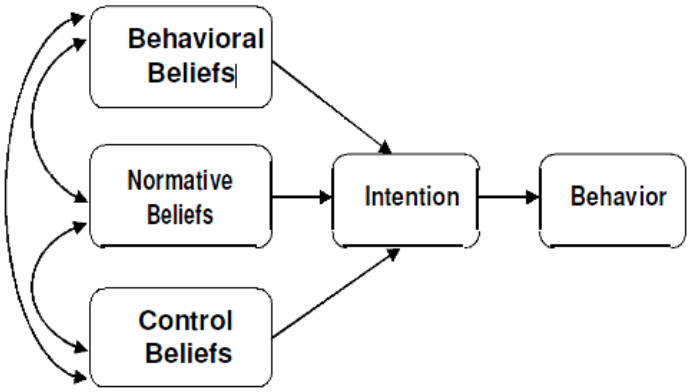


Figure 6; Model of Theory of Planned Behavior. [21]

The theory of planned behavior is extensively used in studies in the past. This was mostly in health-related behavior, but also in physical activity. Some studies even recommend using this theory in health-related interventions.[21]

3.2.4 Theory of Meaning Behavior

The Theory of Meaning Behavior (TMB) presents two types of stimuli, the so called internal and external motivators. The external motivators are for example getting rewarded for good grades or receiving a medal in sports. Internal motivators can be seen as personal rewards like feeling happy, joy and excitement. These personal rewards often are obtained through unhealthy behavior like eating unhealthy foods. People feel themselves happy while eating even if they know it's unhealthy. The reward in this case is then stronger than the fact it is unhealthy and the behavior will be maintained. In this theory these internal motivators explain why some people behave in the way they do and these motivators are the primary indicators of behavior adoption.
The theory of meaning behavior was used in the past to set up survey questions for eating habits and these questions made it able to predict the adolescent behavior in 78% of the times. The theory takes the emotional worldview of adolescents into account and should therefore be a good predictor for adolescent behavior. [21]

3.2.5 Health Belief Model

The Health Belief Model (HBM) is a method to identify, explain and predict health behaviors. This model also helps researchers in focusing on the relationship between health behaviors, related practices and the utilization of health services. For individuals this model can help evaluating and influencing the behavioral change in regard to a particular health condition. It outlines that an individual will engages in a healthy behavior because of general health values, specific health beliefs about being vulnerable to a particular health threat and because of the believe their health problem can have serious consequences. The HBM tries to modify the key factors that are thought to influence the behavior through intervention and includes knowledge about the condition but does not maintain that alone. In Table 13 the concepts of the Health Belief Model are given and they are shown in Figure 7.[22]

Table 13; Concepts of the Health Belief Model with their definitions and applications. [23]

Concept	Definition	Application
Perceived Susceptibility	One's opinion of chances of getting a condition	Define population(s) at risk, risk levels; personalize risk based on a person's features or behavior; heighten perceived susceptibility if too low.
Perceived Severity	One's opinion of how serious a condition and its consequences are	Specify consequences of the risk and the condition
Perceived Benefits	One's belief in the efficacy of the advised action to reduce risk or seriousness of impact	Define action to take; how, where, when; clarify the positive effects to be expected.
Perceived Barriers	One's opinion of the tangible and psychological costs of the advised action	Identify and reduce barriers through reassurance, incentives, assistance.
Cues to Action	Strategies to activate "readiness"	Provide how-to information, promote awareness, reminders.
Self-Efficacy	Confidence in one's ability to take action	Provide training, guidance in performing action.

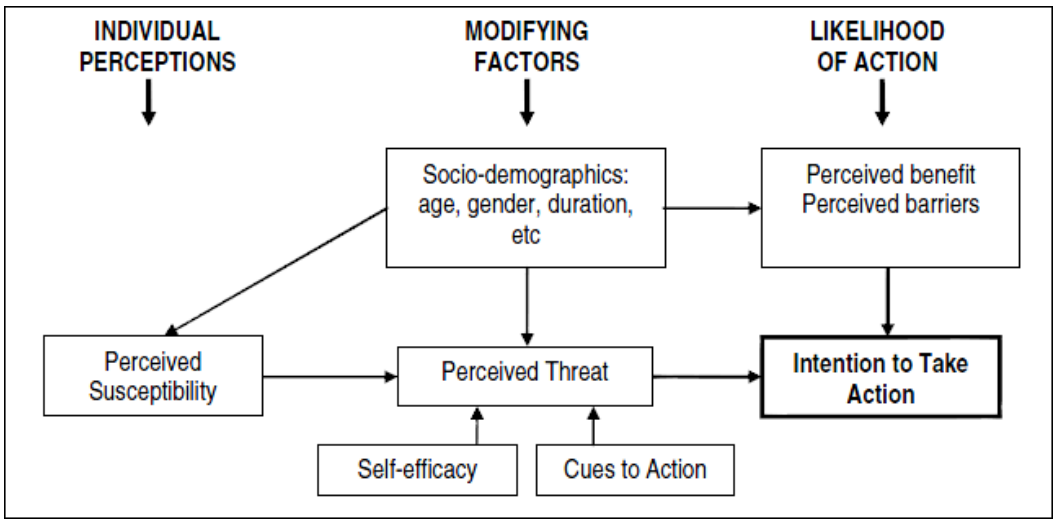


Figure 7; The Health Belief Model. [22]

3.2.6 The Star Model

To bring health promotion programming and ICT development together for producing user friendly, effective and accessible eHealth promotion, the Star Model was developed. It will address the five coordinated actions of the Ottawa Charter[24] with respect to eHealth promotion. To combine these two fields, rapid-cycle change strategies were adapted. This is shown in Figure 8. The Star Model incorporates multilevel concepts and behavior change strategies like the self-determination theory from Ryan & Deci (2000)[24] which encourage using intrinsic motivations to take action as a strategy as opposed to extrinsic motivations for change. For example 'I want to change' against 'I have to change'. To see how willingly someone is to change the stages of change of the Transtheoretical model from Prochaska, Diclemente & Norcross (1922)[24] is used. To include the small gains as benefits the harm reduction approach of Erickson et all (1997)[24] is used. The Star model also emphasizes the need to organize and build capacity

for action and well-being besides supporting change. And finally action research (Argyris et all, 1985)[24] methods for continuous build and feedback knowledge to encourage improvement, learning, and capacity building are used. All these theoretic tools combined will form the Star model. For developing a program listening to the target population and understanding their perspectives and needs is the first important task. It is also important that de users will find the ICT system easy to learn and use. Also should be considered who is using the system so it can be thought of when designing. Prototyping and usability testing of interventions are undertaken to let the product get their needs. User feedback and suggestions combined with observational and quantitative assessment data are important to improve the system. The plan, do, study, act (PDSA) approach for rapid-cycle change forms the core for implementing the Star Model. In Figure 8 is shown how linked PDSA cycles are used to design, test and disseminate the eHealth promotion program. In each cycle information is continuously gathered so modification on the way is possible.[24]

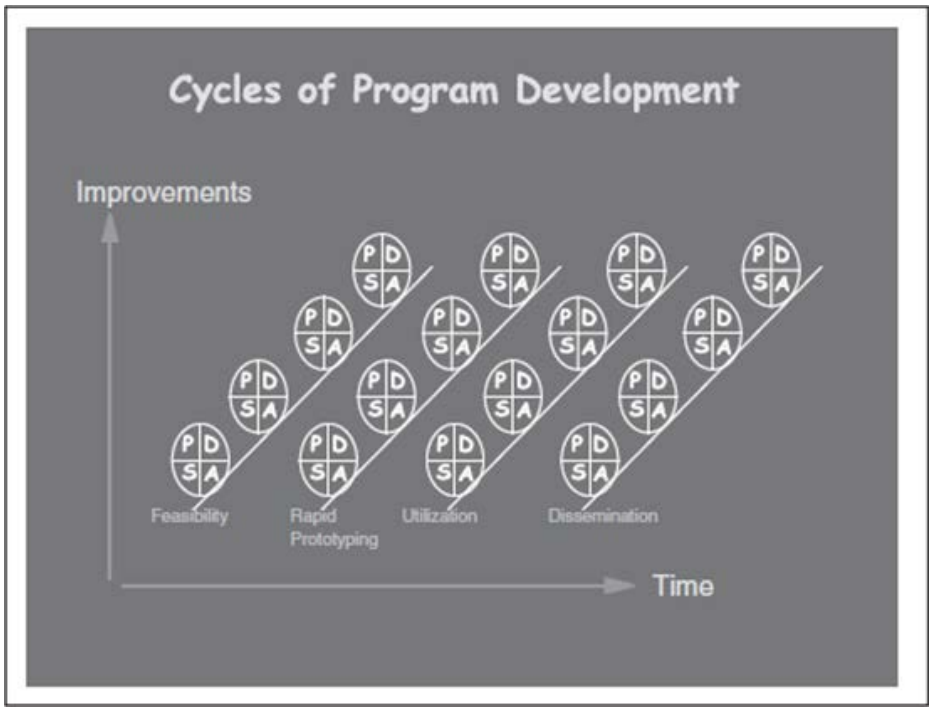


Figure 8; Cycles of Program Development: Display of how a series of linked Plan, Do, Study, Act (PSDA) cycles are used to design, test, and disseminate the eHealth promotion program. [24]

The Star model groups the technical and community development processes into five iterative cycles, namely Listen, Plan, Do, Study and Act, which will now be discussed.

- **Cycle I: Listen**
  In this cycle it is important to interact with the target community and population to identify their needs and wants and how they relate to the technology. The design of the system begins with understanding the task of the system, the users and how these users interact with any already existing system. It is really important to involve the community in a way they feel related to the designed system. [24]
- **Cycle II: Plan**
  In this cycle a plan is set up to address the needs of a community with use of technology and also to specify the technical and organizational requirements for the project. First the design of the system is made based on user requirement, organizational guidelines and policies like accessibility and literacy criteria. [24]

- **Cycle III: Do**
  In this cycle the development of the graphical layout, navigation and Web site components are implemented. Making prototypes using paper sketches, computer images or early versions of the final system for assessment improves the final product and can save a lot of costs. [24]
- **Cycle IV: Study**
  In this cycle the web site components, graphical layout and navigation is reviewed by community members and prototypes are evaluated. A rapid-cycle approach is used for the final development and with each stage the prototype is evaluated and refined. [24]
- **Cycle V: Act**
  In this cycle the product is launched as the study phase is completed. It's important that mechanisms are created to allow ongoing feedback for correcting and refining the system. [24]

The Star-model was initially developed during the development of a youth health promotion project that was based on a website. By using its five iterative cycles the model provides a comprehensive yet practical guide for the development, evaluation and dissemination of eHealth promotion resources. [24]

4 Literature; Serious Gaming

4.1 Introduction

In the past few years serious gaming has become an upcoming industry around the world. In the Netherlands even the government was involved in gaming research through investments. That is understandable when looked at the possibilities gaming can bring on areas as education, training, treatment and more. The gaming-industry represents a huge economic value and is already deeply integrated into society what can make serious gaming just a different way of using a game. At the moment the military, schools, hospitals and all kind of organizations and corporations are using video games as part of training or education. The concept of serious games is still very young but has the possibility to grow out to be a part of the training and education as is now known. In this literature part will be explained in general what serious gaming is en how it evolved. Also will be shown why serious games are designed and developed and what is characterizing and classifying serious games. Then some time is taken for explaining the effectiveness of serious games and how it can be implemented in everyday life in order to use it for healthcare with in particular treating overweight and obese patients but also with focus on preventing weight gain.

4.2 History

The term serious game was already discussed by Clark Abt in 1970 in his book 'Serious Games', but it was during the 'Serious Games Initiative' in 2002 that the term 'serious games' became known to the greater public. Until that year, games with a serious factor were largely confined to education and therefore fell under the term edutainment. The introduction of using games for education in the primary and secondary education in the United States in the late 90's resulted in a huge failure. But in the years after, the gaming market grew and games became more extensive, much faster and also better. With that growth the aspect of using games for education became interesting again, but because of the popularity of gaming and the failure of the project in the 90's, the game itself became more important than the educational aspect. Instead of using the term edutainment for games with an educative aspect, they were now called serious games. The industry grows and games crossed new boundaries, becoming carriers to tell stories, make advertisements or to educate and to train. This shows that the scope shifted to outside the education. Nowadays there are games for military purposes, healthcare games, moral games, environmental games and more. [1]

4.3 Definition

A serious game is simply said a game of which the primary goal is to educate and the secondary goal is doing that in an entertaining way. Or as it was defined by Clark Abt: '*serious games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement.'[5]* The definition gives quite an indication of what a serious game is, but nevertheless the boundary between what is and what is not a serious game is not exactly clear. There are for example games which seem to be made for entertainment but playing them improves the locomotion or the skill to solve things strategically. And even if a game is considered being a non-serious game it can sometimes be transferred into one. For example a shooter which then will be used in the development for a professional military training instrument which in jargon is: repurposing commercial off the shelf games. The other way around is also possible. Sometimes games that are used to train people will then be used for entertainment, like the simulators used in the navy or airline that are now commercialized. Games can be used for serious purposes in many areas, but what most people will agree on is that the entertainment, in which form whatsoever that will be, is of great importance to achieve the learning goal. As Sawyer defined it: '[any]

computerized game whose chief mission is not entertainment [including] entertainment games which can be reapplied to a different mission other than entertainment' (Sawyer 2004). [1, 25]

4.4 Motives, characteristics, classification and effectiveness of serious games

4.4.1 Introduction

Serious gaming is stated to be an upcoming industry, but what motivates a company or government to invest into developing serious games? And what is the difference between a standard game and a serious game when looking at the generic characteristics? The gaming industry is dividing games into genres, but is that also possible with serious games, or is this in need of a different format? And finally, how effective are serious games and is there evidence for this?

4.4.2 Motives & goal

There are quite some motives for the use of serious games. The first is the reduced costs it can bring, of which the flight simulator for pilots is a good example. Simulations are also used in healthcare where for example specialists train with simulated operations to work on their skills. Serious gaming can also be used to decrease the need of medical personnel which is positive for the healthcare costs. For example a patient who struggles with overweight can do his treatment partially at home with use of a serious game instead of relying completely on a therapist. Besides the fact it saves contact hours with the specialist and thus reduces costs, it could also be in the patient his interest not having to visit his therapist that often. Another very important motive for using serious games is the shortening and improvement of education as learning through entertainment should be more efficient. When the game is enjoyable or even addictive and the curriculum is integrated well into the game, learning can be stimulated and more efficient. Learning or doing exercises for therapy is often experienced as boring and annoying. With use of a game this can be changed. Think of patients with overweight who are doing exercises with as only goal to burn calories. This is often done by simple repetitive exercises which are not really stimulating. So with use of a serious game a fun factor can be added in doing exercises which increases motivation and therefore adherence and efficiency of the therapy. Besides the named motives there are many other motives for using serious games, but it depends on the goal that has to be achieved which motive drives the development. [1]

Simply said, the goal is to let people learn or train efficiently in an entertaining way. In this research a game will be designed that treats people with overweight and obesity in a way they can lose and manage weight in a way it is entertaining and effective. In general the goal of serious gaming varies per situation as some games have the goal to transfer information or to refresh existing knowledge. And in other games the goal could be to realize deeply behavioral changes. [1]

4.4.3 Generic characteristics of serious games

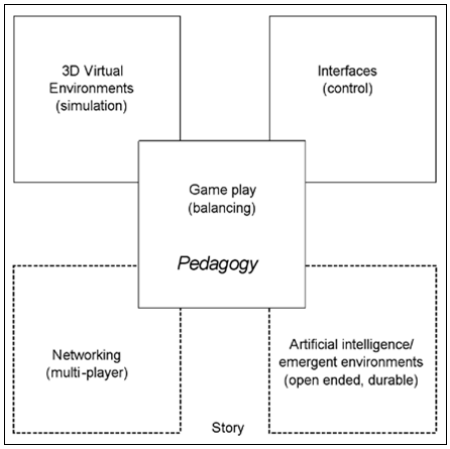


Figure 9; Basic elements of a (serious) game Bergeron, 2006, modified). [1]

Serious games are largely equal to regular entertainment games with regard to the basic elements. There are four basic elements that a game has to content. The first is the storyline; the plot of the game. The second is the game play; the story and structure of the game and the way that it is played. Third is the interface; the program that controls a display for the user and allows him to interact with the system. And fourth is the visualization; how the game is projected. And in the next generation games networking and artificial intelligence will be of great importance. This last part makes sure the game play will continue without influences from the outside. All of these basic elements of a serious game are combined in Figure 9.

According to Overmars (2005)[1] a good game is created when all of these elements are in good balance with each other. In case of a serious game the educational part is the most important, but in order to achieve maximum results these elements stay essential. Especially the game play is essential; because that is the main element that can keep a player interested in the game and therefore will be responsible for the success of the game. Graphic performance and game play have to be mainly functional of which the graphic performance depends on the target group and the goal of the game. [1]

4.5 Game classification

Serious games are nowadays developed for various types of markets and user groups. In the past it has been developed for education, the military and for the business market, but now the government, healthcare and society (for example political and activism) are also involved. The gaming industry classifies the games to their genre, but when classifying serious games the 'serious games user map' from Sawyer as shown in Figure 10 will be used. This format is based on the compartmentalization to user groups.

Figure 10; Serious games user map (Sawyer, 2004). [1]

Bergeron[1] made in 2006 a classification of serious games but that was far from perfect. The format of Aldrich (2005)[1], shown in Figure 11, is based on the game-type but it is explicitly linked to the used learning model. This means it indicates the kind of skills (linear versus dynamic skills) and how these skills are taught (independent or with help of an instructor). [1]

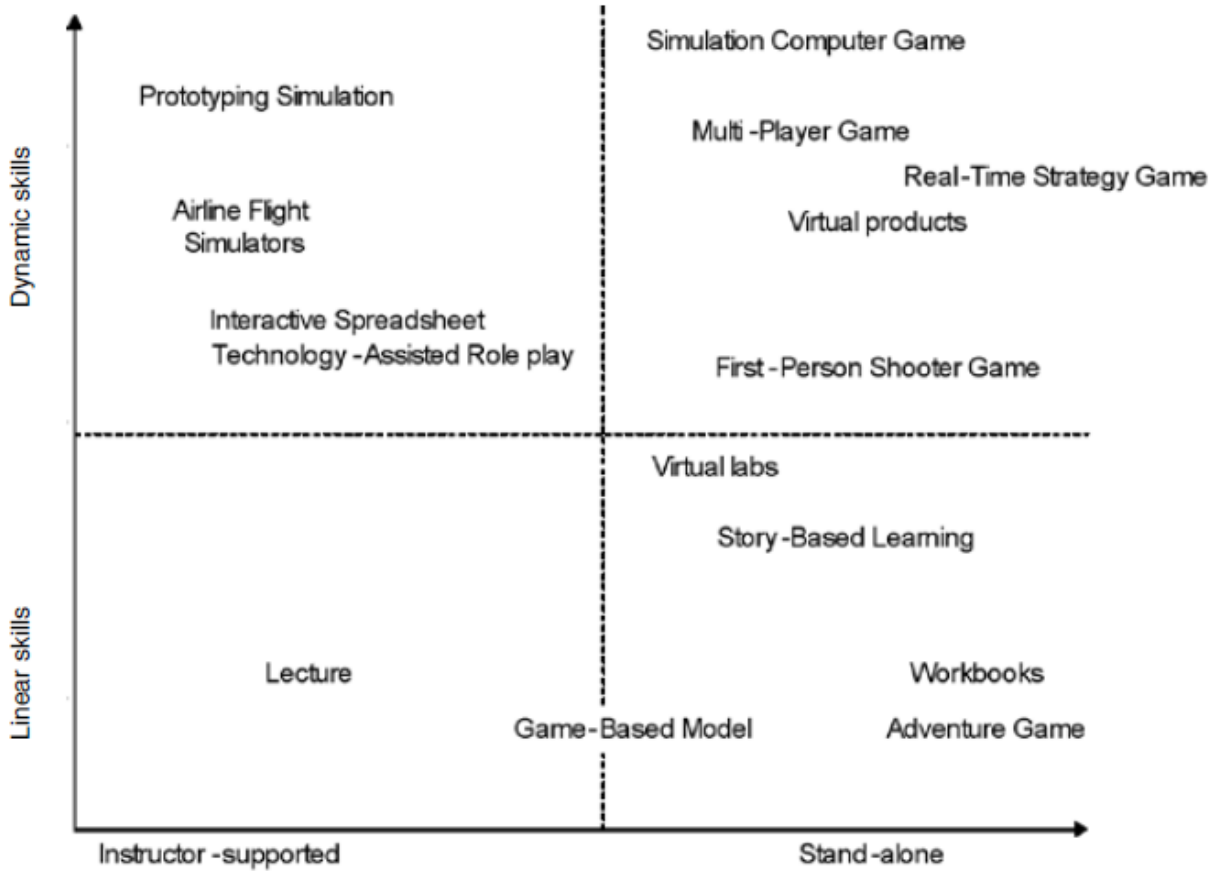


Figure 11; Educational Simulations and Tangential Spaces (Aldrich, 2005). [1]

In the format of Aldrich (2005)[1] the traditional genres from education and business market are central. The scopes of serious games are continuously expanding and especially the online multiplayer market is recently growing. For all these games the four basic elements (Figure 10) have to be present, but it depends on the game in which ratio this is. The classification of serious games in Table 14 is a combination of the market (based on Michael & Chen, 2006)[1] and the type of game (based on Aldrich, 2005)[1]. The use of a game type does not depend on the market because a game that is developed for a certain purpose can sometimes also be used for other things. Therefore the games classified in a certain sector could also be part of other sectors. [1]

Table 14; Classification of serious games in market and game type. [1]

Market	Game type	Example
Military (incl. public security)	• (Flight) simulators • First-person shooters • Technology-assisted role play	• ShipSim, Tramtunnel • America's Army • Brandweertraining
Education	• Interactive spreadsheets • Game-based models • Branching stories	• CO2Fx (Medgame) • Flex Your Power • Behrloo, Profchecks, Medgame
Corporate	• Prototype simulation • Marketing mini-game (business games) • Advergames • Virtual products • Virtual labs	• See Virtual labs • Intel IT Manager Game • Clearahill • Rij-Assistent • LSM Virtual Lab
Government	• See Corporate	• GuelphQuest • MassBalance • Baas op Zuid
Healthcare	• Exergames • Pain relief • Therapy • Motor skills - Rehabilitation (patients) - Train operating skills (medical professionals)	• PowerGrid • Snow World, Re-Mission • The Matrix, Earthquake in Zipland • Balance Rehabilitation Unit • Simendo
Civic society (NGO, citizens)	• political games • news games • activist ('moral') games	• A Force More Powerful • Kuma/War • Darfur is dying

4.5.1 Effectiveness of serious gaming

Most serious games are made with the assumption that learning trough playing has great advances over alternative forms of learning. First of all, this method of learning should adapt in a positive way to the life and experience world of young people. Games would win it from books for example. Thereby games should have a higher captivate than other media. Players just want to continue playing and have the urge to perform well. Another benefit would be that with games the knowledge would be acquired in an active way which is important as it would linger better. This effect would be strengthened because games add context to the learned information. The knowledge does not stand alone but has a feature in the game which makes it relevant. Another argument is that games would be useful to hide the learning goals. The secret of a good game is that it is experienced as enjoyable to do and that learning goals are achieved without really noticing it. [25]

Based on the common sense, people will say that serious gaming is useful. But research has not yet shown real hard facts about the effects of serious gaming. Luckily there has been some research in which the following was said: 'Several reviews of the literature on gaming over the last forty years, including some studies that use rigorous statistical procedures to analyze findings from multiple studies (meta-analyses),

have consistently found that games promote learning and/or reduce instructional time across multiple disciplines and ages. Although many of these reviews included non-digital games (pre-1980), there is little reason to expect that the medium itself will change these results. A cursory review of the experimental research in the last five years shows well-documented positive effects of [digital game based learning] across multiple disciplines and learners' (Toekomstverkenning Serious Gaming 2009) [25]

4.6 Developing serious games

4.6.1 Introduction

For the design of a serious game there are many things that have to be taken into consideration. One of the first things is the medium which is going to be used, i.e. a book, video, computer game/program or mobile phone game/application. In this research will almost solely be focused on the design for a mobile phone. This is because of the upcoming Smartphone industry and the number of people in the Dutch population that already is in the possession of a Smartphone, with internet access. People often have their phones with them and with the technology nowadays learning through serious games can be easily integrated into their daily life. In this part will furthermore some of the basic characteristics and rules for designing serious games on mobile phones be shown and will the effect of multiplayer gaming be discussed.

4.6.2 Serious gaming on mobile phones

Nowadays the mobile phone can hardly be left out of people their lives. Most people own one and although the popularity is the highest among young people, it is also quite popular among adults. Technology these days is going rapidly and Smartphones are becoming a standard when selecting a new phone. GFK Panel Services[1] predicts that 54% of the sold mobile phones in 2011 will be a smartphone with a total of 3.2 million copies. [26] According to 'Telecompaper' the penetration of Smartphones in the Netherlands will be around 38% in the third quarter of 2011 and still increasing. [27] The Dutch Central Bureau of Statistics (CBS) [28] researched that 43% of the Dutch population from 12 to 75 years old used a mobile phone (Smartphone) with internet in the last three months of 2011. The use of internet on a mobile phone has doubled in the past year, going from 21% in 2010 to 43% in 2011 which according to them is mostly because of Smartphones. [28] The telecom network in the Netherlands is able to handle more and more traffic and owning a Smartphone almost means it is a 'must' to have internet on your phone. And with providers offering mobile internet for low prices in the last couple of years, many people got used to it. Even if people have a Smartphone without an internet subscription, many people find their ways to the internet using Wi-Fi. For developing serious games it is perfect, because Smartphones are being able to do the things that are programmed and the internet is there to download the game or application. And of course for uploading data towards the server from the user his Smartphone! [1]

Mobile learning games have been used in many contexts and there have been many proposals in the recent years for games. Although the years have passed, the main characteristics that identify mobile game-based learning applications remain relevant. Based on Trifonova's (2003) concise overview these characteristics are[29]:

- Applications meant for learning should support a playful interaction and needs to be self-explanatory. [29]
- The learning content has to be divided into small parts so that playing the game and learning can take place in short periods, i.e. a break. [29]
- Using the application whenever the user wants to is important, so it should be integrated in the situational and local context of the user. [29]

Surveys showed concurring basic rules with Trifonova's work when developing mobile games. These basic rules are:

- The learning content should not be the focus point, but instead problem-solving activities that result in arriving better skills and self-knowledge. In mobile Game Based Learning (mGBL) games these activities are based on Anderson and Kratwohl's learning goals in the year 2000; remembering, understanding, applying, judgment and analyzing. [29]
- Mobile games should be challenging, excited and should give feedback. They also should have short tasks for earning rewards. The games must not be all about learning with a gaming aspect but they must be real games. Prensky (2001) emphasizes that fun should be priority in a learning game and that the learning content should be second. [29]
- The learning game should keep the user central. The learning needs of the user, capabilities, level and information needs to stay relevant. The game must remain simple and lets the user be in control. Because of the possibility to play the game also in short amounts of time, like a break, results also should be given after these short sessions. And users should be given the space to make own preferences. [29]
- Keep in mind that a mobile phone has a small display and uses a battery. Do not replicate PC-style games. [29]

In the EU's mobile Game-based Learning (mGBL) project[29] some of the same points as above are noticed as success factors. The learning games have to be challenging, cause excitement, earn respect, give social experience, give feedback and enhance knowledge. The word 'learning' has to be mainly avoided with the youth, being incompatible with the concept of fun games. In order to quickly see the game skill values, feedback should be easily accessed and available. Also rewards are of great importance like getting approval from peers or gaining new information. Experts mentioned the importance of multiplayer gaming with collaborative and competitive options. Crucial here is the simulation of real-life communication with for example a convergence platform. For multiplayer games it showed that playful competitions were preferred above competitions with fast knock-outs. The mobile game should also been build out of small parts which the user can complete during game play in order to play during breaks for example. [29]

4.6.3 Game Design

When designing a typical game there are according to Fullerton et al. (2004)[30] three phases of development. The first phase is conceptualization; the planning phase in which brainstorming and identification of the formal and dramatic elements of the game design come forward. Examples of formal elements are rules, objectives, possible outcomes, game controls and mechanics. In dramatic elements can be thought of characters, conflicts, challenges, background story and pleasure. The second phase, prototyping, is to make the first version of the game of which feedback is collected. [Fullerton et al. 2004; Salen and Zimmerman 2004][30] The third phase is play-testing. Feedback from this phase results according to Rucker (2003)[30] into iterative design processes and making game developers prioritize changes. It also lets developers make tradeoffs between available features, quality and the deadline for finishing the game.

When designing a serious game, in contrast to a typical game as stated above, a different framework is needed. Developers have to interweave social interactions, learning objectives and play-elements in order to create a positive learning game. The game purpose and the desired effect on the player determine the focus of user centered design. Therefore the design has to be defined as a specific application, affordances of game play and the effects of game play. The specific application refers to the purpose of the game. Should it be to acquire knowledge or to develop skills? If educational, what are the learning objectives? As an example promoting physical interaction can be used as an alternative for cardiovascular activities.

The affordance of game play is to know what the benefits of the game are. What advantages has the game over real-life and is a certain game genre better than other genres? Secondly, social interactions are stimulating the learning process and games seem ideal for collaborative learning. When designing a game, developers should consider these interactions. The effects of game play should be that players have a pleasurable experience while experiencing positive learning outcomes. Developers should assess this continually during the development in order to create a good game and give it a proper classification. Developing user centered game design has one additional phase that initiates the serious game design. This is shown in Figure 12. [30]

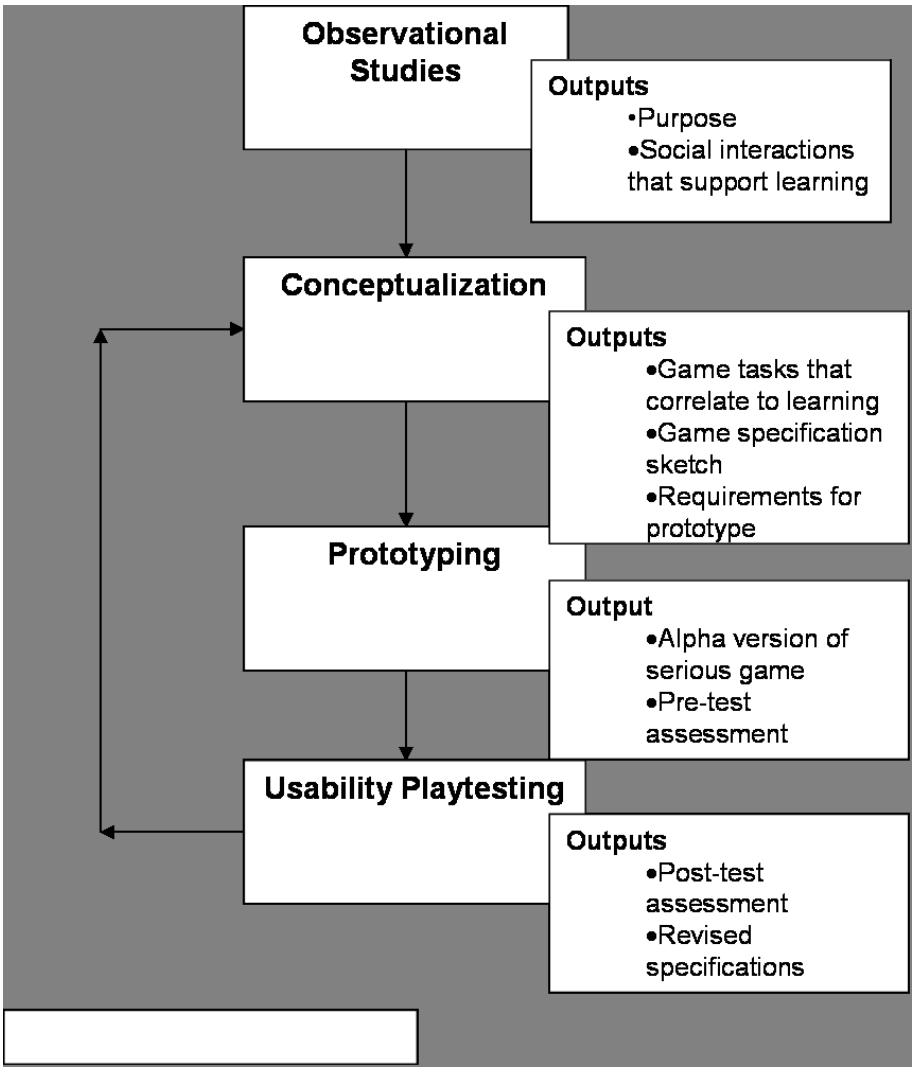


Figure 12; Model of user centered game design. [30]

Whether the game will be accepted by the public depends on the fun-factor. When playing the game provides enough pleasure, the constraints of the game will be accepted. Fun can be defined as the act of mastering a problem mentally, or absorbing patterns for learning purposes (Koster)[31]. Analyzing a problem and solving it better or faster is also known as fun, like breaking lap times or a personal record. Koster also says fun can be derived from aesthetic appreciation, narrative, and social interaction. Successful games nowadays have narrative and social interaction like roleplaying games. The game consists of missions that follow one another up and include personal goals as well levels that attain power. A quit good example is World of Warcraft which binds players with the game but also through build up social interactions with other players. The community can give a game a deeper play experience, an additional content and also a better competitive play. [31]

When designing everyday fitness games based on ideas from Salen and Zimmerman the following design principles are important[31]:

- Core mechanic; this is the set of interactions that is the most repeated during play and which should be used by the developer to influence physical habits. The interactions are hard to master but easy to learn which makes it interesting and fun to improve and learn these interactions. [31]
- Representation; this is how the game presents itself in the aesthetics and narrative form. Making a good representation means the game should not be to complex or to shallow. It should drive players interaction, provide context and it should immerse players in the game world. [31]
- Micro goals; in games players have to achieve certain goals, which mostly are in the form of solving conflicts. By ensuring these goals can be achieved with little work a path of goals is set in order to complete the bigger goal. In this way players will not be overwhelmed and completing more goals provides more frequent gratification enticing sustained play. [31]
- Marginal challenge; the challenges provided in the game should meet the margin of a player's ability. This is important to keep the game experience fun, meaningful and stimulating to proceed to the next level. [31]
- Free play; some game designs can benefit from not setting to many rules. Thus in a way that players can play at their own pace where and when they like and if possible also how they explore the narrative of the game. [31]
- Social play; social relations in gameplay come in an internal and external form. Internal means the roles emerging from the formal structure of the game. External roles come from outside the game, like rivalries and friendships. For strong social play aspects it's wise to utilize internal roles to assist in establishing new external relationships. Communication tools can then help build and maintain those relationships. [31]
- Fair play; In social play the players should have equal chances in order to keep the gameplay fair. This should be embedded in the rules and core mechanic by for example given players that are behind temporary game-advantages in order to restore competitiveness. Or by matching player of approximate skill levels. [31]

4.6.4 Multiplayer aspect

It was stated before that adding a multiplayer aspect to a serious game can provide deeper play experience. But there is more to it. Arteaga et al.[32] for example showed several applications that, among other, use friendly competitions in order to encourage physical activity. Göbel et al.[32] stated that multiplayer games can provide, compared to single player games, additional stimulation. The competitive aspect can provide an ongoing and recurrent motivation compared to single player games which might lose their attraction to the users. An example of such competition is competing with each other in a racing game. Information about the performance of other players, e.g. friends or colleagues, is an important motivational factor and becoming the best is the driving force of its success. And also important, human opponents always insure a different game play, which supports sustainability in terms of motivation. [32]

Using multiplayer in mobile phones can be done in two ways; a remote-server game or a peer-to-peer game. When using a remote-server game, this means that the played game uses an external server to connect all the players. This server receives from every player data and determines the outcomes. It also returns new game-state information to every player individually. When using a peer-to-peer game the players are not connected through an external server, but the game application makes sure the phones connect directly to each other. The mobile phone of each player uses Wi-Fi, Bluetooth or infrared to send and receive data to and from each player directly. Every phone ensures it is in sync with the other phones by checking. The advantages of a remote-server game are the quantity of players which can join the game. When using peer-to-peer this amount depends on the used mobile phones and technology. Another

advantage is the distance, because remote-server games can be played wherever a mobile network connection is available and with peer-to-peer the wireless technology is the determinant. A disadvantage of remote-server is the dependence of the player to the server, which also often needs to be paid for. This is not the case when using peer-to-peer. [33]

Multiplayer games add fun to gaming and that is important for keeping people enthusiast about the game. Peng (2003)[33] showed that 43.35% of the internet users finds multiplayer gaming more fun. People are unpredictable which makes playing more fun, especially when these people are considered to be a challenge (Rouse 2001) [33]. And with mobile phones as social devices and games as social environments, multiplayer games should be popular (Nokia, 2004). [33]

4.6.5 Avatar

Using avatars in serious gaming can enhance game play. According to Yee (2009)[34] using athletic avatars in exergames may encourage users to do longer and more engaged exercise sessions. This is compared to avatars that look normal or represent the player's body shape. Lim &Reeves(2006)[34] in contrast found that letting players select their own avatar improves the engaging in gaming experience. [34]

4.6.6 Main barrier for developing serious games

The first barrier is that there is not much actual proof that serious gaming works and therefore if investing in serious games is worth it. The second thing is that educational content and hardware are quickly outdated. Because developing will take a lot of time, you'll have to keep in mind that the world and technology is not standing still. And of course money is real important, because from the beginning till the end the costs are rising during the development process. And last but not least, failure. Will the developed product work? It is a barrier known for a long time, but sometimes a developer has to take a shot at the target hoping it is going to be a bulls eye.[35]

5 Game comparison

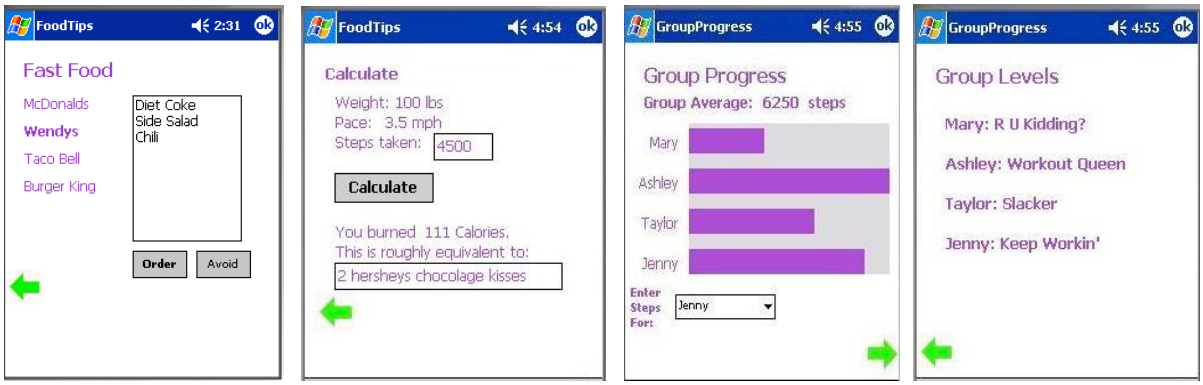
5.1 Introduction

In this part serious games and programs which are developed in research to help people live a healthier lifestyle will be compared. By discussing the positive and negative aspects of these games and programs a better insight can be derived for the design of a serious game to treat or prevent overweight and obesity. From an extended search for research-based serious games or programs for treating and preventing overweight and obesity or to achieve a healthier lifestyle the following eight games/programs were selected for a comparison: Chick Clique[36], Houston[37], Fish'n Steps[17], OrderUP![38], Neat-o-Games[3], MPTrain[39], Shakra[2] and UbiFit Garden[4]. These games will first be described, then compared and discussed and finally a conclusion will be drawn.

5.2 Serious Games

5.2.1 Chick Clique

Chick Clique is a preventative health mobile phone application developed in a small research to help teenage girls get motivated to exercise by exploiting their social desire to stay connected with their peers. It was especially developed for girls because they are more likely to become less physical active throughout adolescence. The concept of chick clique leverages goal setting, self-monitoring, positive reinforcement and social support by using persuasive technology to change the behavior. A teenage girl can set up a clique for a maximum of four players. Each player wears a pedometer and the step count was automatically sent to the mobile phone application. Then the idea was to send an automatic text message to all players including the steps taken that day by each player in an oversight. Each player could also see their own individual process. Chick Click also includes a food tips tool that provides a list of good food choices at various fast food restaurants. It also featured a calculator that gives the number of steps needed to compensate so called 'empty calorie' foods like candy. [36]



a) b) c) d)

Figure 13; Chick Clique: a) Fast food tips; b) Step calculator; c) Group statistics and step; d) Group fitness level report. [36]

After analysis it showed that Chick Clique was effective in terms of raising awareness of the relationship of food, exercise and health. Some participants even started messaging one another discussing health-related subjects. In the post-study questionnaire it appeared that the players thought group performance was the most powerful method to change behavior. [36]

Pilot findings and recommendations showed that sending reminders to the players by the system helped them not to forget to enter their step count. Players also wanted to see the progress over time toward the walking goal. And finally, the food tips tool should be expended because now it was too limited.[36]

5.2.2 Houston

Houston is a mobile phone application that encourages physical activity by sharing step count with friends. It uses a pedometer and a mobile phone with the Houston program. Houston participants can:

- Enter the step count everyday on any time.
- View daily goal and progress toward that goal.
- Receive recognition for achieving the goal.
- View an average daily step count based on 7 days counting.
- Add comments to a step count.
- View a list of recent comments.
- Send step counts and optional comment to some or all of their fitness buddies.
- See the progress of their buddies.
- See trending information: last 7 days, recent comments, goals and averages for all buddies.
- Send message to any/all buddies.
- Request a step count from any/all buddies. [37]

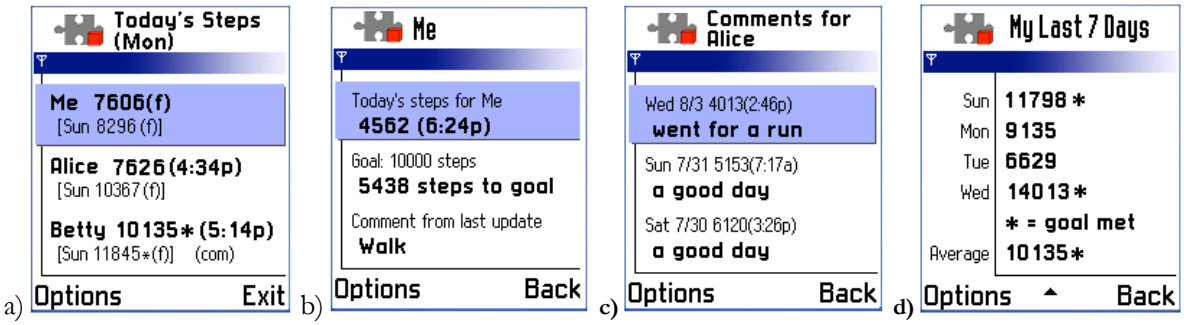


Figure 14; Houston: (a) Main screen, (b) Detail screen, (c) Recent comments, and (d) Trending information. [37]

In Houston players are in control of what they share from their data. People who are not selected will not be notified about an update from that player. Individual goals were established using a modification of the guidelines set by the President's Council on Physical Fitness and Sports, called the Walking Works program. People who used Houston stated that their physical activity was not accurately measured, which was due in large part to the limitations of the pedometers. Users also complained that the pedometer was too bulky and called attention to the users. Future work recommendations are first of all improvement of the pedometers. Secondly the manual versus automatic journaling whereas previous work suggested that doing it manually positively affects the level of physical activity. It also gives users control over their data. Automatic updating on the other side gives a continuous record of data and takes over the burden of remembering to log the activity, but doing it automatically has the potential to reduce awareness and chance of introducing deceptive data. The third recommendation is research on the barriers that prevent physical activity and how to motivate behavioral change. [37]

It can be concluded from Houston that four design requirements that encourage physical activity are:

1. Give users proper credit for activities.
2. Provide personal awareness of activity level.
3. Support social influence.
4. Consider the practical constraints of users' lifestyles. [37]

5.2.3 Fish'n Steps

Fish'n Steps is an application on the computer which tracks the physical activity of the user through a pedometer. Each player got his own virtual pet, a fish in a fish-tank. The growth and emotional state of the fish was linked to the number of steps taken each day. It is also optional to play with or against others.

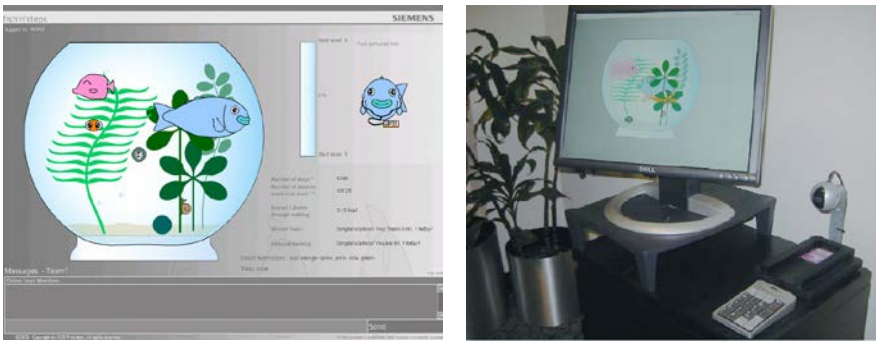


Figure 15; Fish'n Steps: The computer display of a participant after approximately two weeks into the trial in the Fish'n Steps team-condition, the public kiosk and the pedometer platform which rotated through each of the team fish-tanks. The components of the personal display include: 1) Fish Tank - The fish tank contains the virtual pets belong to the participant and his/her team members, 2) Virtual Pet – The participant's own fish in a frontal view on the right side next to the fish tank, 3) Calculations and feedback - improvement, burned calories, progress bar, personal and team ranking, etc., 4) Chat window for communicating with team members. [17]

Fish'n Steps showed a positive change for 14 out of 19 participants. This change was an increase in daily step count, a change in attitude towards physical activity or a combination of those two. The game highlighted that the goals have to stay achievable or challenging in order to inspire the desired change. The daily steps were automatic uploaded in order to prevent false reporting like entering more steps than taken. The daily upload however could not measure or prevent that someone shakes the pedometer in order to increase the step count. It could also not prevent that someone else wore it for the user. The uploaded steps were used to calculate the increase in steps and compared it to a personal goal. With use of previous pedometer studies, three heuristics were used to calculate custom goals per participant. The goal has to be reasonable over the intervention period of six weeks. The average step count increase was 2000 - 3.000 steps according to previous studies. Participants also have a baseline step count which is the amount of steps they normally reach in a day. Fish'n Steps stated that the step count increase of 2000 - 3.000 would be negatively correlated with participants their baseline step count. An upper bound was set, because in previous studies an amount of 10.000 - 12.000 steps was the end-goal. Therefore the upper bound was set on 12.000 steps. The weekly goal was calculated using an exponential function and the daily goal was 1/5 of that. If participants reached that goal, the daily progress was sufficient. If they reached only half it was nearly sufficient and it was insufficient if they did not even reach half of the goal. When a subject exceeded his weekly goal a new goal was set, based on an adjustment of their baseline. The daily progress of a participant was of influence on the fish in two ways. As soon as a total number of steps were exceeded, the next growth level was achieved. When the final level was achieved a baby fish was born and you continued with that fish. The second thing was the change of facial expression due to reaching the daily goal. The fish could be happy, angry or sad depending on the achieved steps that day. [17]

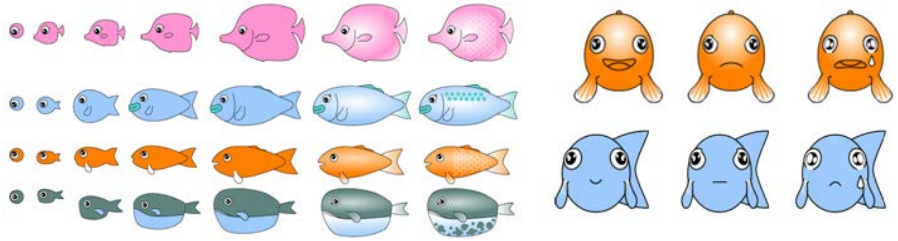


Figure 16; Fish'n Steps: Seven growth levels (left panel) and examples of three types of facial expressions (right panel) of the virtual characters. [17]

There were two game versions. In one version everybody had his own fish-tank, and in the other shared four participants a tank. In the second version the brightness of the water and decoration (plants, small animals) were affected by the achieved goal of the participants. Participants within teams were able to see

how their teammates were doing and could use an anonymous chat application to converse. Participants could see the fish-tank and progress on their own computer by logging in, but they also could see the tank on a display next to the upload kiosk. The application was developed using Macromedia Flash with input from a mySQL database. Before starting with Fish'n Steps the participants wore the pedometer for four weeks in order to determine the individual baseline. Then a six week intervention was held with use of Fish'n Steps. After that, a four week post-intervention was done to see how people were doing without Fish'n Steps. [17]

Figure 17; Fish'n Steps: Study overview. Qualitative interviews (4 total, indicated by triangles) were conducted between each of the phases in the study. [17]

With use of the Transtheoretical Model it was shown that Fish'n Steps has a positive impact on 14 out of 19 participants as evident in either increasing daily steps, advancements in TTM levels or a combination of these two. Participants were additionally motivated by playing in team conditions with a competition between the teams. The fish-states were compared and announcements of winning teams were given. The game created initial excitement, increased the awareness of the physical activity and promoted motivation in a fun and engaging way. The fascination for the game disappeared after the first couple of weeks but created a sustainable behavioral change. The relevancy of the game for a participant depended largely on the current physical activity level, their satisfaction with that, their willingness to change it and their TTM level. Many participants felt a certain responsibility for their fish and tried to take care of it, while others avoided the game sometimes. One of the limitations of the game was the intrusiveness of devices and procedures which prevented participants from engaging. Wearing the pedometer and uploading data in the public kiosk were the most commented. [17]

5.2.4 OrderUP!

OrderUP! is a mobile phone game developed to learn people how to make healthier meal choices. To study the effect of the game, pre- and post-intervention surveys, interviews and diary activities were used. With use of the Transtheoretical Model the results were framed. In order of processes of change, OrderUP! engaged in conscious raising, self-reevaluation, helping relationships and counter-conditioning. In the game players are waiters in a restaurant who have to make recommendations to their customers. By doing this as quickly and healthfully as possible it helps them to keep the job. This scenario was chosen because learning to make the healthiest possible choices when eating at restaurants and fast food is important according to several health organizations. [38]

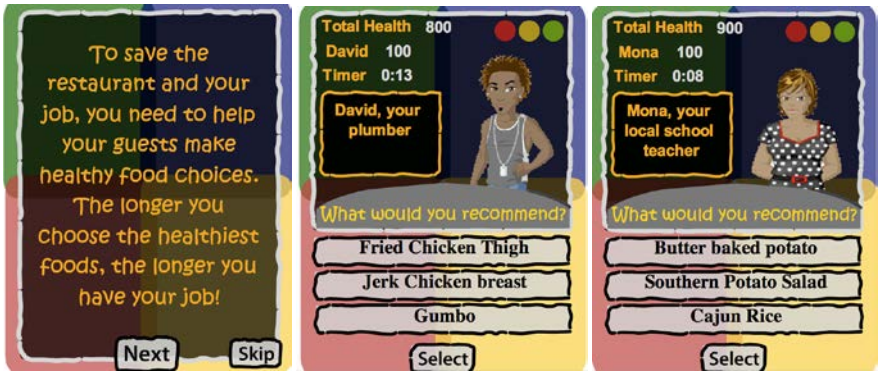


Figure 18; OrderUP! Left screen: Players receive opening screens that explain the premise of the game. Middle and right screen: Players must choose the healthiest options for their customers out of the three dishes displayed at the bottom of the screen. At the top right of the screen, 3 colored circles are displayed (red, yellow and green), providing "stoplight" feedback on the players' choices. At the top left of the screen, the total health points are shown and below that, the health points for this particular customer are displayed next to the customer's name. Beneath the customer's total health points is a timer showing how much time has elapsed in the game. [38]

In the game 10 customers appear repeatedly whom each have 100 health points. The player has to choose for each customer the healthiest option, choosing out of three random meal options. After the choice was made there will be given feedback in the form of a stoplight. Green means the choice was good, yellow means in between and red is the unhealthiest choice. The developers of the game choose meals of which players could have commonly access to in real life. With every meal choice the player makes in the game, the health score of the customer decreases. The healthier the choice was, the smaller the health decrease was and the longer the player stays in the game. This development choice was made to let the player see that making the healthiest choice is important in a subtle way. The player has to serve each customer within six seconds or the player will lose this customer and its points. When a customer gets below 40 points or all guests below 400 points the game will end. The high score of the player therefore is measured in the time he has kept the job. The scores lie around 40 seconds to 4 minutes. Most participants indicated that they probably would play the game in the future and that it was fun to do. Almost every one of them played the game frequently per week. 10 out of 12 participants indicated OrderUP! helped them to learn more about healthy meals. 8 players also indicated that they did not know as much as they thought they did. And it also made them think more deeply about how healthy which foods are. Many participants would even like to have more feedback on their choices because the game does not tell why the choice is wrong. The stoplight idea was used to keep it a game and not a lecture, but users still like to have more information. At some point players thought about their own eating behavior which means they are engaging in the self-reevaluation process. Counter conditioning was also found from 4 to 9 players after playing OrderUP! And eight players described they were eating differently after playing OrderUP! [38]

In the process of change, according to the TTM, OrderUP! helped a great deal. Over time these processes can help people to have lasting behavioral changes. Games as OrderUP! are casual games and can be of great use to address the nine processes of change. The stoplight method of feedback in OrderUP! gave players a basic indication of the healthiness of their meal choices. Because the stoplight method does not gave more feedback, players question and think about why that choice is the healthiest. Some players rather saw more feedback but the content in a casual game should be easily digestible. They are useful for spur questioning and analytical thinking outside of game play. This analytical questioning can facilitate the consciousness raising process. In the future OrderUP! would like to see an examination of the usefulness of simple feedback mechanisms in use of casual games. For future work OderUP! said they would like to see a game design which also makes it possible to play the game with people from the player their social network in order to provoke discussions. This will help to facilitate the helping relationship process.

OrderUP! let players see the relative healthiness of different meals in a fast way and let them made healthier choices in restaurants. This is the counterconditioning process. The mobility of the game, as it is played on a mobile phone, means it is played much more than restricted to a pc for example. Additional benefits are for example that playing before meal-time possibly will affect the food choice made in the canteen on work. So future work should show how mobile games can facilitate the stimulus control process. So, what will lead people to avoid negative behavior? Another future work aspect is the social liberation process in which people become healthier by noticing healthy aspects in their environment. For example, Fujike et al. [3] designed a game that was made to let people fitness but people also started to walk more steps in order to increase their physical health. OrderUP! also suggested future work in the reinforcement process encouraged by a casual game. That means how people will reward and praise themselves for behaving healthy. They suggest that casual games should show players how to begin rewarding themselves when they've taken small steps towards a healthy lifestyle because casual games are inherently easily rewarding. [38]

5.2.5 NEAT-o-Games

NEAT-o-Games are games that try to increase 'non-exercise activity thermo genesis (NEAT)' in people their lifestyle. NEAT is one of two major components of energy expenditure, of which 'exercise activity thermo genesis' is the other. NEAT includes all physical activities and is the one using the most variant portion of energy expenditure, so increasing this will help people to lose weight. The first NEAT-o-Game is the NEAT-o-Race which is a multiplayer game. Each player is wearing an accelerometer that measures the player his activity. The measured data then will be sent to the phone through Bluetooth. The player can accumulate activity-points by being physically active. This also makes the player their avatar in the game move. The earned points can then be used to get hints in the other NEAT-o-Game called NEAT-o-Sudoku. But using points will leave them behind in the race so they have to increase their physical activity to make up for that. It is also possible for players to challenge each other to play for activity points. A race will last for 24 hours or more if the player wishes that. The main characteristics that makes NEAT-o-Games different than others is that it is not played in short terms, but carried out over a longer period interwoven in the daily routine of a player. [3]

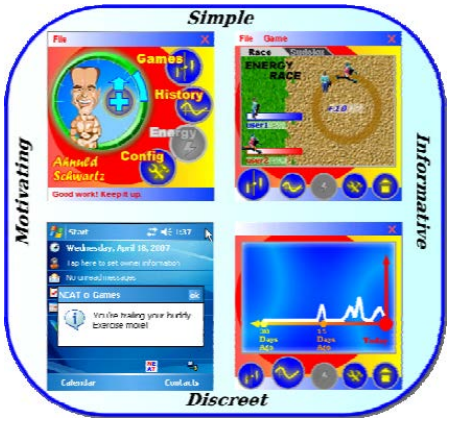


Figure 19; NEAT-o-Games: design principles as exemplified by characteristic screen shots. [3]

According to the design figure, the game should be simple because the target population is the average consuming public. It should be informative in a way that all the information is easily understood. It has to be discreet because the primary use of the phone is not playing the game and therefore it should be running in the background and not interfere with phone tasks. And it has to be motivating in order to keep players interested so behavioral change can be achieved. [3]

Figure 20; NEAT-o-Games: Two-player NEAT-o-Race. The two avatars race around the track and the overall standing is shown on the left. An annotated quantification in the center denotes relative lead or lag with respect to the opponent. The rate of avatar animation is commensurate to the level of each player's physical activity. [3]

NEAT-o-Race is a game that gives real-time feedback based on the players' activities. When the player moves, this is directly shown with the avatar moving. Moving faster will also result in the avatar changing his pace. Depending on the network condition a player can also see his opponent move on his screen.

The home screen of the NEAT-o-Games shows buttons for the game screen, activity history, energy and configuration. It also shows the current state of the race with motivation as 'Good work! Keep it up!' or 'Exercise more!'. The avatar also changes in pleased or unpleased depending on whether you're on top or not of your opponent in physical activity. [3]

Figure 21; NEAT-o-Games: Race monitoring avatars in home screens. If the player's overall activity level is higher than the opponent's, a pleased avatar shows (left screens). If the player's activity level is lower than the opponent's, an unpleased avatar shows (right screens). [3]

The NEAT-o-Sudoku was chosen because it is a mental game that will attract more players, because it is an easy activity point consumer which makes players more active to get new points. It is one of the most popular mental games and is also recommended for education [McCormack 2005]. [3]

Figure 22; NEAT-o-Games: NEAT-o-Sudoku. The left image shows a Sudoku board, in which a yellow ball under the Hint button indicates that the player has available activity points to spend for hints. The right image shows the board after spending the points (the yellow ball has disappeared) and getting the hint (red 5). [3]

After a race session the player gets a message telling him if he won or lost the race. The session data is also saved. When the phone cannot connect to the server the data is saved until the connection is back. The data was then saved in a SQL server. [3]

Positive points of NEAT-o-Games were according to the players the competitive character, the interface, that they could play it whenever, wherever and challenge whoever they wanted. They also liked the energy race and the mental game combined with it. They also stated that it is a game that can be used through the day. Negative points were the sensor which has sometimes technical problems was not stylish enough or was uncomfortable. There should also be more games to reach towards the different age groups and energy expenditure should be in kilocalories instead of accelerometer units. Another point was that the

activity of the player should be given in a more challenging way in the emulator. It was also suggested that more than two players should be allowed in a race and that sensor and phone should be combined. And one participant liked more motivational statements during the game. The game only gives the player a message when he's far behind or ahead in the race. If a player likes to see the race he has to open the program himself and it turns out players do this every 10-25 minutes. Many of them also developed new behaviors, like taking the stairs instead of the elevator, or go for a walk during the break. [3]

For future work it is important to minimize the sensor, extend battery life and possible build in accelerometers, but the accuracy then has to be studied. It appeared very important to show walked steps in kilocalories as players got more motivated understanding the effect of physical activity. Choi et al. [2005] researched how to convert walked steps of a triaxial accelerometer into calories. It is also important to adjust the accelerometer to the place where it is worn in order to get a more accurate and fair count. As for the additional game Sudoku, future work should be to develop some more games to cover a wider audience. In the future there should also keep track of cheating. Shaking the accelerometer gives a different signal than for example walking so this is an option to prevent cheating, but it is important to monitor innovative cheating. [3]

5.2.6 MPTrain

MPTrain is a soft- and hardware system that selects music for the user during his exercises in order to make working out easier. The system contains the mobile phone (or e.g. PDA) of the user and uses a set of sensors wireless connected to the phone. These sensors measure the heart-rate and step count of the user and use it to select and play music matching the physical activity (e.g. walking, running). MPTrain is using algorithms that uses the characteristics of the music (e.g. volume, beat), the physiological response (heart-rate) and the current exercise of the user (e.g. walking, running) to learn the mapping. The goal of MPTrain is to encourage the user to speed up, slow down, or maintain the pace with use of music. The interface of MPTrain shows the current state of the user (e.g. heart-rate, song, exercise-progress, volume, etc.) Users can enter their desired exercise plan, change the songs played, set parameters and set personal data including resting and max heart-rates. The next song will be selected 10 seconds before the previous song ends and is based on the current heart-rate compared to the desired rate. The song then will have a beat similar to the gait of the user or will have an increased or decreased tempo if needed. The player will select a song that is not played before in order to keep the music varied. The player can check his progress, change the song and modify the exercising goal at any instant. [39]

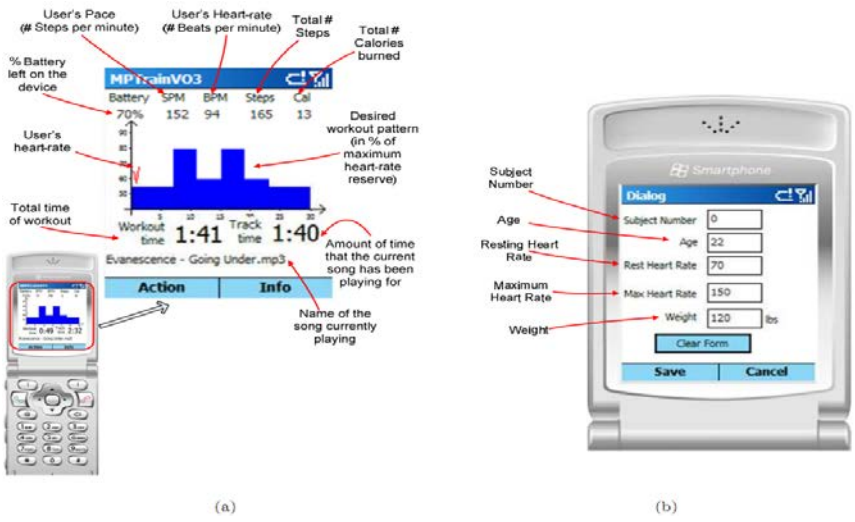
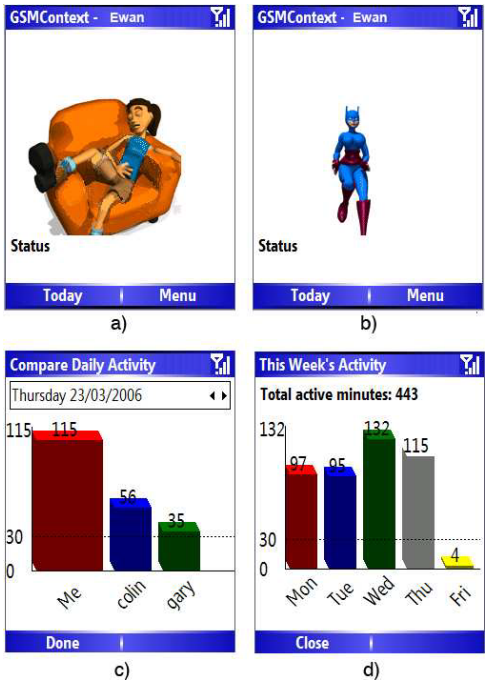


Figure 23; MPTrain: User Interface: (a) Main window with current heart-rate, speed, song being played and desired workout pattern; (b) User's profile window, with the user's name, age, weight and minimum and maximum allowed heart-rates. [39]

It is shown in all tests that people enjoyed running with music significantly more than without and that using MPTrain was also much more enjoyable than using random songs. Users also run harder and were less tired when listening to the music. For future work, workouts from the past could be added to enhance the music selection. A rate system is also useful in order to get feedback on the music with questions about enjoying the music and the effectiveness in workouts. The speed and volume of a song can also be used to improve the enjoyment of a workout. Future work could also be sharing the user his information with friends and family and using GPS data. And an inclusion of diet, overall mood etcetera could also give the workout a better quality. Rating the workout and reviewing it are also improving features for MPTrain. [39]

5.2.7 Shakra

Shakra is a mobile phone application that tries to motivate adults in being active, especially adults who currently are not getting the minimum recommended daily activity. Shakra keeps track of the user his activity by using phone cells to get the location of the user every 30 seconds. The levels of activity in Shakra are 'stationary' (no movement), 'walking' (moderate activity) and 'driving' (e.g. traveling by car, bus etc). Using the moderate activity, Shakra will set up an activity schedule per day. It has to be taken in account that exercising in a gym for example is not tracked. The data that is recorded will be sent to a MySQL server and will be shared with other participants every hour. Syncing directly is also possible. [2]



The argument over using GSM signals to measure activity instead of an accelerometer was the need of external hardware, the accelerometer. Four out of nine participants directly indicate an increase in activity. But it is shown that also the other participants moved more compared to a diary they kept before using Shakra. The participants also liked that Shakra showed the results of other participants and that got some of them quite competitive. They saw Shakra as a game, mutual awareness tool and self-monitoring device. Future work are improving the accuracy of measuring movement and usage of better analyzing techniques. It also has to be tested how this improves the physical activity on the long term and how it is going to weave in everyday life. And it is suggested to have all the hardware and software in one device so no specialized sensors or irritating attachments to the body have to be made.[2]

Figure 24; Shakra: The phone interface. Images a) and b) show two of the screens showing the estimated current activity level: Stationary and Walking. Images c) and d) show screens for examining relative and individual activity levels: Compare Daily Activity and This Week's Activity. [2]

UbiFit Garden

UbiFit Garden is an on-body sensing system which gives real-time information on the user his personal mobile display. It is developed for people who are aware they need regular physical activity, but who (almost) have not started with it. It consists of a fitness device which passes through the physical activities. These activities are shown in details on the user his display where the user also can journalize his activities. [4]

UbiFit Garden is able to register walking, running, cycling, using an elliptical trainer and stair machine by using 3-D accelerometer and barometer from the Mobile Sensing Platform (MSP). This is a small computer with sensors that can contact to the user's mobile phone. Expected is that future phones take over the MSP possibilities. The user can add activities that are, for several reasons, not measured by UbiFit Garden. The user can view a daily activity list, see the weekly goal status, physical activity behavior and receive subtle reminders to stay active. In the screen each thing represents something. A large yellow flower in the upper right corner is shown when the weekly goal is achieved. White butterflies remind the user of past successes and thus represent recent goal attainments. The different types of flowers, as shown in Figure 25, represent the different physical activities suggested by the American College of Sports Medicine (ACSM). They recommend in order having a well-balanced physical activity routine: cardio, resistance training, flexibility and walking. To contribute to a physically active lifestyle these programs should support a range of activities instead of just one, like walking. If the user is inactive he will not be punished for this but the garden just will be empty. [4]

Figure 25; UbiFit Garden: a) at the beginning of the week—small butterflies indicate recent goal attainments; the absence of flowers means no activity this week; b) a garden with workout variety; c) the display on a mobile phone—the large butterfly indicates this week's goal was met. [4]

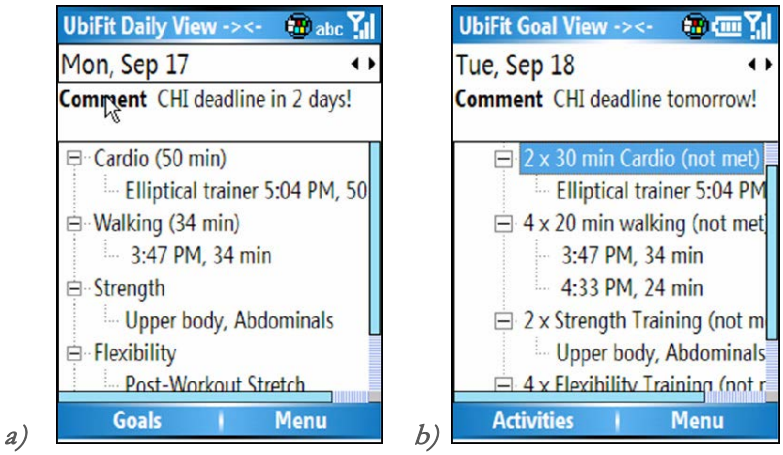


Figure 26 UbiFit Garden: Screen shots from the interactive application. The user's a) daily activity list and b) goal view, showing progress. [4]

Some examples (see figure above) for receiving flowers are doing a 40-minute run or a 3-hour bicycle ride to receive a pink cardio flower. A sunflower is given for a 22-minute walk. A yoga class gives a white flower and a blue flower is given for weight lifting. Walking and cardio have to take at least 10 minutes of the user his time in order to receive a flower. The height of the flower has no meaning. UbiFit Garden state that their trial showed the usefulness and credibility increases when users are allowed to manipulate and add to inferred data. Most participants became quite motivated by the garden. Result also suggested that the ACSM varied exercises were supported by UbiFit Garden. It is also stated that the sensors, even when implemented into a mobile phone, cannot always be used. Think of contact sports or water sports for example. Future work showed that some activities, especially cycling, must be retrained because it did not perform as desired. [4]

5.3 Comparison and discussion

5.3.1 Measuring physical activity

Chick Clique, Houston, Fish'n Steps, NEAT-o-Games, Shakra and UbiFit Gardens have similar aspects, so comparing these games/programs can highlight some of the positive and negative points. They all measure a form of physical activity performed by the user, but use different technologies and methods. Chick Clique, Houston and Fish'n Steps measure the steps taken by the user with use of a pedometer, while NEAT-o-Games and UbiFit Gardens do the same with use of an accelerometer. Shakra uses the cell towers of the mobile phone network to measure traveled distances. The pedometers and accelerometers here are external hardware that has to be worn by the users. Shakra uses the cell phone network so no additional hardware is needed to measure the traveled distance, which is a great advantage. In Fish'n Steps for example, users complained about the intrusiveness and procedures of the device which prevented users from engaging. In Chick Clique the developers implemented the pedometer into a belt so the participants could wear them disguised. In most studies future work stated that the measuring device should be built in. Overall any hardware that can be left out, for example by implementing it into the mobile phone is positive progress. When pedo- and accelerometers are not additional hardware people cannot forget them, cannot complain about it and cannot forget or dislike having to enter received data from the device. The technology nowadays is far ahead of the technology that was available when these games/programs were developed as almost every Smartphone now has a build-in (tri-axial) accelerometer (and possibly a gyroscope). In that way it is capable of measuring steps, and depending on the addition of a gyroscope or tri-axial accelerometer it is also possible to measure other activities like cycling quite accurately. Compared to the position system of Shakra having a (tri-axial) accelerometer (and gyroscope) is much more desirable because it can measure different activities and does not require a cellphone signal which can be problematic inside a building for example.

5.3.2 Storage of data

In Chick Clique, Fish'n Steps, NEAT-o-Games, Shakra and UbiFit Garden the physical activity was automatically saved, as for Houston the users had to enter their step count themselves. As in Houston [37] was stated, doing it manually positively affects the level of physical activity and by doing it automatically it has potential to reduce awareness and a chance of introducing deceptive data. But doing it automatically gave a continue record of data and users do not have to log in every time anymore. In that way they also cannot forget doing it or enter false data. Because the accelerometer is already implemented in Smartphones, data can automatically be stored in the program. It is possible to let users log the data themselves, but that is not desirable. First of all it is making usage more complicated for the user and combined with a busy lifestyle people tend to forget logging the data.

5.3.3 Multiplayer aspect

Except for UbiFit Garden, all these games/programs have a multiplayer aspect. In Chick Clique it is possible to set up a group to share step count which is a real simple program. Houston does the same but in a much more extensive way. Shakra is just like Chick Clique quite simple but uses traveled distances instead of walked steps to share with other participants. NEAT-o-Games use all physical activity in order to make the user his avatar walk circles. In Fish'n Steps the counted steps are influencing the animated fish of the player. Chick Clique and Fish'n Steps can only be used for up to 4 players while Shakra and Houston can add even more players. NEAT-o-Games can only have 2 players playing the NEAT-o-Race against each other. With this multiplayer mode all the games/programs use the power of peer-pressure to stimulate physical activity. As stated by some users from Chick Clique, group performance was the most powerful method to change behavior. And in NEAT-o-Games the competitive character was a positive point of the game. When people are participating in a multiplayer based game/program their commitment to perform physical activities is higher than with single player mode. People do not want to be the worst

player or are quite competitive into becoming the best. Players also will not quite playing as fast as they would have done when they played alone.

5.3.4 Sharing results

In Houston, Chick Clique and Shakra the step count was circulated among the participants. The method with which this was done (e.g. text message) is in this research irrelevant. The emerging mobile internet is the future of up- and downloading data. According to the CBS (2011), 20% of all the internet users also had access to internet with their mobile phone. This is mostly due to the upcoming Smartphone and has quadrupled since 2007. Almost half of the people aged from 12 to 25 that use internet, also use mobile equipment to internet. The people aged 25 to 44 are using mobile internet above average.[40] And with the technology, mobile phones and telecom network improving, the usage of mobile internet will probably increase rapidly. From the games that circulate data to the players, Houston was the only one which lets players chose which data should be shared and with whom.

5.3.5 Interface

There are quite some differences in the interface of the games and the things that can be checked. In Chick Clique only the group performance in the form of taken steps and achieved level of the player can be seen. In Shakra the daily and weekly activity was shown. In Houston players get overviews of the daily goal, average daily step count and overall progress. They could also get recognition for achieving a goal, add comments to their step count or that from their buddies and get overviews of their progresses. In Fish'n Steps players could see on the computer the number of taken steps, steps needed for the next level of the fish-growth, burned calories and who won the team-competition. For NEAT-o-Games players could see the game screen, activity history and a selected avatar that is pleased or not due to the physical activity of the player. And in UbiFit Garden the user can view a daily activity list, see the weekly goal status and physical activity behavior. Positive are the Houston's comprehensive overviews which provide the players with plenty of information. This definitely is better than the overview of the other games with regard to physical activity, but the burned calories as shown in Chick Clique and Fish'n Steps would be a good addition.

5.3.6 Avatar

Using avatars for the game, like in Fish'n Steps, is a good method to bind users to the game. In Fish'n Steps for example, many users felt a certain responsibility for their fish and did their best to prevent it from crying. Physical activity influences thus the emotion of the fish and also causes growth. NEAT-o-Games also used a sort of avatar in their game which was walking in circles as the player was physical active. They also used an avatar that was pleased or unpleased depending on the activity of the player. Shakra did use two images in the home screen which stated inactive and active. In comparison of these games with their used avatars Fish'n Steps comes out the strongest. Most participants bonded with their fish resulting in increasing physical activity. Trying to prevent the fish from crying indicates that emotions are important for an avatar. Giving players a purpose, like reaching the next level so the fish grows, is also a good method to increase physical activity. The walking avatar from NEAT-o-Games is a nice feature, but during walking or running watching it can be unhandy and also will become boring quite fast. And as players stated, the emulator should be adjusted so when players started running the avatar should also run. The avatar in the home screen showing whether it is pleased is just like in Fish'n Steps a good idea. Players can see right away if they did a good job or not. As for UbiFit Garden, there was not really an avatar, but it had a garden with flowers which were earned by accomplishing certain tasks. Earning flowers and therefore having a cheerful background can work motivating and is possibly in combination with the Fish'n Steps avatar a good idea.

5.3.7 Communication between players

In some games or programs it is possible to contact other participants to encourage each other for example. Chick Clique does not have such an application build-in, but relies on friends who text each other. Houston has the option to comment the step count and sending messages to buddies. Fish'n Steps has an anonymous chat function to communicate and Shakra and NEAT-o-Games did not have a communication system at all. Using only a direct chat is not the best option, because players then have to be both online in order to communicate. Having an indirect chat, thus messaging system or using comments can be a good idea as it can encourage players into being physically active.

5.3.8 Behavioral change

Then there are the games OrderUP! and MPTrain. OrderUP! who try to change the behavior of people by using a casual game. Using a stoplight people get a quick rating of how good their answer was. Doing so has the negative side that people do not know why their answer was wrong. On the other hand, not knowing could also stimulate people to look it up on the internet. Giving some additional information is better because people then for sure get (the correct) information. People often forget to look it up later or are not interested anymore. Perhaps by hiding the information and let it pop-up if asked would be a good method to provide additional information if required. The decreasing of points instead of increasing is not a good choice as it does not really motivate. The best choice is still to make players lose points. People will also not play this game on a long term. This game could be a good addition to the NEAT-o-Games and with use of earned points give a hint for in the NEAT-o-Sudoku.
The idea of MPTrain is quite good, because using music in this way is increasing the physical activity and also making exercising significantly more fun. The first disadvantage is the need of external hardware, namely the sensors which measure heart-rate and step count. As said before step counting can now be done with Smartphones, but to measure heart-rate additional hardware is still necessary. When leaving out the heart-rate and by using the music to help users increase their pace for example, this could be an additional feature of physical exercise games/programs. As proposed for future work, implementing GPS data and sharing information could also be a good idea to do which with the technology nowadays is a possibility.

5.4 Conclusion

Comparing the games gave a few good points which could be of great use in the design of the serious game. With use of a Smartphone for the game, (tri-axial) accelerometer (and possibly a gyroscope) is included so measuring physical activity has many possibilities and does not need additional hardware. The data measured from the user his physical activity should be saved automatically to create and receive better results. The game should have a multiplayer option in order to stimulate physical activity and should support enough players to maximize fun and stimulant. The data which is shared should be controlled by the players themselves in a way that they decide who is getting what information. When looking at the interface Houston has the better one, using different kinds of oversight from the player himself as well of other players. Besides showing steps, it is also important to show how much calories are burned by doing those steps. Using an avatar in the game is an excellent idea. People bond with their character and become physically more active when their avatar benefits from that by showing human emotions or growth. It is also important that players can contact each other in order to give positive feedback or discuss things. The possibility of a chat besides a message system is optional but not necessary. The idea of using specific songs while listening to music during exercises is a good idea to stimulate physical activity. In Figure 15 is an overview of the games given showing their characteristics.

	Exercise form	Food tips	Multiplayer	Sharing data choice	Possibility to communicate with players
Chick Clique	Step count	Yes	Yes	-	-
Houston	Step count	-	Yes	Yes	Yes
Fish'n Steps	Step count	-	Yes	-	Yes
OrderUp!	-	Yes	-	-	-
Neat-o-Games	Overall physical activities	-	Yes	-	-
MPTrain	Step count	-	-	-	-
Shakra	Step count	-	Yes	-	-
UbiFit Gardens	Overall physical activities	-	-	-	-

Table 15; Comparison of the serious games and their characteristics

6 Overview literature studies and game comparison outcome

- Answering the research sub-questions -

In the past chapters literature studies about 'Overweight, Obesity and Weight Management', 'Serious Gaming' and 'Behavioral Change' were conducted and a 'Game Comparison' was made. This knowledge is necessary for designing a research-based serious game for treating overweight and obesity. In these past chapters a wide variety of subjects were discussed and a selection of research-based serious games were compared, but a clear overview showing which choices should be made in designing this serious game were not yet given. In this chapter these findings will be written down answering the research sub-questions listed in the introduction.

6.1 Literature outcome; Overweight, Obesity and Weight Management

In this part an answer will be given to the following research sub-question:

What are effective methods for treating and preventing overweight and obesity to contribute to a healthier lifestyle with view on implementation in serious gaming?

6.1.1 General

To measure overweight and obesity in adults, the body mass index (BMI) is an easy and good method to use. By dividing the weight by the squared height of the person, the BMI score can be determined. A BMI score of 18.5 - 25 is considered as normal, 25 to 30 means overweight and 30 or higher is classified as obese. For Children, especially in puberty, overweight and obesity is difficult to determine and the use of BMI is not accurately enough. Therefore when using BMI scores as starting point, the target group should be adolescents and adults. [9] In the Netherlands over 50% of the adult population is overweight of which 14% is obese. If an adolescent is obese, there is an 80% chance of also being obese as an adult. [8] Therefore it is extra important that the serious game addresses adolescents and depending on the outcome of the design perhaps also children if possible.

When alerting people on overweight it is better to point out to the unhealthy life years that can come with it then pointing towards the decrease in life years. Suffering from diseases, being unable to work, et cetera has a much higher effect on people than knowing the life years are less. The most important determinants of overweight and obesity are environmental and individual factors. Having a sedentary lifestyle and eating micronutrient poor foods promotes weight increase. As for environmental factors, it shows that people living in the same family often are all overweight or obese as they share habits and live in the same environment. [8] For the design of the serious game it therefore can be quite important to use multiplayer options so people who influence each other can then stimulate one another in becoming healthy. The serious game should also try to change the individual factors, as for sedentary lifestyles this could for example be physical activity during working breaks. Achieving a weight-loss of 10-15% is seen as a successful treatment for people with obesity as in the United Kingdom the NICE-guideline called 5% already clinical relevant.[8] The literature study Literature; Overweight, Obesity and Weight Management' showed that using diets for a serious game was not optional. First of all is dieting not a method that can be used easily for everyone and also is not always the answer to the problem. People differ from each other and may need different approaches to lose and maintain weight. Nowadays there are many types of diets and with our current knowledge and time-table it is not possible to give advice about dieting. Following a diet should be accompanied by a qualified dietician as it could do more harm than good when applied incorrectly.

6.1.2 Physical activity level

Besides diets, physical activity and behavioral change were researched methods to lose weight and increase health. Physical activity norms to lose weight defined by the government and by people who support these

norms or defined their own were discussed. The 'Nederlandse Norm Gezond Bewegen (NNGB)'[11] which is achieved when someone is at least 30 minutes moderate strenuous physical active for five days a week is one of them. Then there is the 'Fitnorm'[11] which means that someone has to be strenuous active in their free time for at least 20 minutes a days, three days a week. And finally there is the 'Combinorm'[11] which shows the distribution of the percentage Dutch adults that meet the NNGB and/or the 'Fitnorm'. [11] Kemper (2004)[8] supports the NNGB theory, but says that for overweight and obese people this should be at least 60 minutes. Fletcher (2001)[8] supports this last advice of 60 minutes and adds that the intensity load must consist of 55-70% of the maximum heart frequency. According to Ooijendijk (2002)[8, 11] these daily exercises are very important as sports only contribute to 5% of the total energy consumption. And the clinical review 'Management of overweight and obese adults'[14] states that physical exercises should be moderate intensive instead of very high intensive, leading to exertion in order to prevent weight increase. Activities of moderate degree of exertion are also useful for sustaining for longer periods of time resulting in a relatively higher degree of fat oxidation over time and increasing energy expenditure by activities that are weight-bearing. According to the just named clinical review, overweight and obese people should be 60 minutes physical active with moderate exertion for at least five days a week, although for obese people 90 minutes would be more sufficient. This level of physical activity would also possible be sufficient to keep people that are moderately overweight from becoming obese. [15] According to the guideline 'Goede Voeding 2006'[15] these physical exercises should be 4 to 6.5 times the resting metabolic (4 - 6.5 MET). Examples of exercises that apply are brisk walking with 5 km/h, cycling (16 km/h) or for example gardening. This is however in general for the population not enough to prohibit overweight, says the literature in 'Overgewicht en obesitas'. [12] According to this advice it ten should be at least one hour a day of moderately strenuous activity. [15] Physical activity should become built in into the daily life like doing opportunistic exercises or be physically active after work. Also was given that sports could stimulate this behavior and so prevent a positive energy balance.

6.1.3 Target group

As stated before, the serious game should mostly address adolescents and adults, but this needs to be more specified. The purpose of the serious game is to help mainly people with overweight and obesity become healthier by losing weight. In the literature was shown that some people do not meet the NNGB[11], Fitnorm[11] and Combinorm[11]. This can be addressed, among other, to the overweight and obese group of people. It was researched that people who did not meet the norm are in three-quarter of the time still positive about physical activity and two-third of them finds being physically active enjoyable. Inactive people were less positive about physical activity and the majority does not enjoy it. In both groups they note that the environment of these people is also not physically active or very stimulating them to be physically active. Almost half of the people that do not meet the 'combi-norm' feel like being able to be more physically active if there is a will. In the group of inactive people this is just one-fifth to a quarter. In the literature was shown that it is wise to pay attention to everyday activities like work/school and the household. Especially work, with the increasing automation, computerization and stimulation of comfort, needs attention to prevent a decrease in physical activity. In particular work with poor movement tasks like policy- and administrative functions. According to Jans et al. (2007)[11] these people are struggling to compensate this sedentary lifestyle with more active leisure. But also physical household tasks are important because according to Stamataksis et al. (2009)[11] this can decrease the risk of premature deaths. Indications for increased inactivity among people are the modern form of leisure, like the increased average time people spend per day watching television. Also the mechanization and automation of work and transport, which results in a sedentary lifestyle increased. As for the youth, the time children play outside decreases with the years. Watching television and playing on the computer became more important and received more leisure time. [11]

6.1.4 Metabolic Equivalent (MET)

To give activities a value, the Metabolic Equivalent (MET) was conceived. Measuring in calories means that 1 MET equals about 1 kcal/kg/h (kilocalories per kilogram bodyweight per hour). To give an example of how MET can be used for counting burned calories a person who weighs 70 kg will be used. If this person exercises moderately intensive for about half an hour with 5 MET five times a week, he will burn about 875 kcal a week. Walking 6km/h is about 3 MET and jogging with 10 km/h is about 10 MET. MET values for different types of activities are given in Table 16. Jogging three times a week for half an hour gives about 1.050 kcal per week on calorie-loss. [8]

Table 16; Energy consumption in MET with different activities (Ainsworth et al. 2000, Fletcher 2001) (translated table) [8]

Activity	MET
Billiards	2,5
Watering plants	2,5
Household	3,5
Gardening	4,4
Walking (6 km/h)	5,0
Aerobics or ballet dancing	6,0
Skiing (alpine)	6,8
Jogging (10 km/h)	10,0
Squashing	12,1

Being moderately intensive active has preventive effects on chronic diseases as cardiovascular diseases, COPD and diabetes mellitus type 2 and shows that those people have three to five times less chance on those diseases than inactive people. It is also helpful for losing weight and lowering the blood pressure. [8, 13, 14]

6.1.5 Conclusion

It was concluded from this study that using the body mass index (BMI) is an easy and good method for measuring overweight and obesity in adolescents and adults. [9] It also showed that treating overweight and obesity during adolescence is important as there is an 80% chance of being obese as an adult when being obese as an adolescent. [8] When defining the target group, the main goal should be addressing to overweight and obese adolescents and adults overall. [9] Most of these people do not meet the norms 'NNGB', 'Fitnrom' or 'Combinorm' or are just inactive. They are often uninspired by their environment to be physically active and/or do not enjoy it. [11]

Also was stated that the environmental and individual factors are the most important determinants for overweight and obesity. Having a sedentary lifestyle and/or being part of a family where there are overweight or obesity problems weight increase is promoted. Using multiplayer options in a serious game could address to this problem by involving the environment in the game and stimulate individual and commonly physical activity. Achieving a weight-loss of 10-15% is seen as a successful treatment for people with obesity, as in the United Kingdom the NICE-guideline called 5% already clinical relevant. [8] The use or addition of diets for treating and preventing overweight and obesity is with the current knowledge and time-table not optional. There are many types of diets which should be accompanied by a qualified dietician as it could do more harm than good when applied incorrectly. Therefore is concluded that using physical activity to treat and prevent overweight and obesity is the best choice for this research. Within physical activity the best option is to let normal-weight people be 30 minutes moderate strenuous physical active for five days a week in order not to become overweight. For overweight people this should be at least 60 minutes and for obese people 60 or if possible 90 minutes. [8] [11] [15] It is also shown that daily exercises of moderate intensity are more important than very high intensive exercises which lead to exertion. [14] It is important to get physical activity build in into daily life, like walking for an hour after

work but also being more physical active during the day though opportunistic exercises. With use of a serious game being physical active can become less of a burden and more enjoyable, preferably together with people in the environment as multiplayer options can give stimulants to stay physically active. The physical activities have to embrace work/school like being able to play during breaks, but is should also embrace the free-time of the player afterwards. Using MET scores can help setting goals for the serious game in the design-phase or during the game itself. [11]

6.2 Literature outcome; Behavioral Change

In this part an answer will be given to the following research sub-question:

What are effective methods to cause positive behavioral changes in the lives of overweight and obese people to contribute to a healthier lifestyle with view on implementation in serious gaming?

6.2.1 Behavioral change theories

In this literature part the Transtheoretical Model (TTM) [19], the Social Cognitive Theory[20], the Theory of Planned Behavior[21], the Theory of Meaning Behavior[21], the Health Belief Model[22] and the Star Model[24] were discussed. Of these theories eventually the Transtheoretical Model (TTM) and the Social Cognitive Model were usable for the design of the serious game.

6.2.2 Transtheoretical Model (TTM)

When taking a look at the stages of change of the Transtheoretical Model, it can be concluded that for the people in the 'precontemplation' or 'contemplation' phase the game probably will not be suitable. The people in these two lowest stages are not ready to change and do not want to be helped or do not even know if they want to be helped yet. Helping and convincing those people falls outside the time and possibilities of this research. The people that find themselves in the 'Preparation' phase are the most suitable for using in the serious game. These are the people who want to take action quite soon and will seek methods to achieve their goal. They are in the stage that they will buy a self-help book, join health education classes or in this research, download the designed serious game. With use of the serious game, these people will advance to the 'action' stage where they have made changes in their life-style thanks to the game. If this was successful they arrived in the final stage, 'maintenance', where they will work to prevent relapse and become more confident. Most people relapse in the action stage, but 85% will relapse only one or two stages lower. In the design of this serious game a method should be found to prevent relapse, probably by using small steps in changing the behavior and by using social networks like multiplayer aspects to support players. The TTM also provides processes of change that are relevant for intervention programs. For this game only the last five steps are of importance because earlier was stated that the users of this game were in a state of behavior where they want to change. From these processes it often cannot be concluded directly how to use this in a serious game, but it certainly helps in the design for behavioral change. The processes that are useful in this case are 'Stimulus Control' where environmental things are removed to forget bad behavior. Examples are replacing fatty foods by fruits, but also parking further away than normal to get more physical activity. Then there are the 'Helping Relationships' which points to social support from therapists, buddy systems et cetera. In this serious game this can be done by using multiplayer options to create a kind of buddy system. After that, 'Counter Conditioning' is stated. This is learning other healthier behaviors to replace the problem behavior, like taking stairs instead of elevators and thus do opportunistic exercises. Then there is 'Reinforcement Management' which means rewarding good behavior. This can be done by earning things, receiving group recognition et cetera. And finally, 'Self-Liberation', which combines the belief of change and the commitment to act on that belief. Making choices and for example by promising this, the chance to keep committed is higher. [19]

6.2.3 Social Cognitive Model

When looking at the Social Cognitive Model it consists out of three key factors: the behavioral factor, environmental factor and the personal factor. The listed concepts from this model can be used for the game design. The first is the 'Environment' for social supports which for this serious game can be given by a multiplayer option. The 'Situation' is to correct misperceptions and promote healthful forms which can be done by giving information. The 'Behavioral capability' is promoting mastery learning through skills training. In this serious game it can be done by repeating for example physical exercises. For the 'Expectations' part, this serious game could model positive outcomes of healthful behavior, but only outcomes that have a functional meaning according to the 'Expectancies'. 'Self-control' shows that opportunity for self-monitoring have to be given but also goal-setting, problem solving and self-rewarding. 'Observational learning' is important to see how it should be. 'Reinforcements' promotes self-initiated rewards and incentives. For example by getting a better high-score or win from opponents. It is important to change behavior in small steps in order to ensure success ('Self-efficacy') and individuals need to be trained how to solve problems and how to cope with stress ('Emotional coping responses'). And finally, 'Reciprocal determinism' which is considering multiple avenues to behavioral change, including environmental, skill, and personal change. [20]

6.2.4 Other behavioral theories

The Theory of Planned Behavior[21], Theory of Meaning Behavior[21] and the Health Belief Model[22] were not directly useable for this serious game, but nevertheless can provide good information for better understanding of the behavior of individuals. The Star Model[24] also cannot be used due to time and the financial aspect as they use the target population for information and feedback when developing their program while for this assignment it is based on findings in literature.

6.2.5 Conclusion

From this summarized information it can be concluded that the target population are people who find themselves in the 'Preparation' state of the TTM. With use of the serious game they would then switch to the 'Action' stage and then even to the 'Maintenance' stage. To prevent relapse and stimulate people social networks are important. This could be social support from therapists but also buddy systems for example. [19] In the serious game this can be done by using multiplayer aspects. People also need to learn healthy behaviors to replace problem behavior which in this case would be replacing a sedentary lifestyle with a more active one. For example by doing physical activities and doing opportunistic exercises. Another important aspect is 'Reinforcement Management' or 'Reinforcements' which means rewarding good behavior. The possibility to earn things or receive group recognition would comply for this aspect. And finally it is important to change behavior in small steps to ensure success ('Self-efficacy'). [20]

6.3 Literature outcome; Serious Gaming

In this part an answer will be given to the following research sub-question:

What defines a serious game and is of importance to improve the adherence and to achieve positive behavioral changes when designing a health improving serious game to treat and prevent overweight and obesity?

6.3.1 Basic elements

In the 'Generic characteristics of serious games' was stated that a serious game consists of four basic elements, namely: the storyline, the game play, the interface and the visualization. If these elements are in balance a good game is created. Of course it has to have an educational part, but the four elements are of real importance to keep the game interesting. The educational part has to be integrated in a way that the player is enjoying the game and learns without really noticing. [1]

6.3.2 Designing games for Smartphones

According to the GFK Panel Services[1] 54% of the sold mobile phones in 2011 will be a Smartphone and the Dutch Bureau of Statistics (CBS)[28] researched that 43% of the Dutch population from 12 to 75 years of age used a Smartphone with internet in the last three months of 2011. The mobile phone internet doubled in the past year from 21% to 43%.[28] Using a Smartphone for this serious game is therefore a highly relevant option. With the internet growing and the mobile technology evolving, games and connectivity are perfectly applicable. Another huge advantage of using a mobile phone is the fact that most people carry their phones always with them. This means that the game can be played whenever it comes out. For developing mobile-phone-games there are some relevant characteristics, according to Trifonova's (2003)[29] concise overview:

- Applications meant for learning should support a playful interaction and needs to be self-explanatory. [29]
- The learning content has to be divided into small parts so that playing the game and learning can take place in short periods, i.e. a break. [29]
- Using the application whenever the user wants to is important, so it should be integrated in the situational and local context of the user. [29]

Surveys showed concurring basic rules with Trifonova's work when developing mobile games. These basic rules are:

- The learning content should not be the focus point, but instead problem-solving activities that result in arriving better skills and self-knowledge. In mobile Game Based Learning (mGBL) games these activities are based on Anderson and Kratwohl's learning goals in the year 2000; remembering, understanding, applying, judgement and analyzing. [29]
- Mobile games should be challenging, excited and should give feedback. They also should have short tasks for earning rewards. The games must not be all about learning with a gaming aspect but they must be real games. Prensky (2001) emphasizes that fun should be priority in a learning game and that the learning content should be second. [29]
- The learning game should keep the user central. The learning needs of the user, capabilities, level and information needs to stay relevant. The game must remain simple and lets the user be in control. Because of the possibility to play the game also in short amounts of time, like a break, results also should be given after these short sessions. And users should be given the space to make own preferences. [29]
- Keep in mind that a mobile phone has a small display and uses a battery. Do not replicate PC-style games. [29]

In the EU is mobile Game-based Learning (mGBL)[29] project some of the same points as above are noticed as success factors. The learning games have to be challenging, cause excitement, respect, have social experience, give feedback and enhance knowledge. The word 'learning' has to be mainly avoided with the youth, being incompatible with the concept of fun games. In order to quickly see the game skill values, feedback should be easily accessed and available. Also rewards are of great importance like getting approval from peers or gaining new information. Experts mentioned the importance of multiplayer gaming with collaborative and competitive options. Crucial here is the simulation of real-life communication with for example a convergence platform. For multiplayer games it showed that playful competitions were preferred above competitions with fast knock-outs. The mobile game should also been build out of small parts which the user can complete during game play in order to play during breaks for example. [29]

6.3.3 Everyday fitness games

When designing everyday fitness games based on ideas from Salen and Zimmerman the following design principles are important:

- Core mechanic; this is the set of interactions that is the most repeated during play and which should be used by the developer to influence physical habits. The interactions are hard to master but easy to learn which makes it interesting and fun to improve and learn these interactions. [31]
- Representation; this is how the game presents itself in the aesthetics and narrative form. Making a good representation means the game should not be to complex or to shallow. It should drive player's interaction, provide context and it should immerse players in the game world. [31]
- Micro goals; in games players have to achieve certain goals, which mostly are in the form of solving conflicts. By ensuring these goals can be achieved with little work a path of goals is set in order to complete the bigger goal. In this way players will not be overwhelmed and completing more goals provides more frequent gratification enticing sustained play. [31]
- Marginal challenge; the challenges provided in the game should meet the margin of a player's ability. This is important to keep the game experience fun, meaningful and stimulating to proceed to the next level. [31]
- Free play; some game designs can benefit from not setting to many rules. Thus in a way that players can play at their own pace where and when they like and if possible also how they explore the narrative of the game. [31]
- Social play; social relations in gameplay come in an internal and external form. Internal means the roles emerging from the formal structure of the game. External roles come from outside the game, like rivalries and friendships. For strong social play aspects it's wise to utilize internal roles to assist in establishing new external relationships. Communication tools can then help build and maintain those relationships. [31]
- Fair play; in social play the players should have equal chances in order to keep the gameplay fair. This should be embedded in the rules and core mechanic by for example given players that are behind temporary game-advantages in order to restore competitiveness. Or by matching player of approximate skill levels. [31]

Most of these points are evident and of great importance for the development of this serious game. These and the other principles will be well noted when designing the game.

Getting information about the performance of other player, e.g. friends or colleagues, is an important motivational factor and becoming the best is the driving force of its success. And also important, human opponents always insure a different game play, which supports sustainability in terms of motivation. [32] . Peng (2003)[33] showed that 43.35% of the internet users finds multiplayer gaming more fun. Using multiplayer options in mobile phones can be done in two ways; a remote-server game or a peer-to-peer game. With the internet availability these days a remote server would be the best choice as they are not bounded by distance. [33]

Using avatars in serious gaming can enhance game play. According to Yee (2009)[34] using athletic avatars in exergames may encourage users to do longer and more engaged exercise sessions. This is compared to avatars that look normal or represent the player's body shape. Lim &Reeves(2006)[34] in contrast found that letting players select their own avatar improves the engaging in gaming experience. [34]

6.3.4 Conclusion

From this summarized information it can be concluded that the serious game should become a game for Smartphones and if possible definitely with usage of mobile internet. It has to be easy to understand and with learning contents that are divided in small parts so people can play whenever and wherever they like

for short and long periods of time. The game has to be challenging and exciting and fun should be a priority in order to keep the player interested. The game has to give feedback, even after short tasks and has to be easy accessible and available. Short tasks should be rewarded by gaining things or getting approval from peers. Adding a multiplayer aspect to a serious game can provide deeper play experience and more important, can be used to encourage physical activity and work as additional stimulation. Using friendly competitions are preferable for this. Being informed on other players, e.g. friends or colleagues, is an important motivational factor and should be implemented if possible. For the design of a game using the internet, a remote server would definitely be preferred. Also using an avatar in the game can enhance game play.

6.4 Literature outcome; Game Comparison

In this part an answer will be given to the following research sub-question:

What research-based serious games are currently available for treating and preventing overweight and obesity and what can be used from these games to design a health improving serious game to treat and prevent overweight and obesity?

From the serious game comparison it can be concluded that the following things can be of importance for a serious game: when designing a serious game for usage on a Smartphone it should definitely be using the build-in (tri-axial) accelerometer (and possibly a gyroscope) for measuring physical activity. The received data should be automatically saved to avoid cheating or forget data-logging. The goal setting should be done with use of the given norms (NNGB, Fitnorm or the Combinorm) [11]. The game should have a multiplayer mode in order to stimulate physical activity which can be played by several players. The data which is shared should be controlled by the players themselves in a way that they decide who is getting what information. The interface should have different kinds of overviews from the player his own game, but also from other players to stimulate gameplay. Besides showing steps, it is also important to show how much calories are burned by doing those steps. Using an avatar is important for stimulating physical activity. People can bond to their avatar if it benefits from the player his activity an also having human emotions can help stimulating. For the multiplayer option it is important that players can contact each other in order to give positive feedback or discuss things. The possibility of a chat besides a message system is optional but not necessary. And finally the idea of using music during the physical activity shows to be a good stimulating option for being physical active.

7 Game Design

7.1 Introduction

In the first chapters of this thesis a literature study and game comparison is conducted of which the most important outcomes are summarized in the past chapter. With this outcome and with use of own insight and ideas a serious game is designed for the treatment of overweight and obesity. In this chapter the designed game will be explained step by step with additional drawings to clarify.

7.2 Selected game aspects from literature findings

The main goal of this serious game will be to increase the physical activity of overweight and obese adolescents and adults to stimulate weight loss and achieve positive behavioral changes. Although the game is mainly designed for this defined target group, it is also suitable for everybody else. Hopefully it also addresses to children as preventing and treating overweight and obesity at a young age is of great importance for future health.

Physical activity is chosen as the basis of the game because it is expected to give the best results for losing weight and achieving positive behavioral change in this time limited research. Main reasons for using physical activity are the easy accessibilities to activities like walking and the fact that large gains can be achieved on this platform. There are many opportunities and possibilities to be physically active but people often tend to remain leading their physically inactive lifestyle. An example is avoiding opportunistic exercises like using the stairs instead of the elevator. For this game therefore is decided to focus on physical activities that are readily easy and does not need additional tools. The main physical activity will be walking but also encourages jogging or running. Future work will be to research whether other activities like cycling can also be added.

The government tries to stimulate people to become more physically active, gave some good advices and has set up norms. Using these norms as guidance resulted in the decision to implement 30 minutes of moderately strenuous activity a day for five days a week for overweight people. For obese people this will be 60 to 90 minutes a day. The game will be suitable for work/school like during breaks, but also other daily activities will be valued in this game. In order to set up an activity-scheme the baseline of the user regarding to 'taken steps' will be used. The earlier given MET table will be kept in mind but not actively used. In the game burned calories will be showed to inform and stimulate the players. The choice for calories instead of the MET score is because calories are way more recognizable to the greater public.

For the platform of the serious game is decided to design it for the Smartphone because this is a rapidly increasing market with easy internet interacting possibilities and also are people almost always carrying their phone with them. That means people can play the game whenever and wherever they like and even more important, the (tri-axial) accelerometer (and possibly gyroscope) of the Smartphone can be used to measure physical activities which is be the basis of the game. To prevent cheating like shaking the phone, software which already exists and makes quite a good distinction between steps and shaking, should be used to prevent this. To stimulate people in being physically active the game will also have a multiplayer option. This requires an internet server to set up the multiplayer part and thus requires an internet connection on the Smartphone. Nowadays this is often not a problem as people have internet in their subscription or can easily use Wi-Fi. When players cannot use Wi-Fi continuously the game should update the physical activity of the player when a connection can be made.

The game will be easy to understand and learning contents will be divided in small parts. The game will be playable in short amounts of time, give feedback that can be viewed at any time and will give rewards for positive results. The challenges in the game will meet the margin of a player his ability to keep the game fun, meaningful and stimulating. For the multiplayer option fair play is very important and players will receive equal chances to remain competitiveness and of course the pleasure of playing. And finally to encourage players in being physically active there will be made use of an avatar which from now on will be addressed with 'character'.

The serious game that is designed will try to let people enjoy being physically active and hopefully let physical activity become build-in into daily life. That is when can be spoken of a behavioral change and that is what will be aimed for. It is not expected that people play the game for a very long period, but hopefully they achieve a behavioral change in a way that it will have a positive effect on the health of that person now and in the future.

7.3 Game Design Introduction

The designed game will be an application for the Smartphone which in this thesis will be designed with a view to the Android platform. This is a developer and user friendly operating system which momentarily and probably in the future remains market leader. The game however is not going to be actually developed during this thesis, only designed. The game is completely self-designed using the freeware program Paint.NET. The designs are made in screens of 500 x 900 pixels, representing current and future Smartphone screens. In this chapter the game will first be explained in a short version to give an overview of what the game will be like. Then in the following chapters the game will be explained extensively and the design drawings will be added to it.

For this serious game the Smartphone will be used on which the game will run as an application. The accelerometer of the Smartphone will be used to measure the physical activity of the carrier in the form of taken steps. Before starting the game a step goal will be set which depends on the player his BMI score, age and base-line (the average steps a player takes in a whole day). The intention is that the player achieves a new goal every day for five days a week. In this way the literature norms for the daily and weekly activity are met. In this game the daily goals will be held during the week, meaning on the Monday, Tuesday, Wednesday, Thursday and Friday. To stimulate players to stay active they will receive rewards in the form of credits for completing such a daily goal. No credits are given when the goal is not reached and for doing more physical activity than necessary extra credits can be earned. This is limited to prevent players from over-exercising. These five goals summed up together form the weekly-goal which when achieved will be rewarded with credits and a new level. When one or more daily goals are not reached, the player can still achieve the weekly goal but then has to make up for the remaining steps. This can be done by doing more steps than the daily goal requires (but is limited) or by doing it in the weekend on Saturday and/or Sunday.
In the game, a player gets his own character with choice between a boy and a girl version. The player is able to upgrade his or her character with credits they can earn during the game. The idea is to spend these credits in the shop to buy clothes and accessories for the character. The game can be played as single player but also as multiplayer, which is a strong aspect of the game when speaking of adherence. In the multiplayer part a group of maximum eight players can join a game together. The game also has a page which contains a race track where players can compete against each other individually. The whole track corresponds with the weekly goal of the player and is divided in five stages which resemble the five daily goals. The player his pawn on the track will be driven by the steps taken by that player. In other words, the player has to be physical active to go forth with his pawn. To keep the game fair, the baseline and level of the player will be taken into account. This makes sure that a beginning player has as much of a chance to win as an experienced player. The race starts in the beginning of the week on the Monday and ends in the weekend on Sunday. In the race there are also ways to earn credits to give players extra stimulant. Players can receive extra rewards for completing the stage of that day as fastest, which already was their goal. They are also rewarded for being the fastest over all five stages or by having done the most extra steps (thus more than their daily goal requires) over all five days calculated in percentage for fairness. This last bonus comes forth out of the possibility to earn credits for doing more steps than the daily goal requires. On daily basis this is made independent to the race because of the set limit to prevent over-exercising. To still somewhat involve this in the multiplayer part a bonus for overall doing the most steps is given. In the end of the week on Sunday evening the earned credits of each player will be summed up

including the credits that were spent in the shop that week. The final winner of the multiplayer part of that week will be the player with the most earned credits. The first, second and third place will then be rewarded with some extra credits. Then the race starts over again giving each player new equal changes to win that week.
To give players a good overview of their progress and activity history a page called the 'view screen' will be implemented in the game. On this page players are also able to see each other their character to show off their earnings which is done to stimulate physical activity. And finally in the game there is a part where the shop is established so players can buy clothes and/or accessories for their character. The main idea of the game is now given, but in the next chapter the game will be extensively explained with use of the design images to support the text.

7.4 Start-screen

When the game is started the start-screen (Figure 27) will be opened. This is a onetime screen that only will be shown when the game is started for the first time. In this screen the title of the game and the information blocks that have to be filled in are shown. Players then have to fill in their name, age, height and weight. Except for the name, this information will not be shown in the game or to other players. The age, height and weight will be used for setting up daily and weekly goals. The height and weight will be used to calculate the BMI-score which shows whether someone has a normal weight, is overweight or obese. When a block is filled in correctly it will turn blue which also applies to the selected character. When all information is filled in correctly, the white letters of the START-button will turn blue and the player can begin the game. The filled in start-screen is shown in Figure 27.

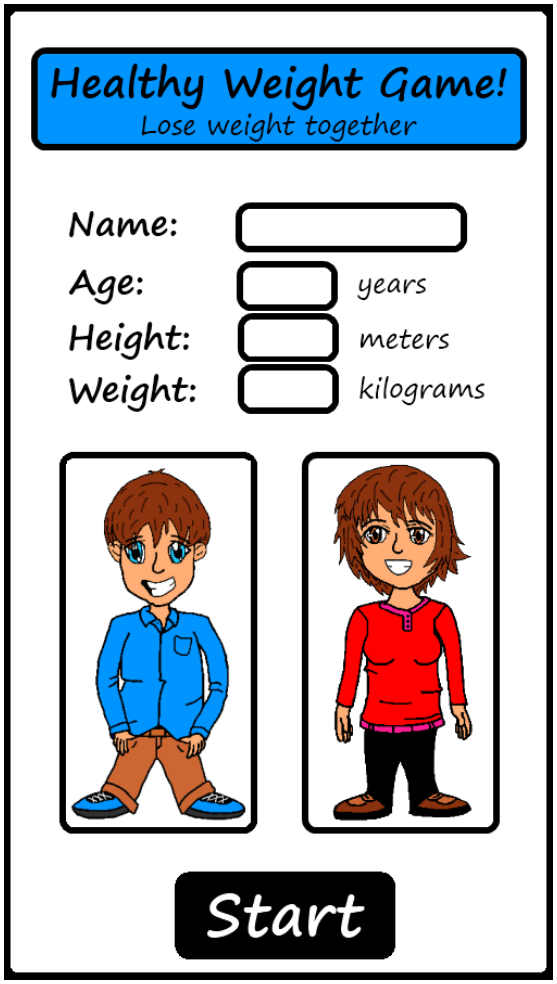


Figure 27; The start-screen

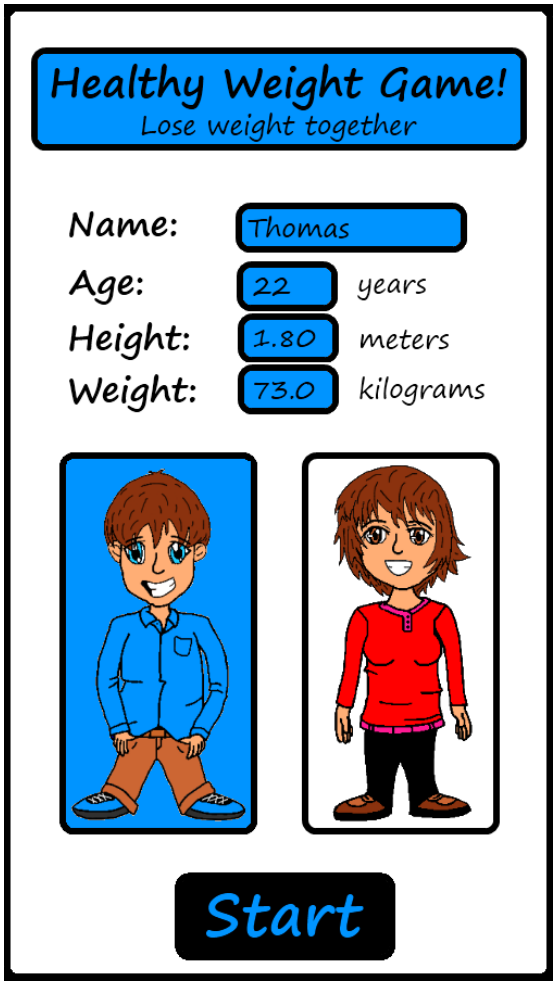


Figure 28; The filled in start-screen

7.5 Information-screen

The information-screen is the second screen the player will get to see when he presses the start button in the start-screen (Figure 27). In this information-screen (Figure 29) a tutorial-video will be played which explains the game to the player. The video shows what each screen contains, how to interpret it and what the rules of the game are. First is explained that the game has four tabs, each containing a part of the game. These parts are the 'Home' screen, the 'Race' screen, the 'View' screen and the 'Shop' screen. Then each of these screens will be discussed separately in the just named order. In the end of the video the player will be expressively told about the importance of the baseline measurement that needs to be done. The baseline is the amount of steps the player takes during an average weekly whole day. The game needs to measure this baseline in order to set up appropriate goals in the beginning and also to set up a fair gameplay in the multiplayer part of the game. To measure the baseline the player is asked to carry his mobile phone in his pocket for an average whole day so the game can register the taken steps of that day. It is also made clear to the player that this needs to be done to optimally fulfill the purpose of the game. The game runs in the background during the measurements meaning that the player still can use his Smartphone like normal. If a player truly carries his phone during that day and his steps are counted he will get rewarded with ten starting credits. Now that the baseline is set the game can be played.

Figure 29; The Information-screen

7.6 Home-screen

The home-screen (Figure 31 and Figure 31) is the screen that will be shown when the game is started, with exception of the first time the game is launched on the phone. On the top-end of the screen the four tabs are shown of which the home-screen is logically the first tab. These tabs are selectable so the player can maneuver through the game parts. The home-screen is mainly designed to show the player his character but also to show the steps taken that day, the daily goal, the weekly goal, the burned kilocalories of that day, the current level of the player, the credits the player has left and the progress bar of the daily goal. This can all be found with help of Figure 30. In the beginning the step count and burned calories are logically set on 0 because the player hasn't started playing yet. With help of the measured baseline the daily and weekly goal is set which in Figure 31 shows a daily goal of 8.000 steps and a weekly goal of 40.000 steps. For every new day the step count will be reset to 0 and a new daily goal is set. The weekly goal however remains the same. It is intentionally decided not to continue counting the steps after a day and thus summing up the daily goals because when a player is falling behind this will give a demotivating

signal. The gap between falling behind and being on schedule becomes bigger and by being confronted with the thousands of steps that the player is behind will demotivate him and he will be likely to give up. Therefore each player is given a fresh start everyday so they can try again to achieve the daily goal. The game however still keeps track on the remaining steps and will give the player the possibility to catch up in two ways. The first one is by doing more steps than the daily goal requires in order reducing the arrears. This method however is limited to prevent over-exercising. The second way to make up for the arrears is by doing those steps in the weekend. In this way players are still able to reach the weekly goal. In the home-screen are also shown the burned calories as they should encourage people to stay physically active. The burned calories will also be reset with every new day, just like the taken steps. On the right is the level shown where the player currently is at and also his earned credits. With every achieved weekly goal the player will increase one level which could also lead to his character losing weight. Credits are earned when the daily or weekly goal is achieved as well by doing more steps than necessary or by winning multiplayer game aspects. The way credits are given and the amounts will be shown in the race-screen chapter. In the home-screen the progress bar on the right shows the percentage of the daily goal that is already achieved in order to stimulate the player to continue being physically active. And finally there's the character, which takes the most space of the screen because of the importance of the character.

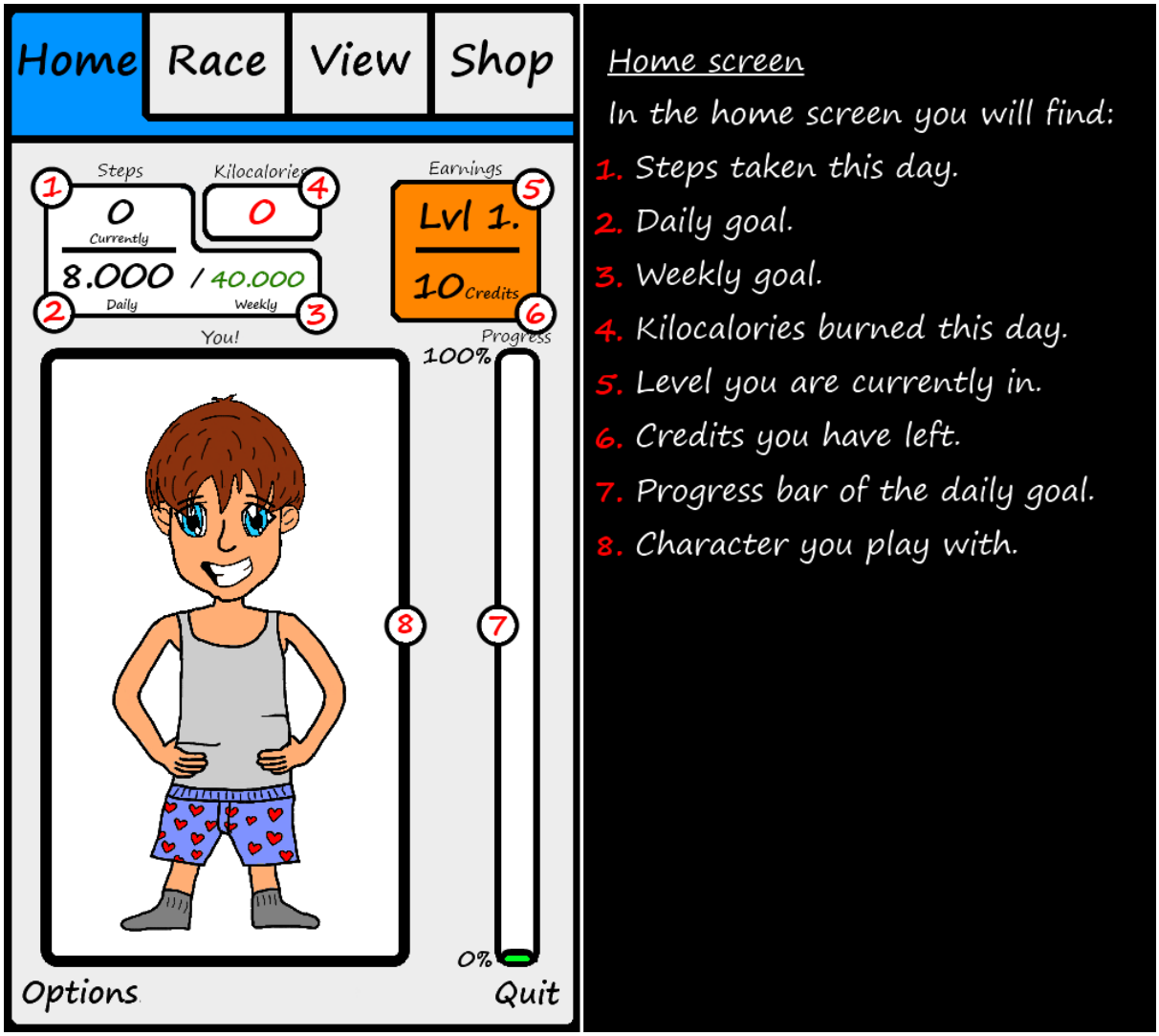


Figure 30; The home-screen with explaination of the numbered points

In the beginning of the game the player his character is standing in its underwear (Figure 31 and Figure 31) as the player has to earn credits to buy clothes and accessories. Depending on the BMI of the player the character will become chubbier with higher BMI-values. In Figure 31 is shown how the starting character will be if the player has a normal weight, which is the desired form for the overweight or obese players. In Figure 31 however is shown how the character will be for overweight or obese people. There is decided to make it chubby instead of quite overweight or obese to not insult people or make much difference between players. By leveling up the character becomes slimmer and leveling up can only be done by reaching the weekly goal.

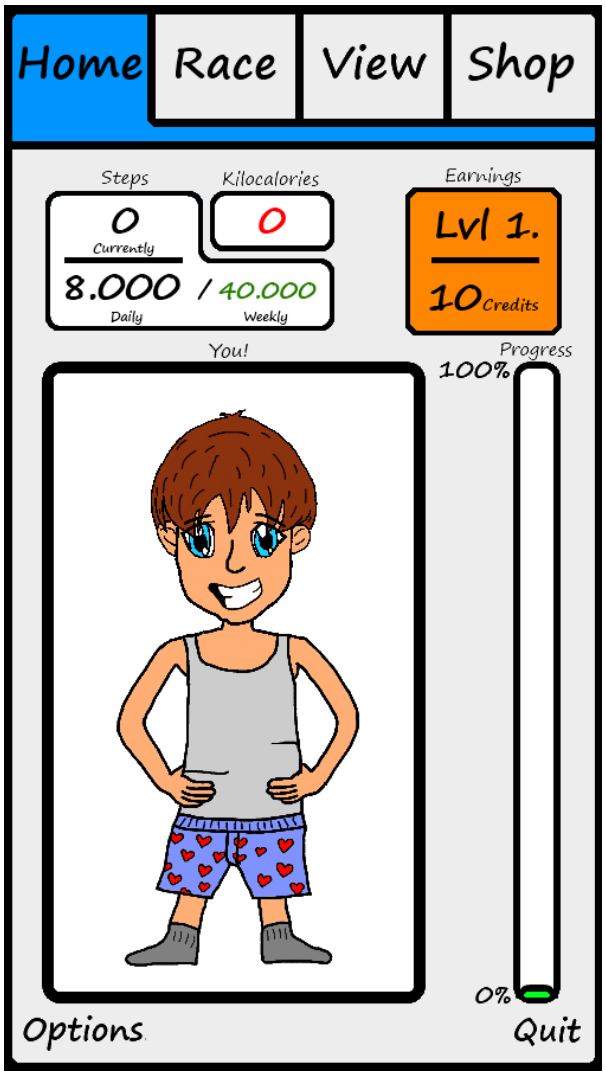


Figure 31; The home-screen of a normal-weight player

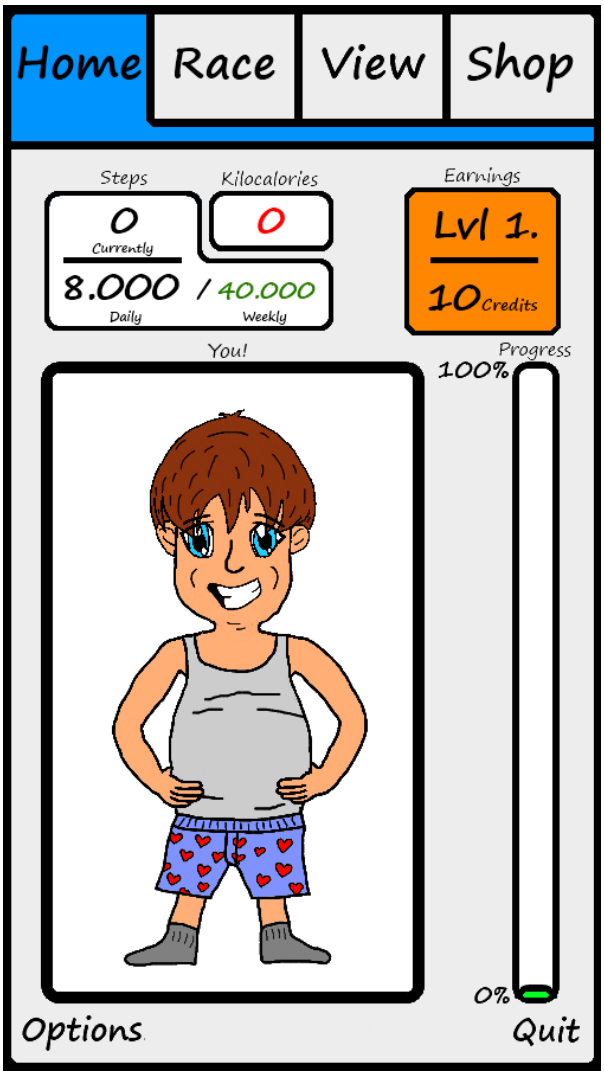


Figure 32; The home-screen of an overweight or obese player

To show how the character could look after for example three weeks Figure 33 is given. Here the player has walked 2.794 steps today which mean that he has burned 103 calories and is at 37% of his daily goal. He already reached level 3 and has 6 credits left. Apparently the player has used the other earned credits to buy a shirt, pants and shoes. What also stands out is that the character is standing in a relaxed position and is smiling. This indicates that the player is doing a good job.

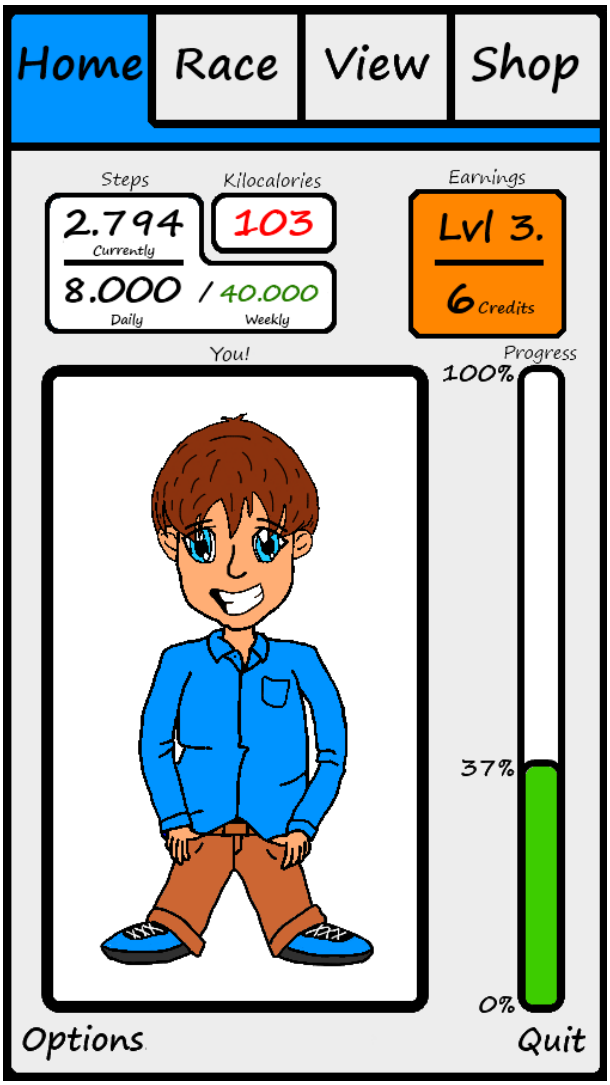


Figure 33; The home-screen of an advanced cheerful player

To stimulate players in be physically active there is decided to give the characters three different emotions. When a player is on schedule and doing fine, the character is pleased as was shown in Figure 33. When the player is not doing badly but could do better, the character is neutral as shown in Figure 34. And finally if the player is falling behind, his character will become sad which is shown in Figure 34.

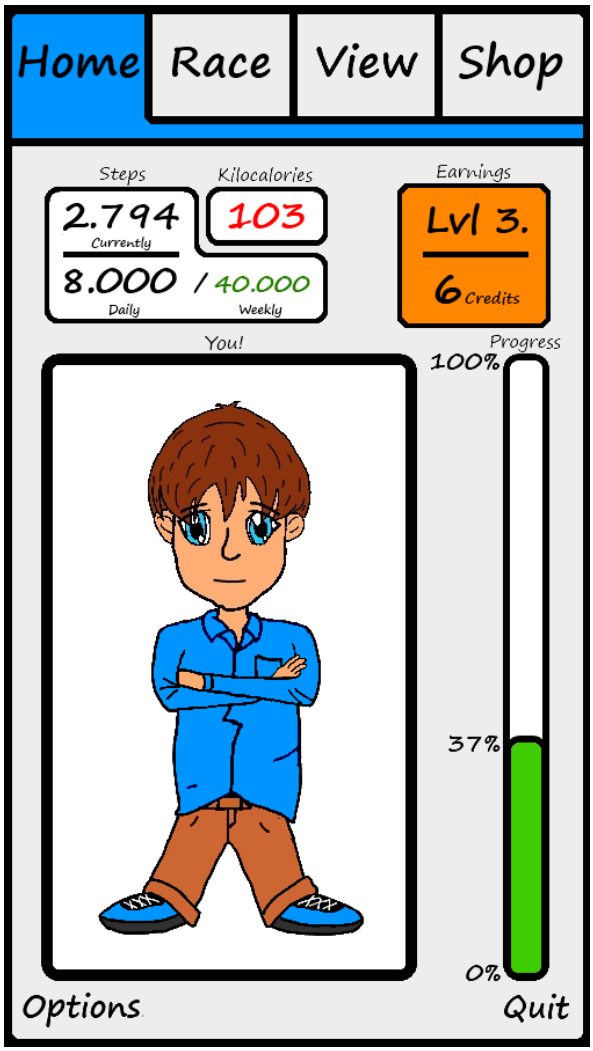


Figure 34; The home-screen of an advanced neutral player

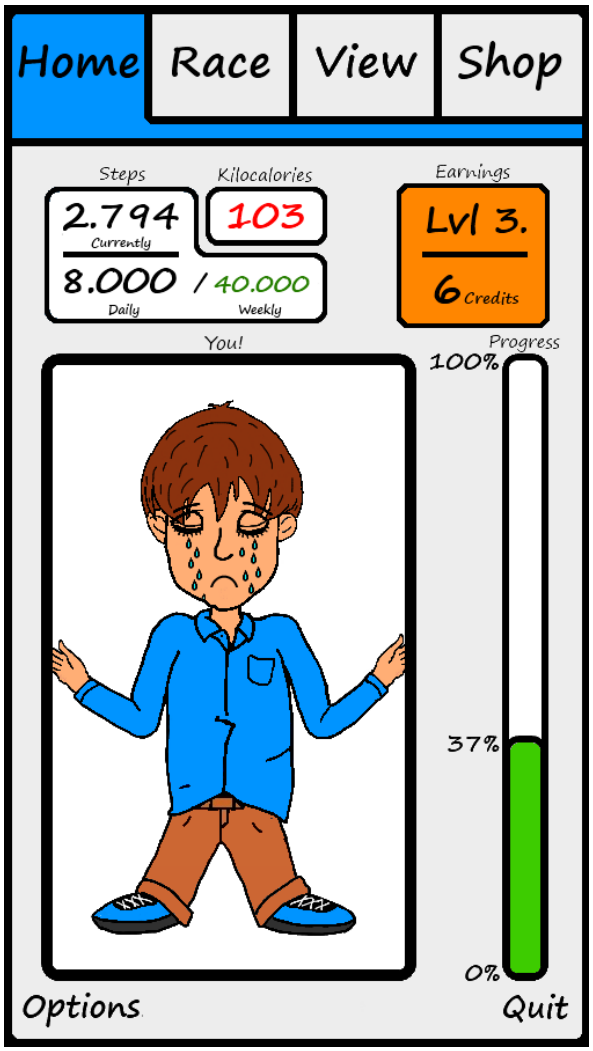


Figure 35; The home-screen of an advanced sad player

7.7 **Race-screen** (and distribution of credits)

The race-screen (Figure 37) is an important component of the game. The multiplayer part is developed to add fun to the game and to stimulate physical activity through rivalry. The race-screen consists first of all of the race-track itself that will lead the pawn of the player through dry lands, over waters, along forests and over mountains. Above the race-track the names of the three players that are currently first, second and third are shown. On the right the level and credits of the player is given, just as in the home-screen. On the left of the credits the rank of your own pawn is given, which in this case is the 4th place. And on the right the progress bar is shown. Note that this is not the same progress bar as in the home-screen. The bar in the home-screen shows the daily goal, as the bar in this screen shows the weekly goal because the whole race-track equals the weekly goal. On the race track is also a ghost-pawn shown with the text 'GOAL!' which shows where the player his pawn should be at that moment. If the label is red then he is behind and if it is green he is in front or on schedule, which is a good thing. The decision was to follow the government's norm of five days of physical activity which resulted in five daily goals that together form the weekly goal. Therefore the race-track is also divided into 5 stages shown by the green numbered flags. The first day of the multiplayer game is a race to the first flag, the second day you proceed to the second flag etcetera. If all players achieve exactly their daily goal they are all gathered at the flag at the end of the day. In practice this is probably not the case which means that gaps between some players will occur. All the players that just made it to the flag, i.e. they reached their daily goal, or didn't make it to the flag will nevertheless all start from that flag the next day (see . Figure 38). This choice is made to give

people that fell behind some stimulation to do better the next day, just like resetting the daily step count and giving a new daily goal. Players who have done more steps then their daily goal required from them will not only be rewarded with extra credits, but their pawn will also pass the flag for a certain distance. This distance is limited in order to keep the rivalry between the players intact. Although the credits will be discussed later in this part, it can already be revealed that players can earn credits for doing 10%, 20% or 30% more steps than the daily goal requires from them. To translate this to distance advances in the race track players are given respectively a 2%, 5%, and 10% head start in the next stage-race for doing respectively 10%, 20% and 30% more steps. The rewarded head start gets exponentially higher by doing higher percentages of steps. This is done in order to make the 30% steps even more appealing. So by doing more steps players are given a head start in the following stage race (see Figure 38). This advantage is not taken away with which is meant that if that player just reached his daily goal in the next stage-race and not further, he will still have the advantage of the previous head start. For example, if he got 30% more steps he was rewarded with a 10% head start. This means that this player only has 90% left of the distance to reach the next flag. If he then made his daily goal and not further then he is in fact back at the same position as before, which is 10% ahead of the flag. Therefore in the following race he will then start again with the 10% advantage he had before. If he didn't made his goal he can lose his advantage depending on how far he came. If this was 90% or less he will start at the flag like the other players that didn't make it. When for example this was 95% he still has 5% of advantage left. The last scenario is when this player did again more steps than the daily goal required. For this scenario is decided that the new advantage will be summed up with the previous advantage. With again 30% more steps this will give him now a 10% plus 10% is 20% head start. With this system a player is capable of getting a max of 40% head start in the final round. But after that final stage the weekly race is finished and a new one is started where everybody will start equally at the start. The advantage of still going for the extra steps in the last stage-race is getting rewarded for it and also for having done the most extra steps over the whole weak calculated in percentage as will be shown further in this chapter.

The winner of the race is simply said the player who has earned the most credits that week. People have different activity patterns which means it cannot be a time-race for determining the winner. Some of the players are active during their work while others for example go for a walk in the evening. Determining the winner as the fastest racer is therefore unfair and demotivating for many players. To remain rivalry between some players and keep it stimulated the time-race dimension is still used for earning credits like being the fastest of the stage-race or by being the fastest overall but for the fairness it will not be highly rewarded. This does not mean slower players cannot become the fastest, because by doing more steps than the daily goal required a head start can be earned which certainly can help to become the fastest. Especially when head start on head starts are earned. So for becoming the winner of the overall race the earned credits are decisive. All the credits earned that week will count for this including the spent credits that week.

It was not discussed before but players can earn the following credits for the following aspects:

- **Reaching the daily goal**
  - **Everybody***: 10 credits*
  - **Being the fastest**: *2 credits (only with the multiplayer game)*

- **Doing more steps than the daily goal indicates**
  - **10% more steps done**: *1 credits*
  - **20% more steps done**: *3 credits*
  - **30% more steps done**: *5 credits*

- **Reaching the weekly goal**: *20 credits*
- **Being the fastest player overall:** *5 credits (only with the multiplayer game)*
- **Having done the most extra steps**: *10* credits *(only with the multiplayer game)*
- **Becoming first, second and third in the race which is measured in earned credits that week**
  (Only for four participants or more, else only the nr. 1 is rewarded)
  - ***1st place:*** *30 credits (only with the multiplayer game)*
  - ***2nd place:*** *20 credits (only with the multiplayer game)*
  - ***3rd place:*** *10 credits (only with the multiplayer game)*
- **Not reaching half of the daily goal:** *-5 credits*
- **Not reaching half of the weekly goal:** *-10 credits*

With these rewards a maximum of 150 credits a week can be earned. This is if the player earned the maximum credits for all the aspects. In the game players can also lose credits to prevent them from not being physically active at all. If a player reaches less than half of the daily or weekly goal he will lose respectively 5 and 10 credits or even lose bought items if his credits cannot cover the withdrawal. The punishment is chosen to be half of the value that is given when the same goal is reached.

The credits of the player will not be shown to other players in order to keep it unpredictable and exciting. If attention is paid carefully players can still get a good prediction of how many credits another player has, but in practice most players will not be able to tell exactly how much. In the race-screen is shown who is currently first, second and third but the credits these players have earned are not given. In this way players hopefully are stimulated to keep going when they fell back because they cannot tell how far they are behind.
In the end of the week, when the whole race is played, a pop-up will be shown with the credits of every player in order of highest to lowest (see Figure 36). The bonus for being first, second and third is not added to the score in that scheme.

Figure 36; Race-screen pop-up at the end of the weekly race

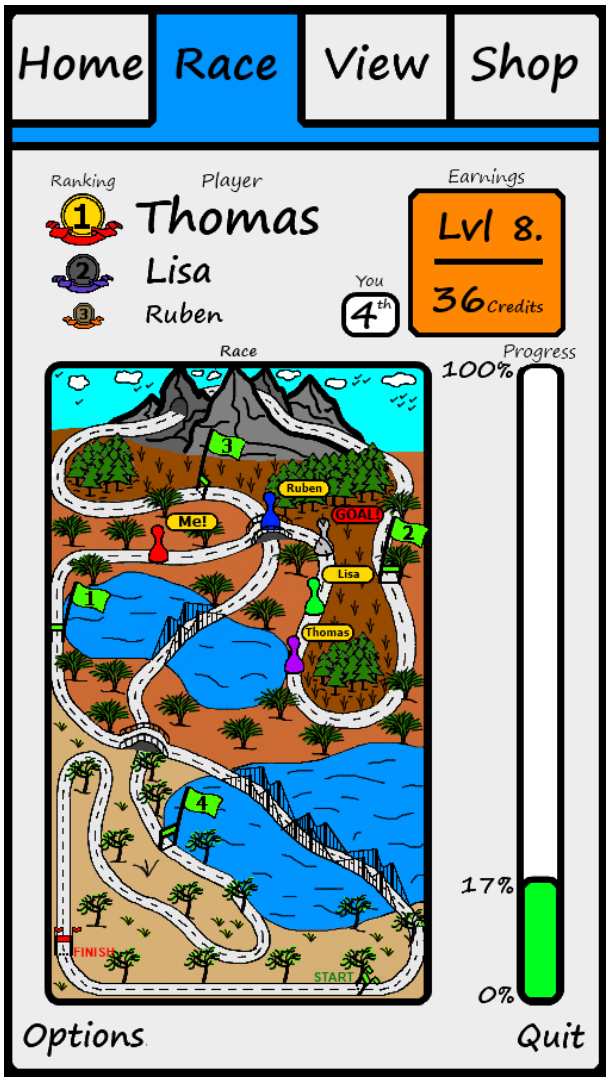


Figure 37; The race-screen during the second stage race.

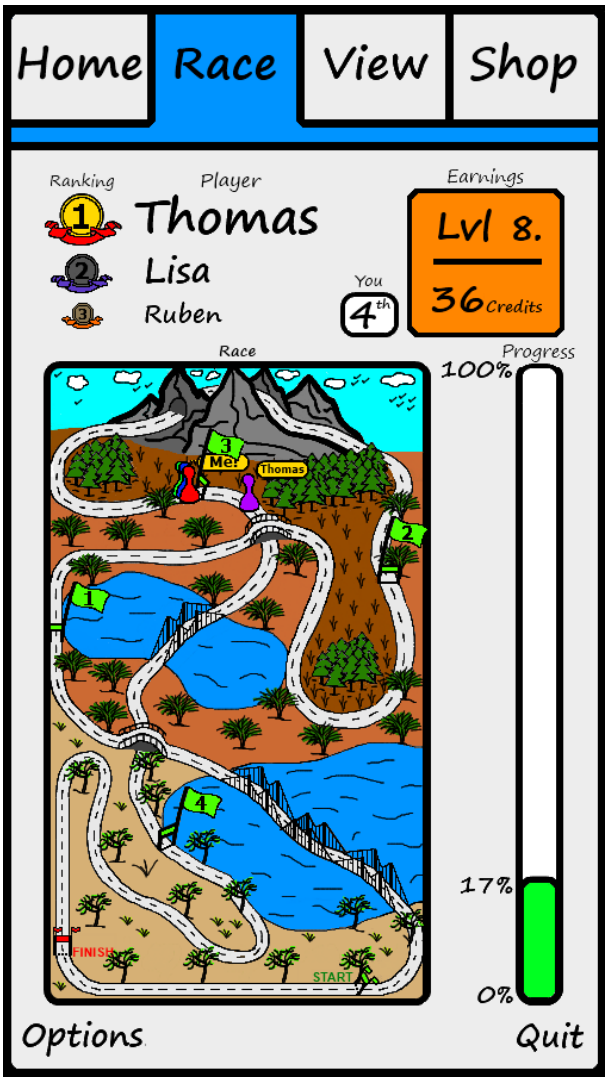


Figure 38; The race-screen when the third race is about to start. Thomas has a head start here.

7.8 View-screen

In the literature outcome came clear that players should always be able to check their progress and history. Therefore is decided to make a screen that shows this information, the view-screen (Figure 39). In this screen players can see each other their characters. In that way players can show off their earnings towards other players or show them how much slimmer they have become in time. Players can also check their own progress and activity history. In the screen is a graph given which can be set to day, week, month and year on the horizontal axis. For the vertical axis the player can choose between steps, kilocalories and kilometers. Above in the right corner is shown what the average steps are per day. The graph is a block diagram but this can be changed to other views in the options. And finally the view-screen shows if players are doing a good job or not in order to motivate them.

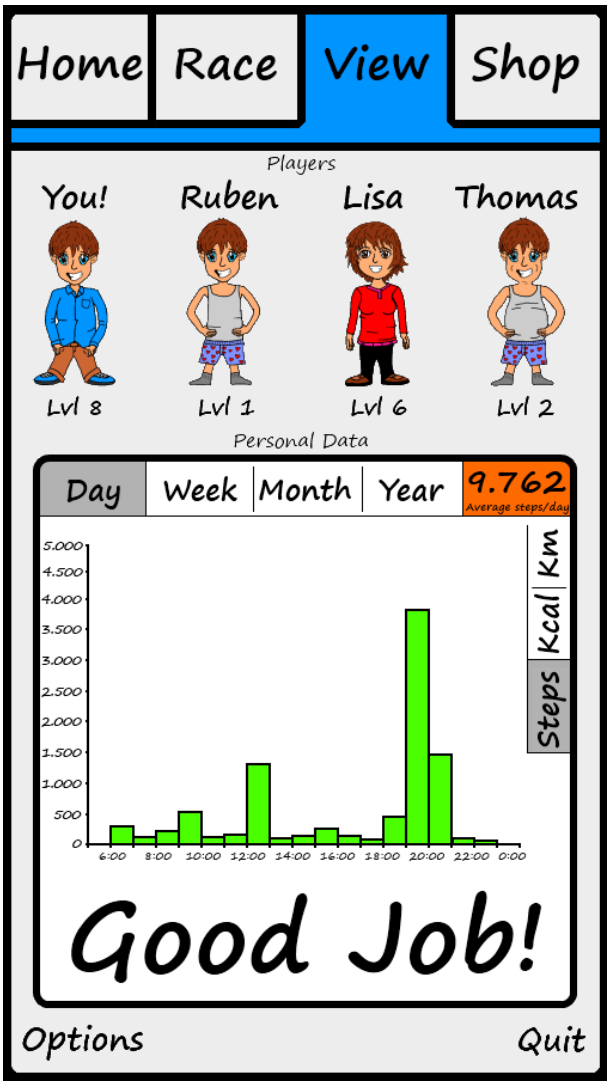


Figure 39; The View-screen

7.9 Shop-screen

In the shop-screen players can spend their earned credits to buy shirts, pants, shoes, hats, hair-types or accessories. To keep the players stimulated in the beginning none of the items in the shop are exposed. They are marked with a question mark and after leveling up the items under the question marks are exposed one at the time depending on the level the player is at. In Figure 40 the player has already played free the watch, necklace and mp3-player. These items cost credits which can be found under the item itself. The earned credits of the player are in this screen shown next to the character. On the other side is a previous and clear all button in case players want to cancel things they have put on their character or if they want to start over dressing up their character. With both buttons the bought items will still be available and in their possession. Besides that the character is looking better with the bought accessories there are also some nice gimmicks. For example when the watch is bought the player will be able to use a stopwatch. These are small things that will give a nice twist to buying items. However, the music player has a bigger advantage. When the music player is bought the player will be able to listen to music while being physical active. In the beginning there will be three carefully selected songs to choose from. These songs are selected on their beat in order to help people with their activities. The first number can be selected when walking slowly, the second for normal walking and the third for walking fast.

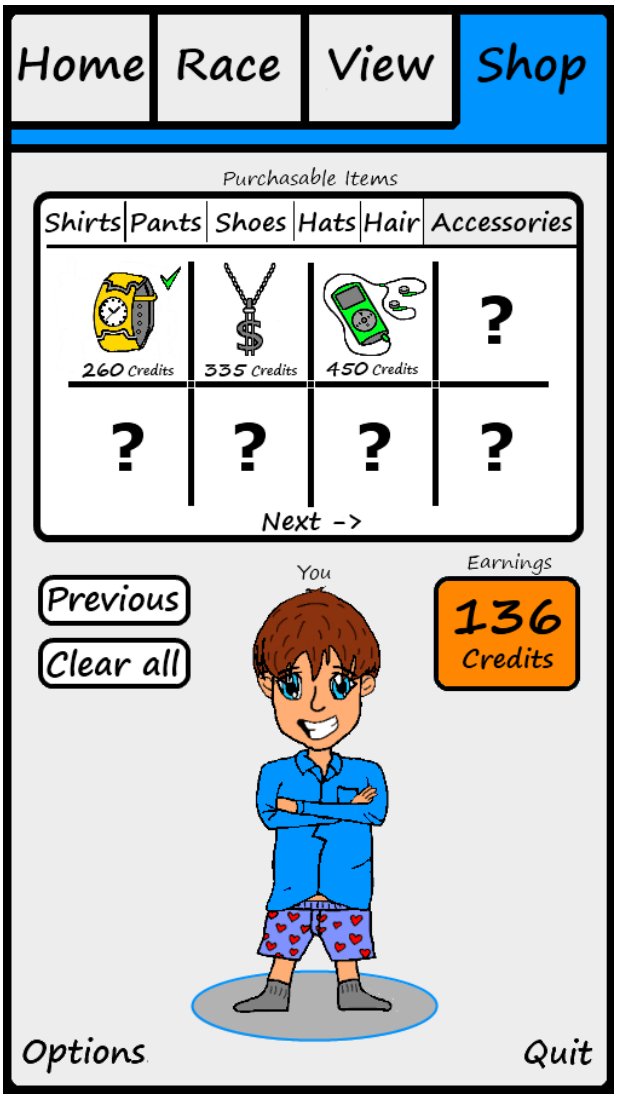


Figure 40; The shop-screen

8 Survey and evaluation

8.1 Introduction

To find out how the designed game is received among potential users an online survey was held. In this survey participants were shown the tutorial video (see appendix) of the designed game after which they had to answer questions (see appendix) related to the game. This survey was made using 'Thesistools' on www.thesistools.com and distributed on Facebook resulting in unsolicited participants. In this survey 53 participants, who filled in the survey completely, were used in the processing. With the outcome of the survey a good overview can be given of how the designed game is received among potential users. With these results the game can be improved as participants were also given the chance to give their opinion multiple times during the survey.

8.2 Survey outcome

In this survey participated 53 people of which 20 were men and 33 were women. The survey questions and their outcomes are given in the graphs below but can also been seen in the table of appendix 11.2. In both the graphs as the table is a distinction made between men and women. The bold values in the appendix table are the number of participants that voted on the options shown in the first column. Behind the bold values are the percentages given to give a better impression and overview. These percentages are also used making the graphs below for giving a better overview when discussing the survey outcome.

8.2.1 General questions

By evaluating the outcome of the survey some conclusions can be drawn. First of all needs to be noted that the participants of this survey are mostly between the age of 18 and 25 year (77.36%). This applies to both sexes (90% of the men and 69.70% of the women). Of the participants 1.89% is underweight, 69.81% has a normal weight, 22.64% is pro-obese and 7.55% is obese according to their BMI score. Men are in this case more overweight with respectively 40% pre-obese and 10% obese men in comparison to 15.15% pre-obese and 6.06% obese women. Also needs to be noted that most participants are well-educated shown by the 11.32% that does 'Hoger voortgezet onderwijs (Havo, VWO)', the 24.53% that does 'Hoger beroepsonderwijs (HBO)' and the 56.60% that is doing 'Wetenschappelijk onderwijs (WO)'. In this section the only significance between both sexes is that 70% of the men were doing 'Wetenschappelijk onderwijs (WO)' compared to 48.48% of the women.

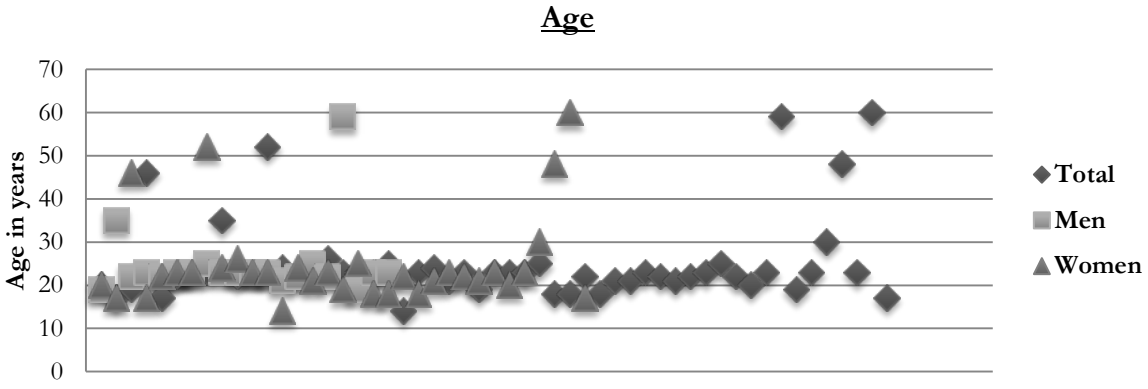


Figure 41; Outcome survey question: Age

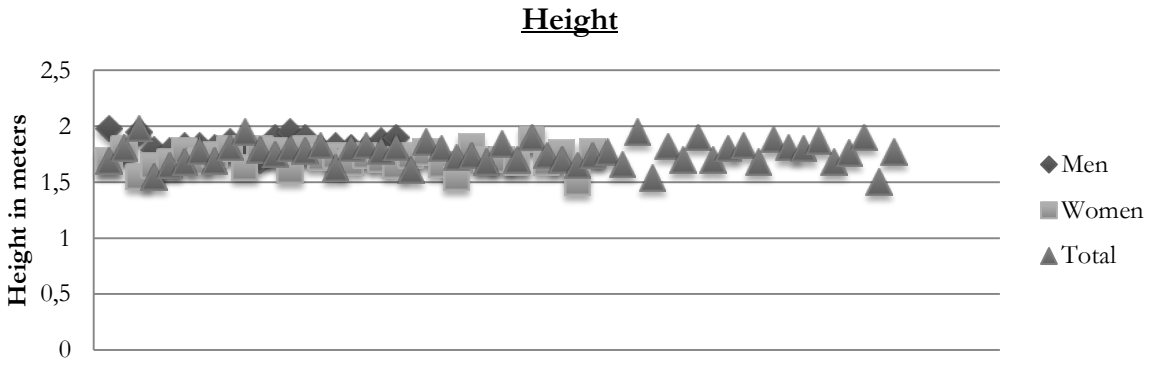


Figure 42; Outcome survey question: Height

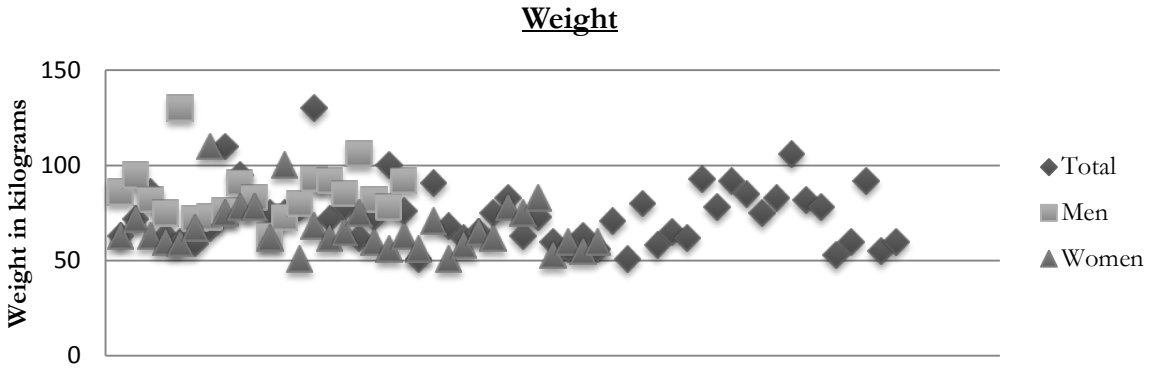


Figure 43; Outcome survey question: Weight

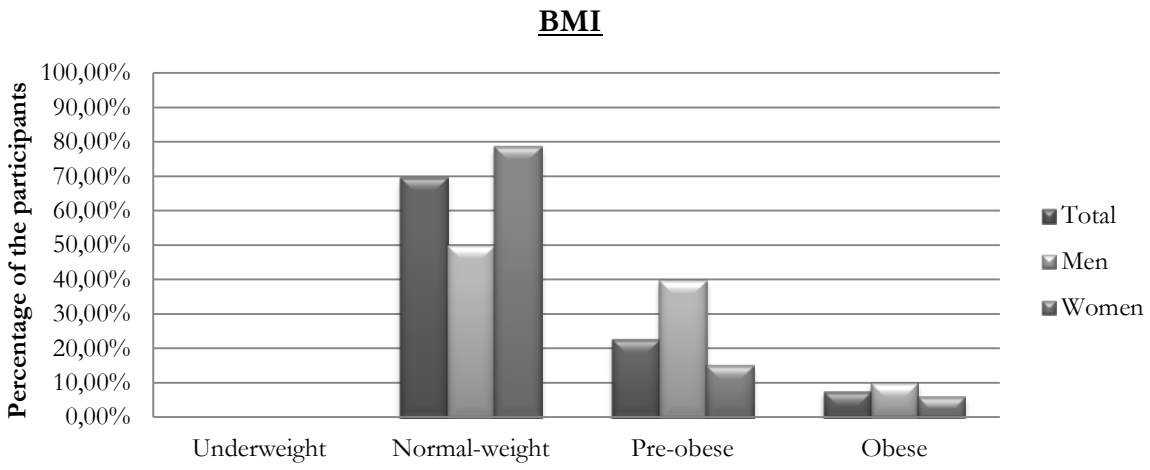


Figure 44; Outcome survey question: BMI

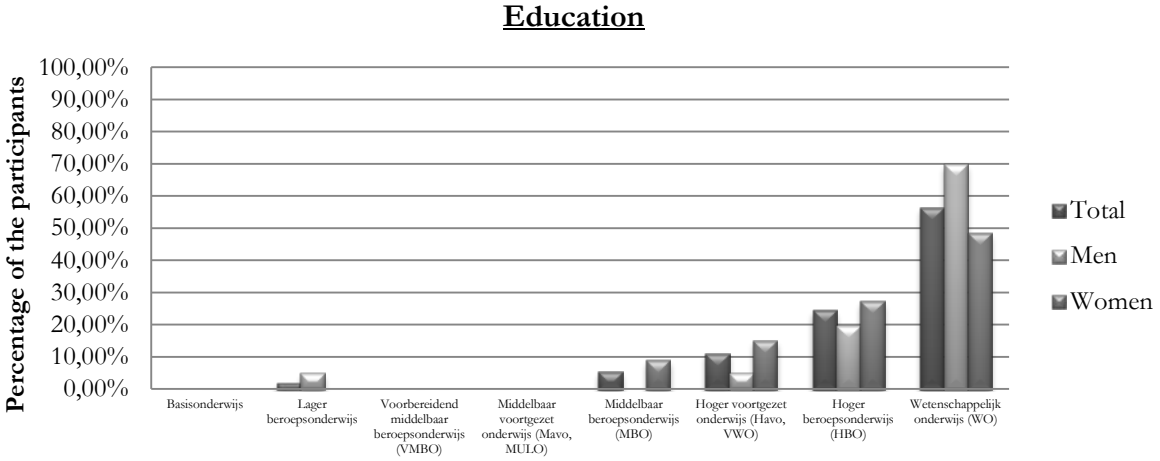


Figure 45; Outcome survey question: Education

8.2.2 Game related questions

General

From this point on the tutorial video was shown to the participants explaining in 9:01 minutes how the game works. To 88.86% of the participants the game was clear while 9.43% understood is largely (mostly caused by reduced concentration as the video was too long according to them) and 1.89% did not understand the idea. There are no significant changes between both sexes on this part. Overall the participants stood open for using a serious game to treat or prevent overweight and obesity as 45.28% found it a good idea, 35.85% found it above average and 16.98% found it an average idea which combined gives 98.11%. Also in this part there are no significant differences between both sexes.

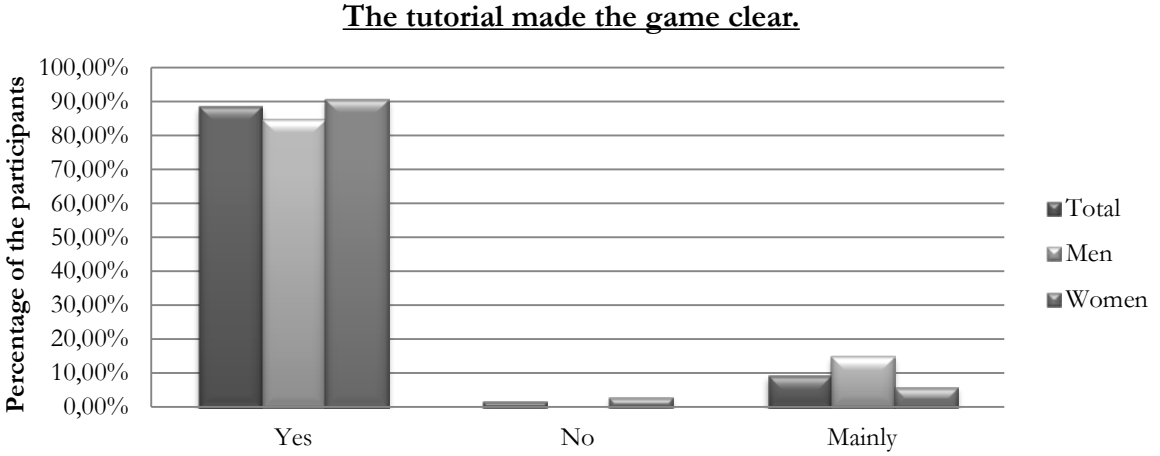


Figure 46; Outcome survey question: The tutorial made the game clear.

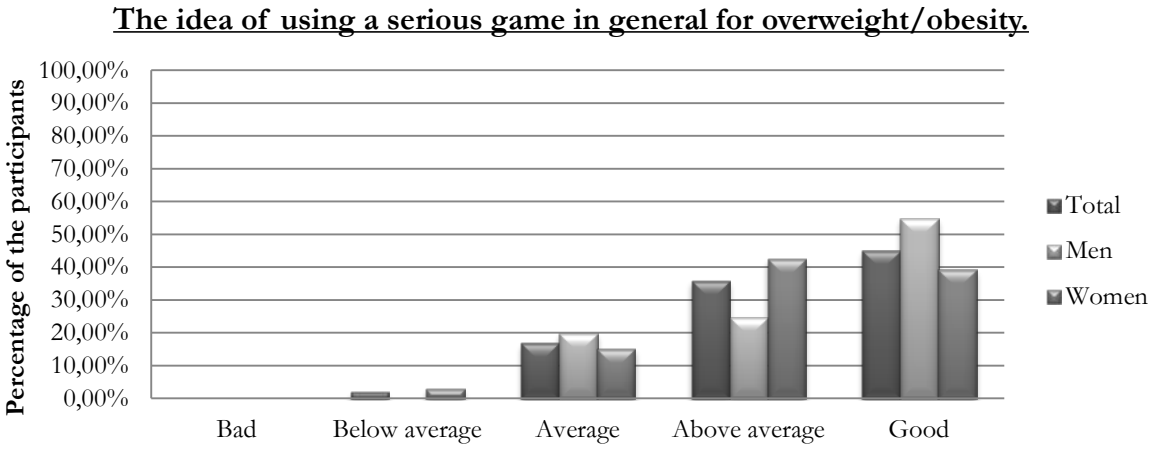


Figure 47; Outcome survey question: The idea of using a serious game in general for overweight/obesity.

'Healthy Weight Game' in general

When asked if the Healthy Weight Game lets users reach a healthy weight range 29.41% answered with 'yes', 60.78% with 'maybe' and 9.80% with 'no'. Notable here was that the participants who answered 'no' were all female. These females mainly added to their choice that physical activity alone was not the solution and that the eating pattern of people was the problem. The participants who answered with 'maybe' had different opinions. Some stated that users should first be self-motivated to lose weight to make this game work while others thought it could help stimulate/help them anyway into becoming more physically active. Some other additions were that using competition as part of the game could definitely help. When users were able to see that other people were also physical active they would become stimulated, especially if it were friends. There were some statements that the game gave insight in weight and physical activity, but that there was missing guidance in losing weight in a healthy way. One participant even suggested a dietician for guidance during the game as additional treatment. Also was added that the rewards should be kept interesting for players for not losing their interest. As before, some participants stated that the eating habits were the main problem which should be addressed to. A final adding was that perhaps some people would not play the game in fear of condemnation by others. According to 65.38% of the participants users will (eventually) have a positive behavioral change by using this game. 5.77% did not expect that to happen and 28.85% thought maybe. On this question women were with 71.88% quite more convinced than men with 55.00%. Most players thought this would depend on the user at hand. If players were competitive they would play the game more seriously and possibly have behavioral changes. Some participants thought again that professional guidance was needed to accomplish this change. And some thought it would give users something to think about resulting in possible opportunistic exercises.

When asked what options applied to the Healthy Weight Game 92.45% of the participants thought it would be a good addition to own initiatives to exercises. There were no participants who found it a good substitute for dieting, although 41.17% found it would make a good addition to dieting. 3.77% found it was a good substitute for physical therapy and 56.66% found it a good addition for physical therapy. Looking at both sexes on this point shows no significant differences.

When asked which elements are important for any serious game for overweight and/or obesity 81.13% added physical activity, 60.38% added competition, 66.04% added rewards, 28.30% added saving up for things instead of immediately receiving, 71.7% added displaying current information like steps, calories et cetera, 16.98% added the use of a character and 67.92% added the possibility to review results to their list. Remarkable here was that men valued physical activity more than women with 90.00% versus 75.76%. Women however valued displaying current information like steps and calories more than men with 84.85% versus 50.00%. The possibility to review results was more meaningful to men with 80.00% versus

60.61% of the women. There were also some suggestions for elements given by the participants. Some examples are having a message board for the multiplayer part, constant updates for new rewards and a calorie-intake measurement method which is shown on the screen so users can get better insight in ingested and burned calories.

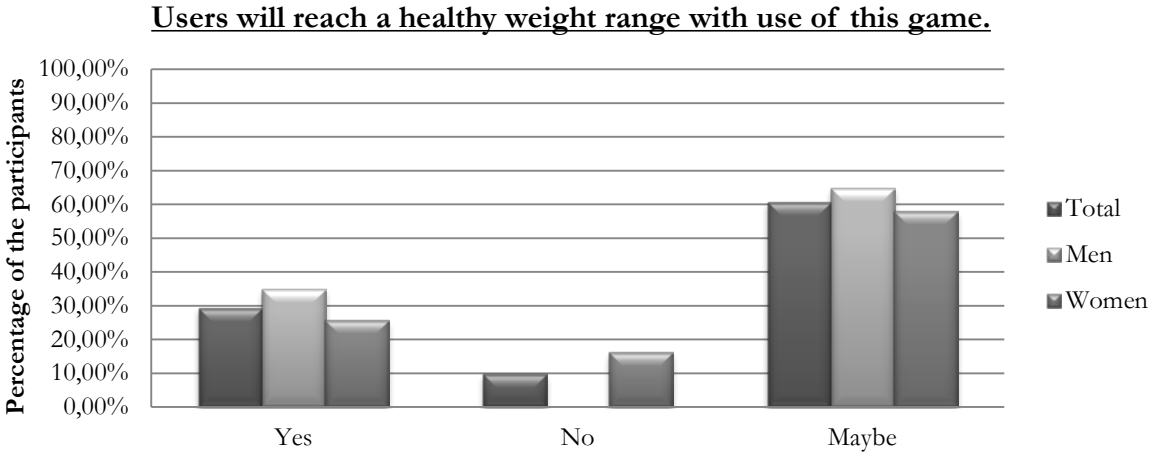


Figure 48; Outcome survey question: Users will reach a healthy weight range with use of this game.

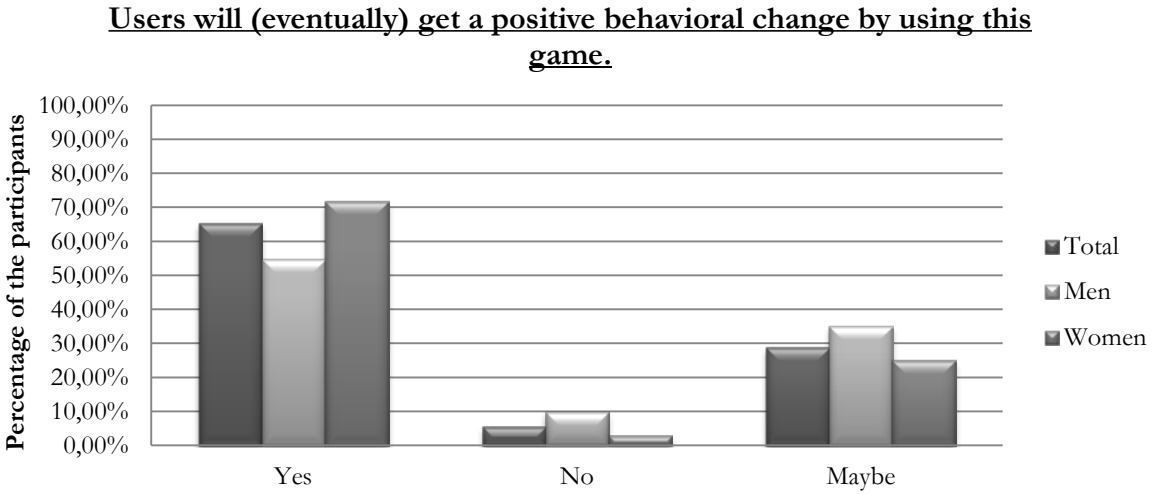


Figure 49; Outcome survey question: Users will (eventually) get a positive behavioral change by using this game.

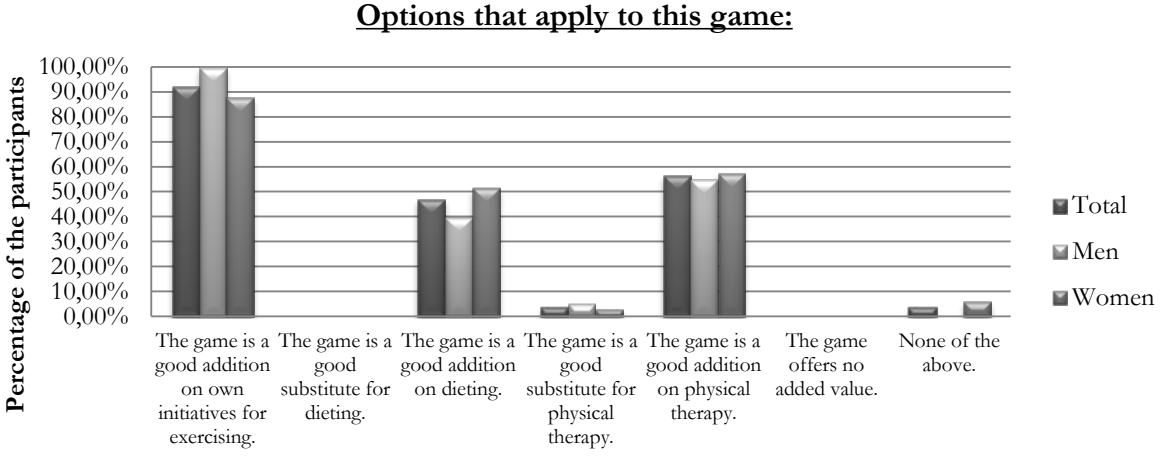


Figure 50; Outcome survey question: Options that apply to his game.

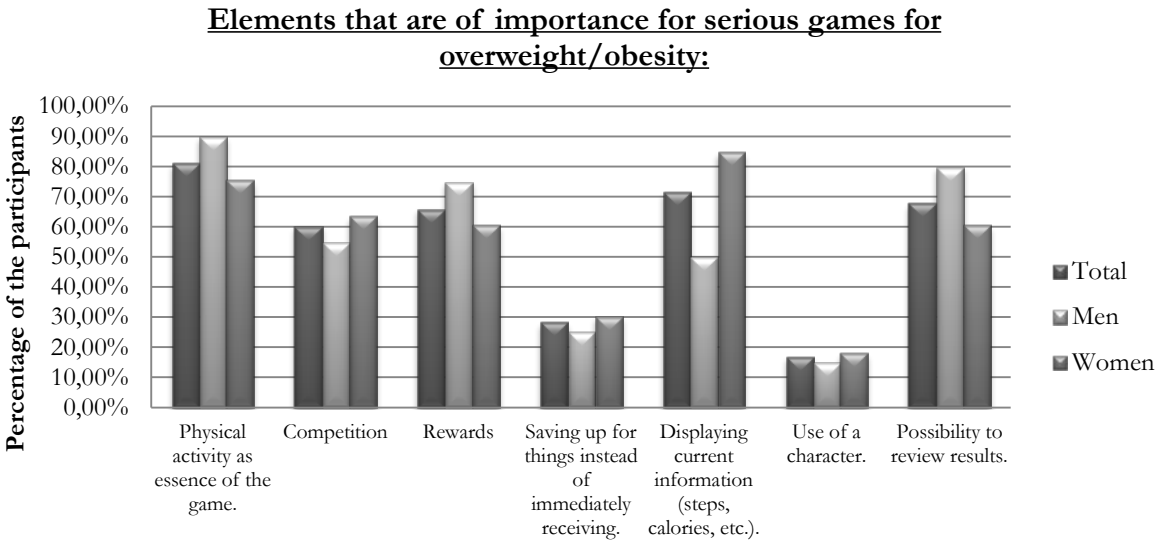


Figure 51; Outcome survey question: Elements that are of importance for serious games for overweight/obesity

Home screen

Evaluating the questions about the game-screens showed that the home-screen is well received. 30.19% found it a good screen and 52.83% found it above average of which men were more positive than women with respectively 40.00% versus 60.61% 'above average' votes and 40.00% versus 24.24% 'good' votes. Of the participants 84.91% stated there was nothing missing or redundant to this screen. There were almost no differences between the sexes. Two participants would have removed the character as they were only interested in the achieved results. The participants found the daily goals held on the Monday, Tuesday, Wednesday, Thursday and Friday in 32.08% of the time a good idea/ 35.85% found it above average and 15.09% found it average which gives an 83.02% acceptance of the idea. Women were more font of this idea as they voted 'good' for 39.39% compared to 20.00% of the men. This imbalance was then restored on the 'average' votes with men 30.00% and women 6.06%. The characters in general were by 39.62% liked, while 33.96% found them above average and 18.87% found them average which combined gives 92.45%. Men were slightly more positive here. The idea of characters resembling their user weight is thought of good by 54.72% as 28.30% found it above average and 11.32% thought average. Combining the votes of 'above average' and 'good' gave almost no difference between men and women. That these characters lose weight by achieving weekly goals is by 49.02% found good, 39.22% found it above average and 7.84% thought it was average. Remarkable here was that women valued this more with 85.06% of 'good' votes versus 35.00% of the men. The mood change of the characters is thought to be above average for 39.22% and 41.48% found it useful. For the question if they liked it 15.83% voted 'average' while 53.85% liked it above average and 30.77% liked it at all. Again were women fonder of this idea than men.

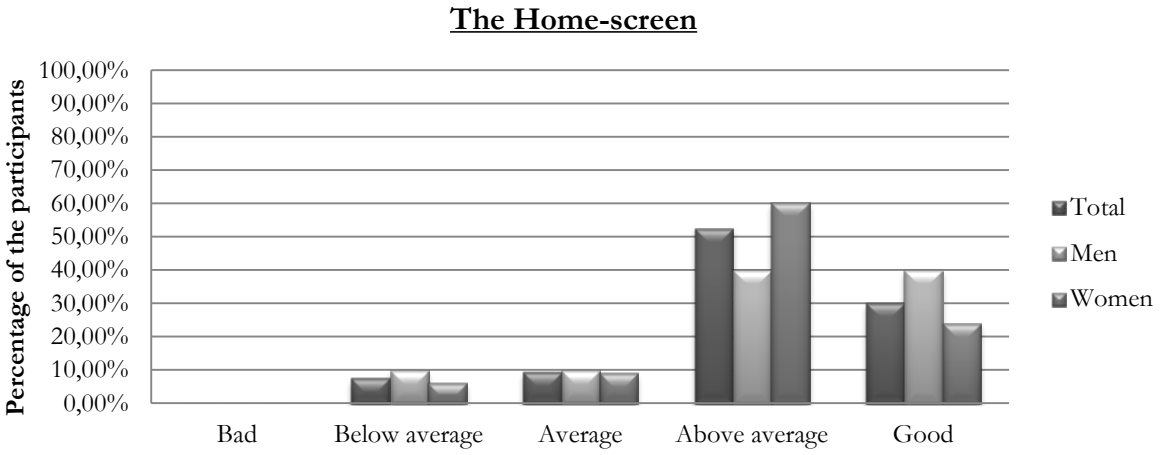


Figure 52; Outcome survey question: The Home-screen

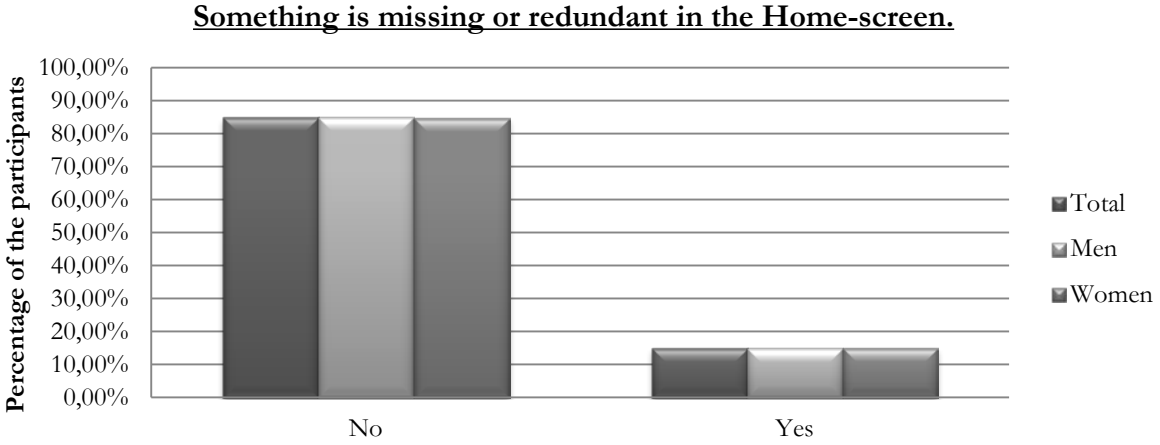


Figure 53; Outcome survey question: Something is missing or redundant in the Home-screen.

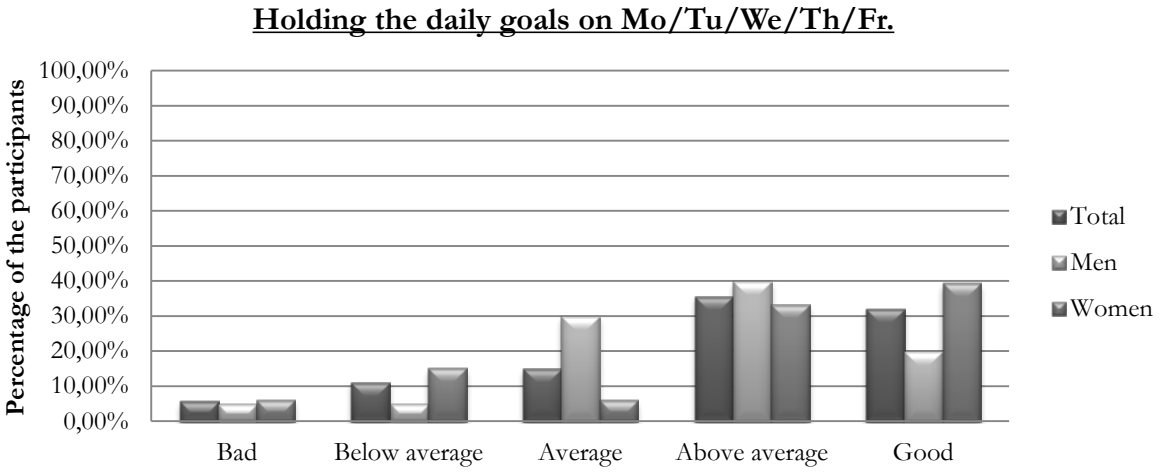


Figure 54; Outcome survey question: Holding the daily goals on Mo/Tu/We/Th/Fr.

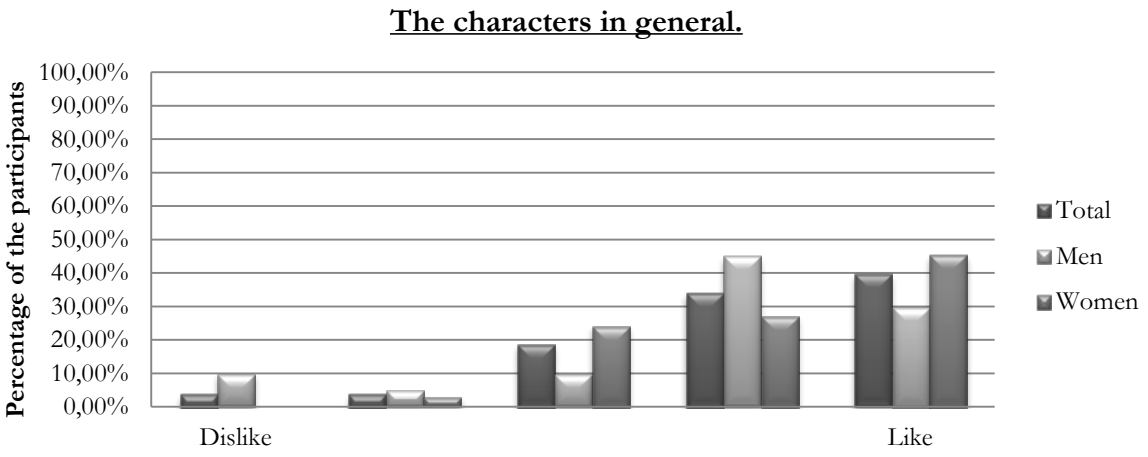


Figure 55; Outcome survey question: The characters in general.

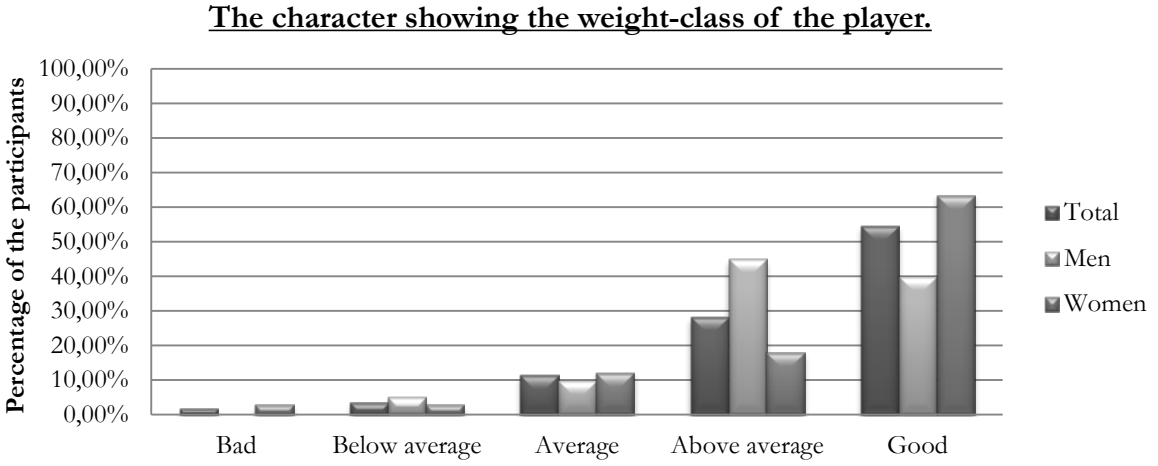


Figure 56; Outcome survey question: The character showing the weight-class of the player.

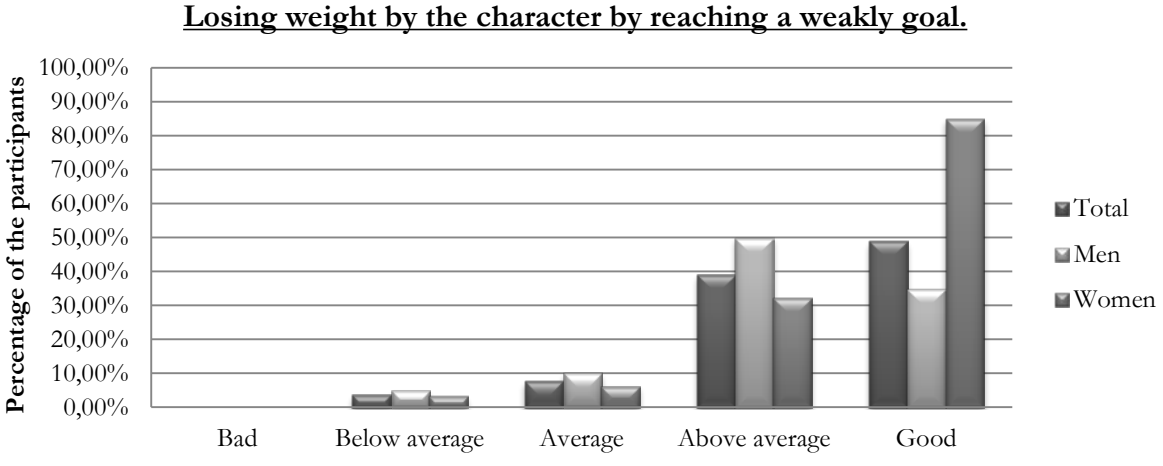


Figure 57; Outcome survey question: Losing weight by the character by reaching a weakly goal.

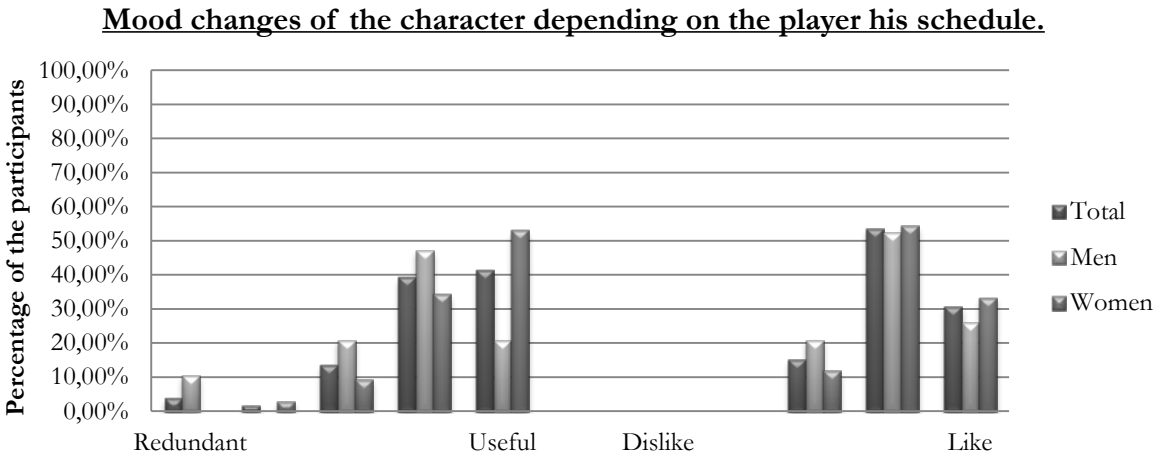


Figure 58; Outcome survey question: Mood changes of the character depending on the player his schedule.

Race screen

Then the race screen, which 35.85% found good and 47.17% thought it was above average. 86.54% thought there were no missing or redundant things while 13.46% thought there were. There were no significant differences between both sexes in both questions. Additions from the participants to the missing and redundant part were that there should be more levels (stated by multiple participants), the walked steps should be placed next to the pawn in the race-track, it was too complicated, the players were too small projected, the scores of others should be given in the screen and the distance between yourself and the next player should be shown to stimulate more.

30.77% liked the race track, as 44.23% found it above average and 19.23% voted average. Overall men and women were equal about the screen. The idea of racing against each other was well received with 32.69% of 'above average' and 55.77% of 'good' votes. 41.51% liked it above average and 52.83% liked the idea at all. Remarkable here was that women were quite more positive about racing against each other with 66.67% of 'good' votes versus 35.00% and 60.61% of 'like' votes versus 40.00%.

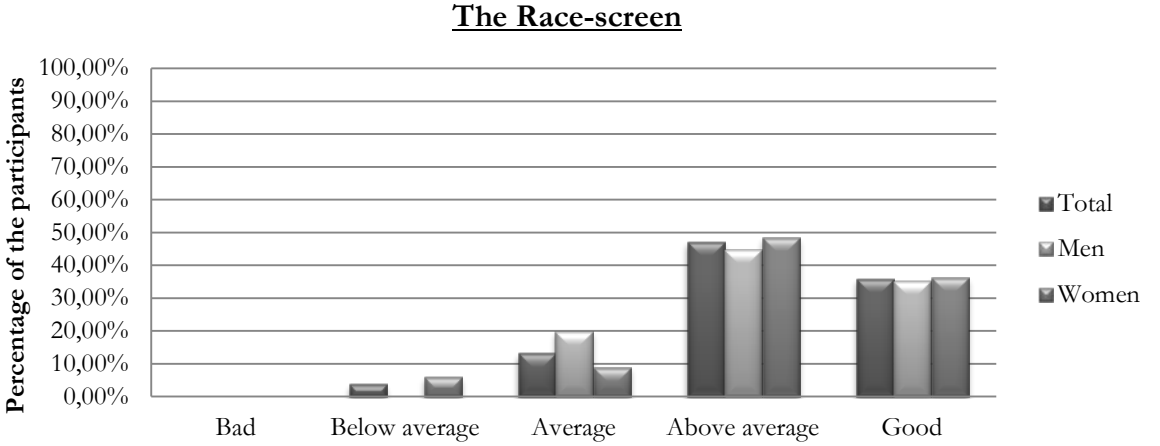


Figure 59; Outcome survey question: The Race-screen

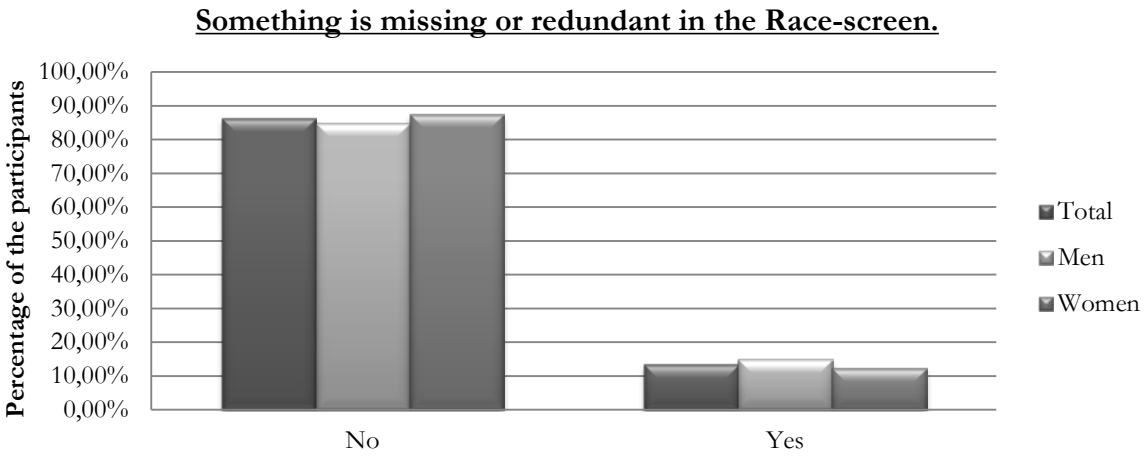


Figure 60; Outcome survey question: Something is missing or redundant in the Race-screen.

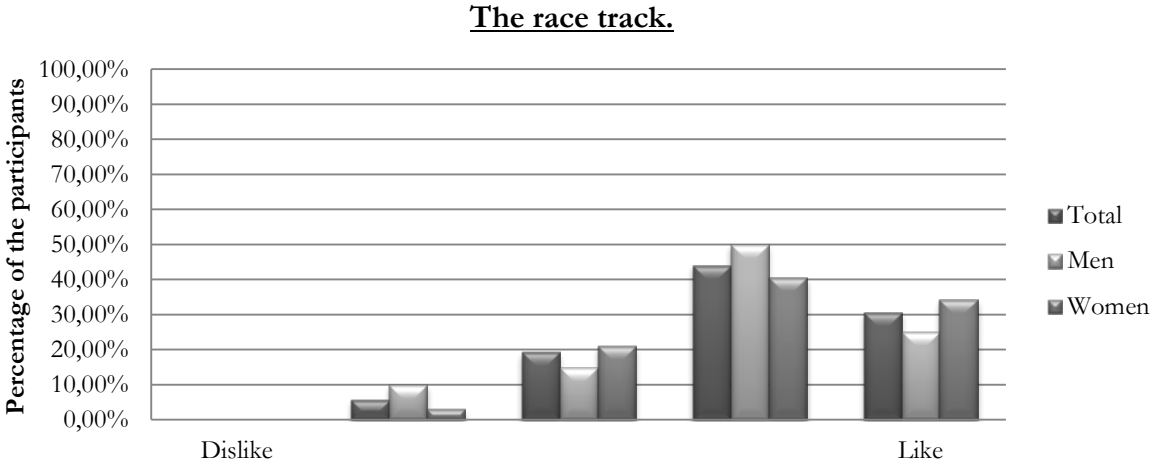


Figure 61; Outcome survey question: The race track.

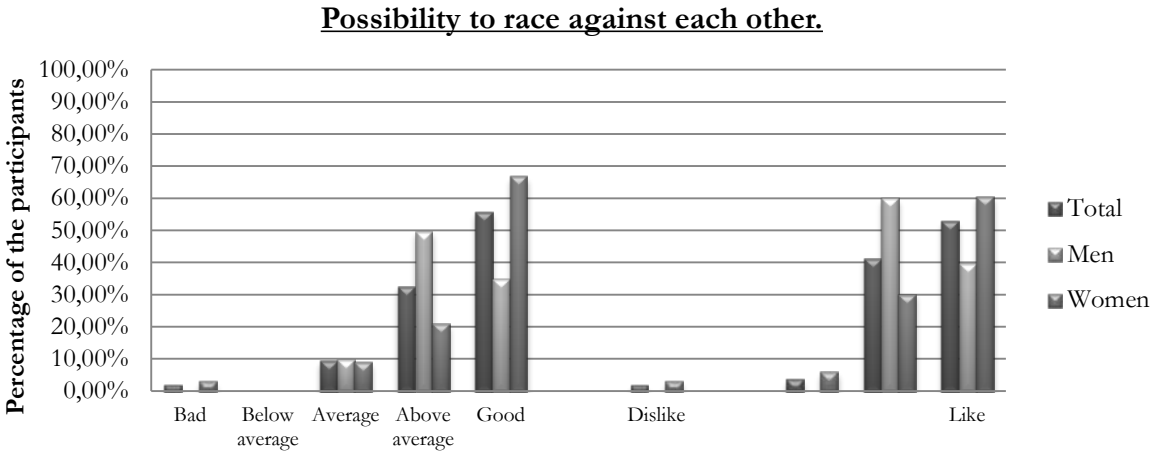


Figure 62; Outcome survey question: Possibility to race against each other.

View screen

The view screen was also received well with 46.15% 'above average' and also 46.15% of 'good' votes. Women were a bit more positive as they gave 57.58% of 'good' votes versus 25.00%. When asked if something was missing or redundant 90.75% voted 'no' and 6.06% 'yes'. The following additions were given by individual users: the accent should be on own data and not that of others (perhaps in a different tab), other users should not be able to see that other users are overweight and the kilometer parameter is nowhere used in the application and could be left out. For the question of players should see the character of other players as stimulant the answer was 58.49% 'yes', 5.66% 'no' and 35.85% 'maybe'. Men were with 70.00% 'yes' versus 51.52% of the women more positive about this. The possibility to hide characters for other players is answered with 'yes' by 37.74%, 'no' by 28.30% and 'maybe' by 33.96%. In this part 45.00% of the men answered 'no' versus 18.18% of the women while women voted 45.45% 'yes' versus 25.00% from the men. 79.25% found it a good idea to get the option of seeing your own results as 20.75% found it above average. Women were in this part more positive with 93.94% versus 55.00% of the men. As for the opportunities of the result-viewing, 69.81% found it fine as it is while 20.75% thought it was a bit too much. Here there were no significant differences between men and women.

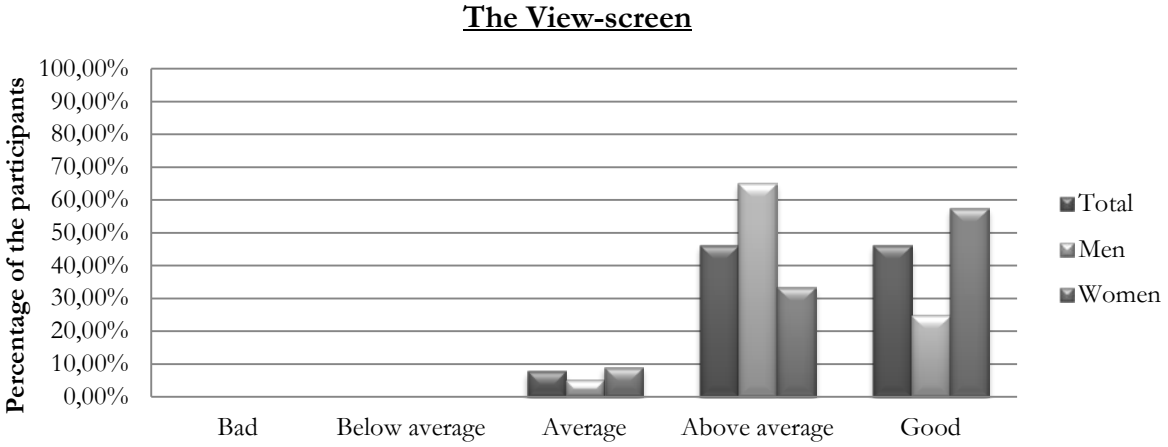


Figure 63; Outcome survey question: The View-screen

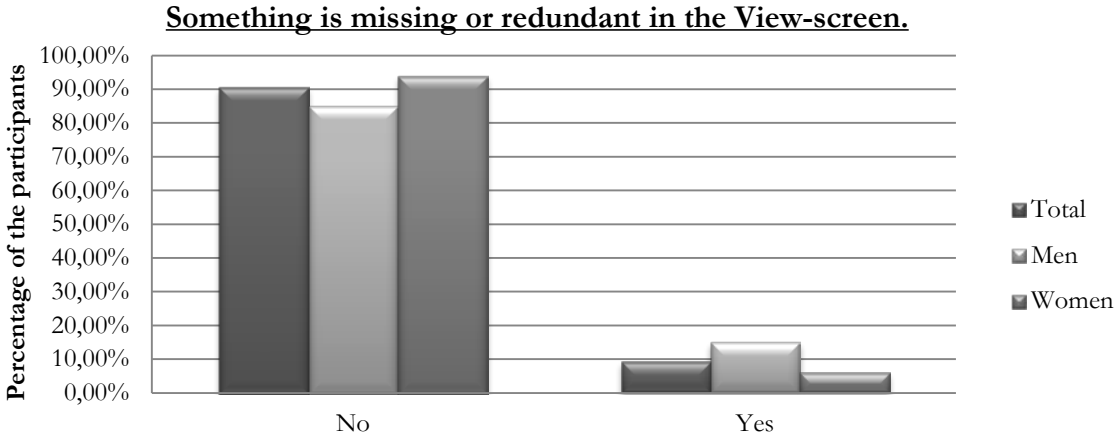


Figure 64; Outcome survey question: Something is missing or redundant in the View-screen.

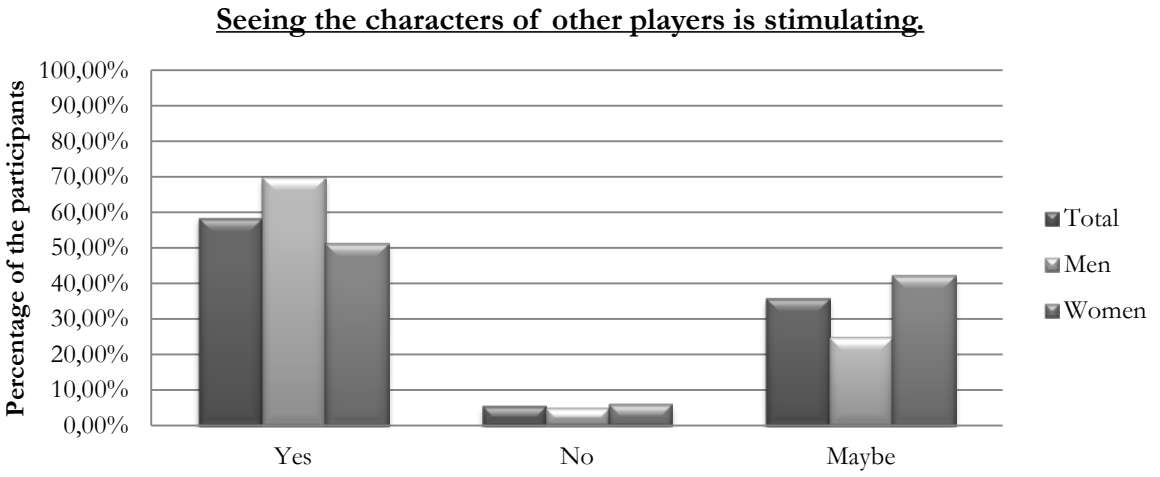


Figure 65; Outcome survey question: Seeing the characters of other players is stimulating.

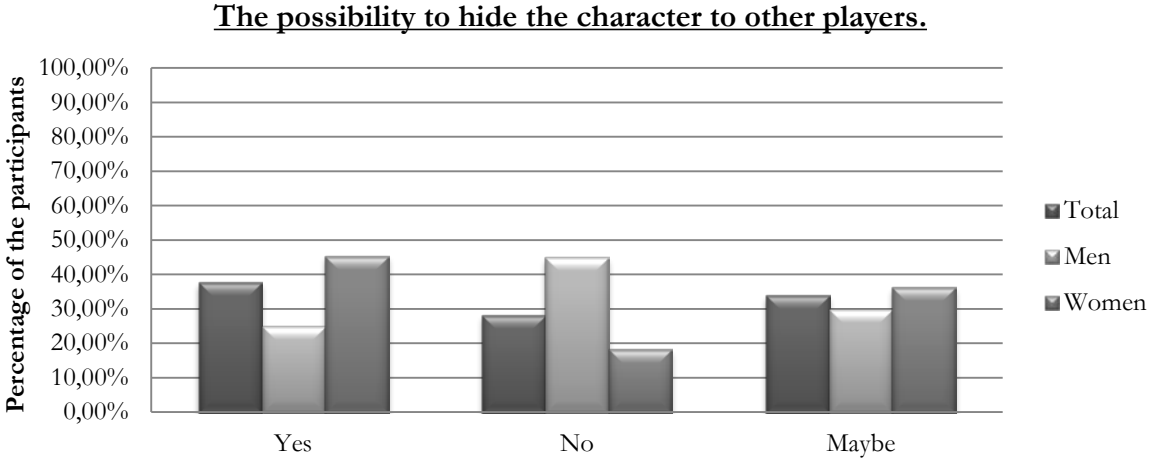


Figure 66; Outcome survey question: The possibility to hide the character to other players.

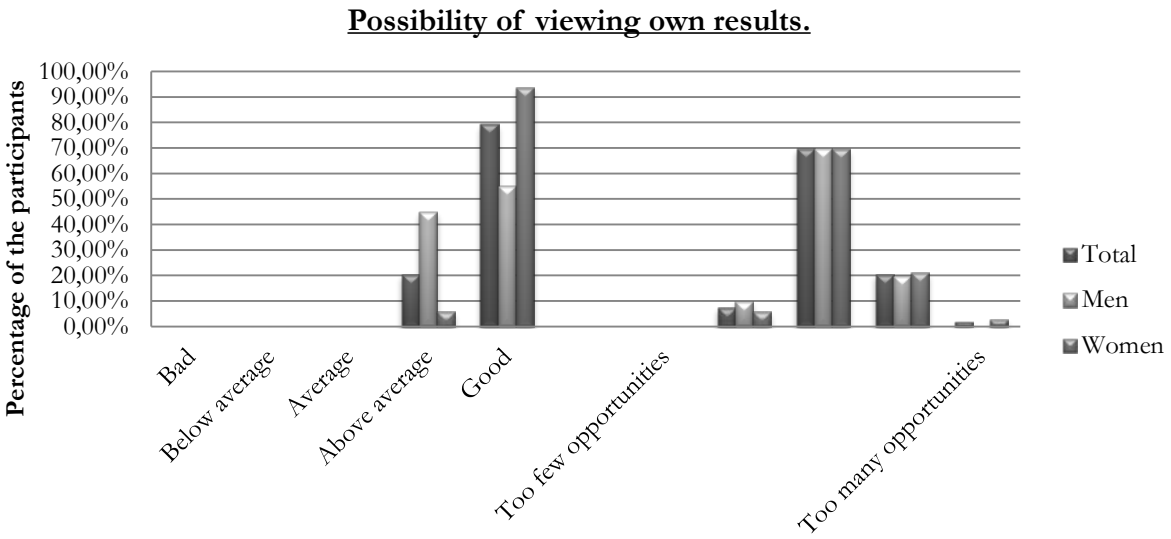


Figure 67; Outcome survey question: Possibility of viewing own results.

Shop screen

Then the shop screen, which was received as good by 33.96%, above average by 43.40% and average by 15.09%. There was almost no difference between both sexes in this part. As for the missing or redundant question 78.85% answered 'no' while 21.15% answered 'yes' which is in comparison to the other screens higher. The individual additions were making a closet for bought outfits, having the option to sell/trade items and also being rewarded with random items instead of just buying. Another suggestion was the option of buying food to feed the character and in that way show the player what good and bad food choices are. One participant thought of leaving the shop out and use credits to earn a day off or steal points of opponents. Some others liked more products and also cheaper things to buy. Overall the idea of earning credits was well received as 64.15% thought it was a good idea and 32.08% voted 'above average'. The idea of rewards in form of changing the character's appearance were liked by 30.77%, 'above average' voted by 46.15% and 13.46% found it average. In both questions men and women were almost equal in their votes.

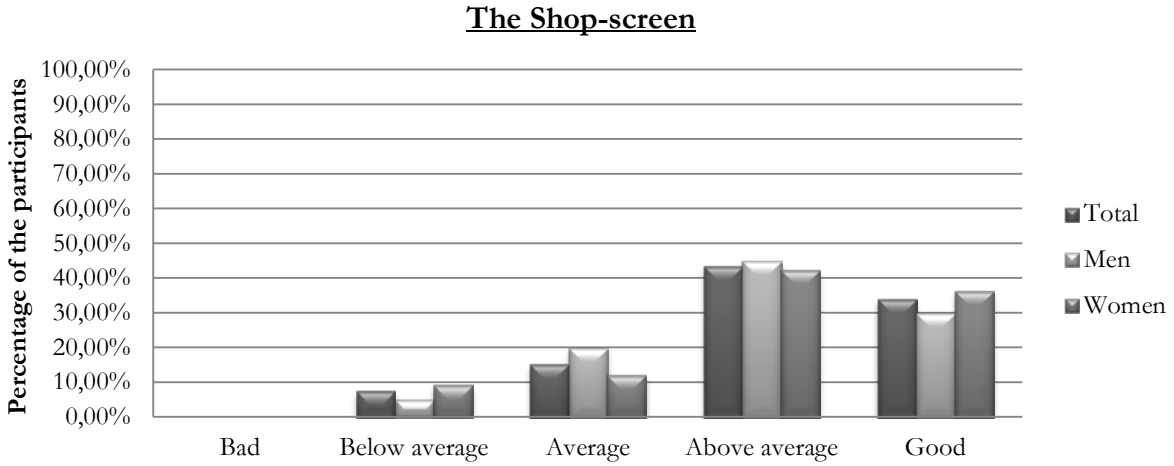


Figure 68; Outcome survey question: The Shop-screen

Figure 69; Outcome survey question: Something is missing or redundant in the Shop-screen.

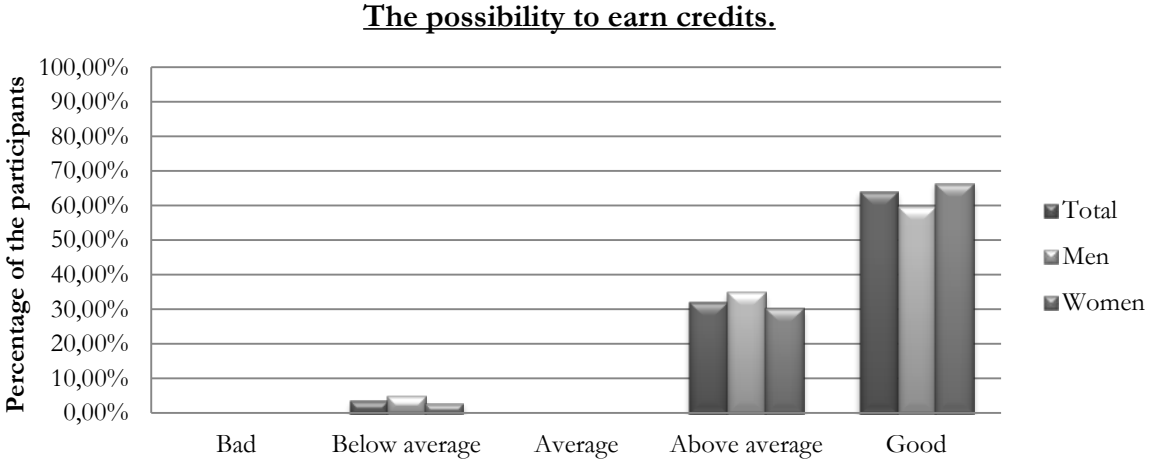


Figure 70; Outcome survey question: The possibility to earn credits.

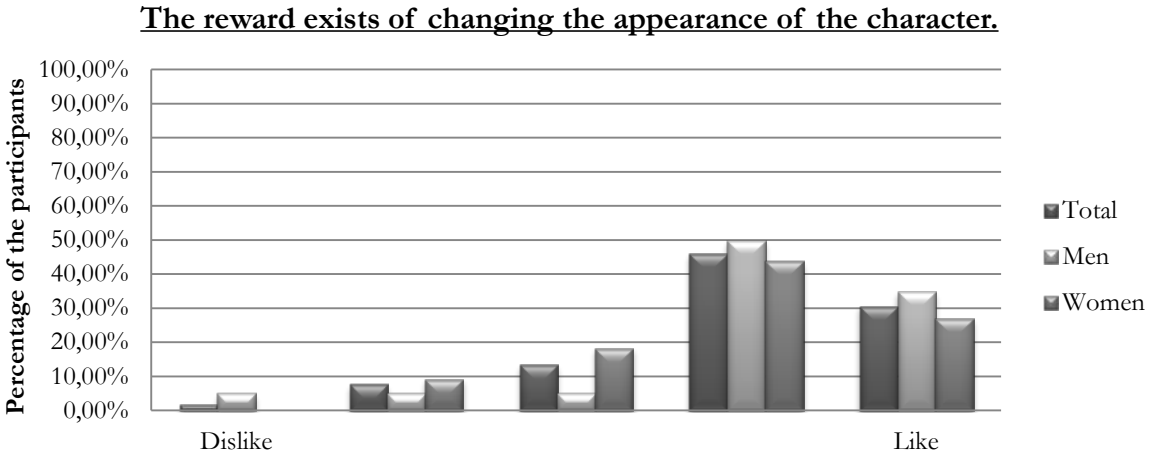


Figure 71; Outcome survey question: The reward exists of changing the appearance of the character.

'Healthy Weight Game' influence on own lifestyle

The question if it would help the participants personally to a more active lifestyle 30.19% answered 'yes', 50.94% with 'no' and 18.78% with 'maybe'. Of the participants who voted 'yes' the majority was women with 36.36% versus 20.00% of the men. 16.98% of the participants could imagine this game helping them to lose/maintain weight, as 60.38% not saw that happen and 22.64% said maybe. Men were in this part a bit more positive than women. From the participants who answered 'no' most said they were healthy and physical active enough already. A few thought the game would not contribute to losing/maintaining weight. For the question if the game would offer enough stimulation 16.98% thought it would, 60.38% thought not and 22.64% thought maybe. Man and women thought quite equal of this question. The players who thought it would not stimulate enough gave mostly as main reason that it would become boring after a while as rewards were not new anymore. For the expected time they would play the game 5.66% would use it more than three months, 1.89% 3 months, 9.43% 2 months, 18.87% 1 month, 7.55% 3 weeks, 9.43% 2 weeks, 7.55% 1 week, 5.66% less than a week and 33.96% did not know how long. In this question women would use the game slightly longer as also all the 'more than 3 months' votes came from women. If the game was available for download 79.25% would download it as 20.75% would not try it. When the game was not free 13.73% would pay for it and 86.27% would not. For both questions there were no significant differences between men and women.

In the end the final grade for the Healthy Weight Game was a 7.57 out 10 with grades in a range from 5 to a 10. There was no significant difference between both sexes.

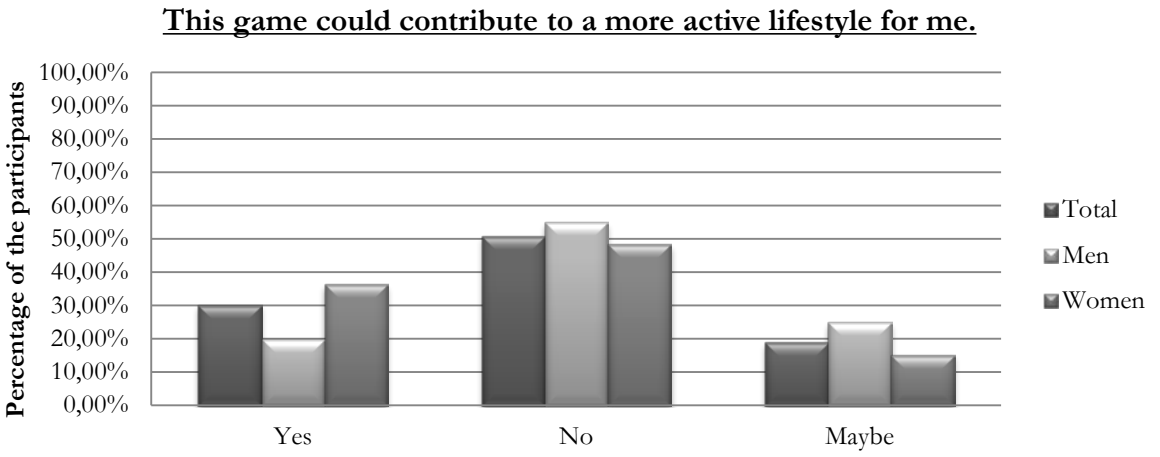


Figure 72; Outcome survey question: This game could contribute to a more active lifestyle for me.

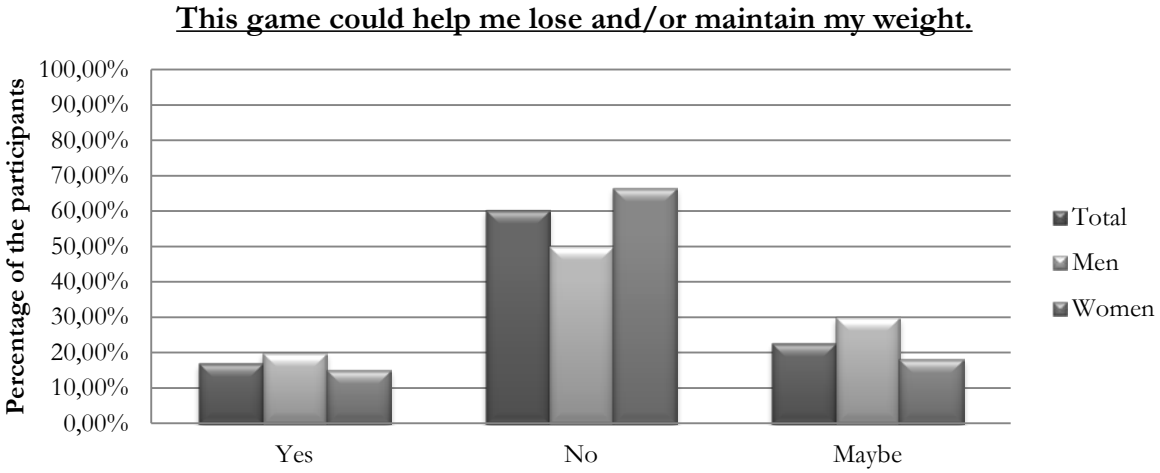


Figure 73; Outcome survey question: This game could help me lose and/or maintain my weight.

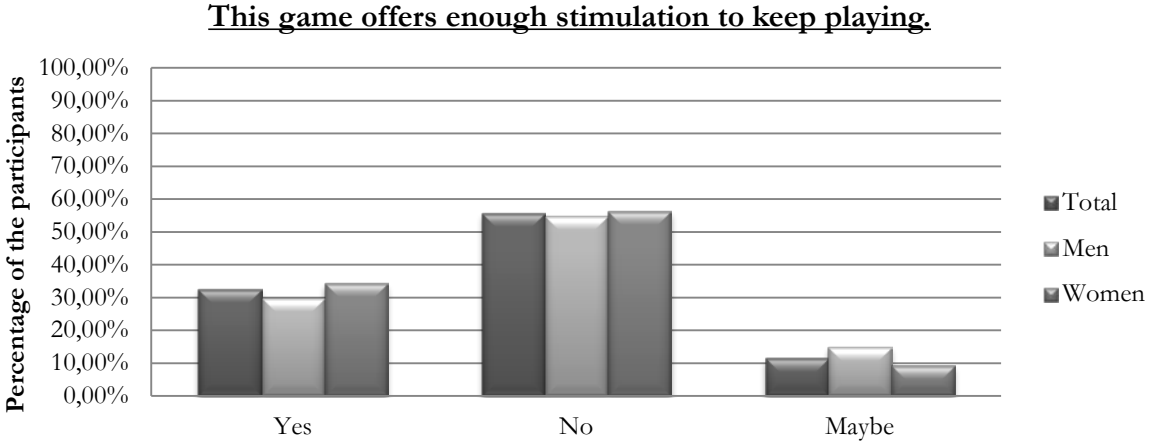


Figure 74; Outcome survey question: This game offers enough stimulation to keep playing.

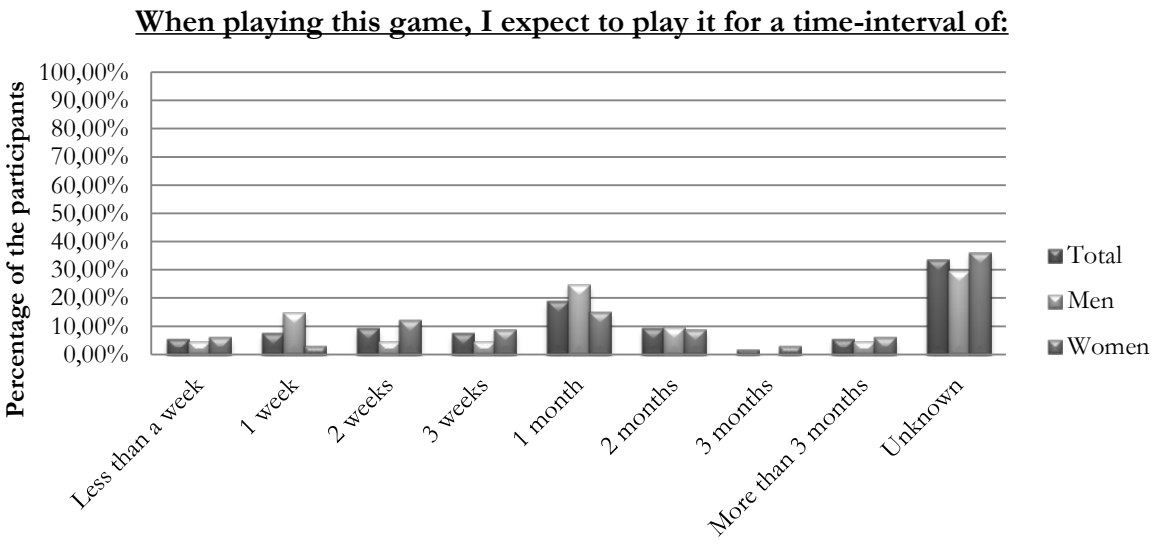


Figure 75; Outcome survey question: When playing this game, I expect to play it for a time-interval of:

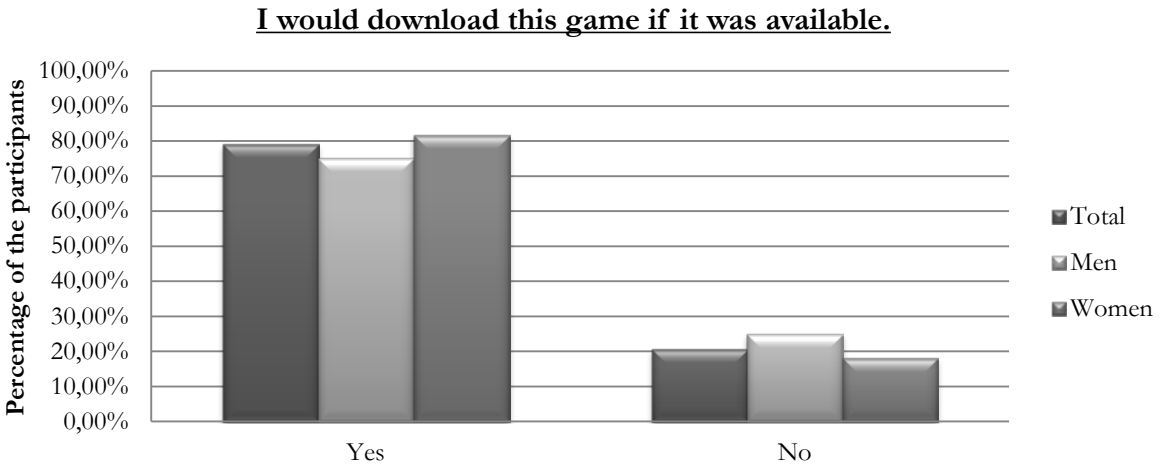


Figure 76; Outcome survey question: I would download the game if it was available.

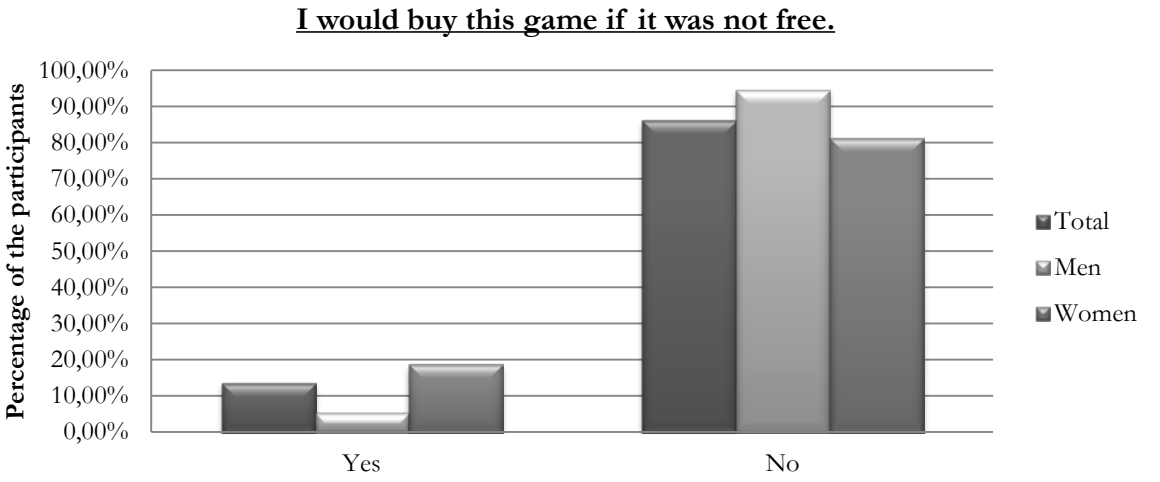


Figure 77; Outcome survey question: I would buy this game if it was not free.

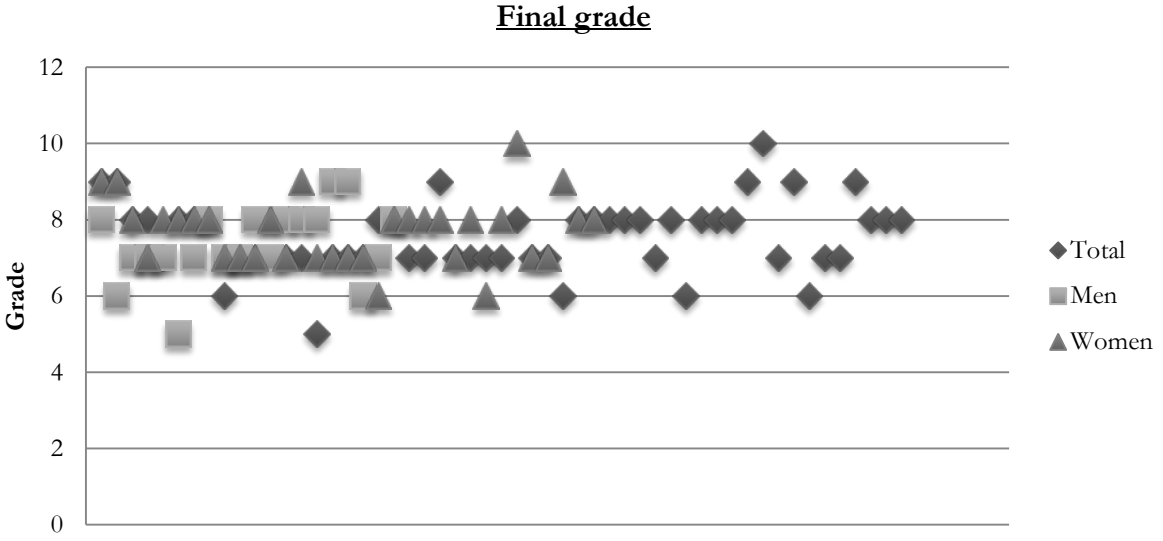


Figure 78; Outcome survey question: Final grade

Additional comments

Finally there was the option to give some last comments which gave the following additions from individual participants: using the BMI of the player to exclude him from buying certain items in order to stimulate weight loss. Another comment was using social media as Facebook to share results. One participant thought that every effort of becoming physical active or healthy is good, but that the app should become a bit more professional as in background and letter type. Also was said that the competition aspect would be the strength of the game. Another participant added that unknown rewards would be helpful to keep people playing. Also is it important that rewards are useful for the player to keep it interesting like earning songs. Showing tips to help users get back on schedule, use age correction, add eating patterns and keep in mind that old people are not that good with technology. Another adding was that the competition is very motivating and that the shop is then just a bonus. Another participant worried about the battery which perhaps would be drained by the background running? One user would like to have more personalities for their character and more different emotions. Some would use it only to see the burned calories and step counting. Another one noted it could not be used for sports like swimming et cetera or when people do not have their phones with them. Some liked adding assignments like sit-ups and cycling for 20 minutes. Another participant said it was more a funny way to work on your schedule instead of a stimulant. And finally an adding was it was not useful for serious overweight but fine for a little overweight.

8.2.3 Conclusion

General questions

The evaluating group is mainly of a young age (18 to 25 year) and most are highly-educated. The advantage of such a specific group (of age and education) is that the results give a good representation of this group. Another advantage is the acquisition of the insight that younger people have in applications and gaming as this is nowadays already highly integrated into their lives. The biggest advantage although is that with this feedback the Healthy Weight Game can be improved or even used for this young age category. That would be highly preferred over older people as a chronic disease like obesity needs to be treated as early as possible. The disadvantage of this group is that there cannot be drawn any conclusions based on other ages or lower educations.

Game-related questions

The game was well understood after seeing the tutorial, meaning the game has no open parts. Also came clear that people think serious gaming can be a good method to treat or prevent overweight. The majority

also thinks that the Healthy Weight Game is one of those games that can help losing weight and even induce positive behavioral changes. The Healthy Weight Game is a good addition to own initiatives to exercises and also could work well as addition to dieting and physical therapy. According to the participants, physical activity, competition, rewarding, displaying current information (e.g. steps and calories) and the possibility to review results are of importance for a serious gaming which is also applicable on the Healthy Weight Game. A remarkable outcome was that only 16.98% of the participants found characters an added value for serious gaming in general. Displaying information like steps and calories is, when focusing on women as the target-group, quite important. The idea of implementing a message board is something to think of for improving the game but also having continues updates on the rewards. Having a calorie intake measurement is another idea which needs to be researched. The home screen was well received and the fast majority would not change it. The daily goals should remain on weekdays which especially women fond the most. The characters were overall well accepted and do not need change. Looking at the earlier question of using characters this gives a contradictory feeling. That characters are adjusted to the weight of the user and can lose weight by achieving weekly-goals is also well received and should remain. Especially the part of losing weight fell good with women. The mood changes of the character are also found useful and liked by the majority of which again women were the fondest.

The race screen was well received and also here the fast majority would not change it. The same applies to the race track which occasionally should be changed according to some participants. The possibility to race against other players was well received, but it shows that women liked and fond this idea a bit more than men. The conceived ideas from participants to implement more levels, showing the currently walked steps next to the pawn and especially the steps between yourself and your predecessor are good ideas for improvement of the game.

The view screen was well received and also here the fast majority would not change it. Slightly more than half of the votes stated that the characters of other players should be shown of which men were the fondest of this idea. The option to hide the character from other players was mainly desired by women as most men thought it should be obligated to show the character. An adjustment for the game however could be to let players decide whether they want to share their avatar with other players or not. The option to see your own results is definitely liked by women. Almost every woman voted 'yes' for this option compared to half of the men. The large majority of participants also thought the result-viewing opportunities were fine and not too much or too little.

The shop screen was well received and also here the fast majority would not change it. The idea of earning credits was exceptionally well received and also changing the characters appearance as reward was good. Hereby should be noted that often was stated that this needs to be kept interesting by having rewards which were more interesting for the player, e.g. earning songs. In the design of the Healthy Weight Game this was already thought of to keep players stimulated. Some interesting conceived ideas were selling/trading items with other players and to receive random rewards instead of the option to buy it. Another good idea was the option to buy food for your character with the goal to learn users what are good food choices. And finally, an idea was to have the option to steal points of opponents to make the game more competitive and thus stimulating.

'Healthy Weight Game' influence on own lifestyle

30.19% of the participants thought the Healthy Weight Game could help them become more physical active while 18.78% voted 'maybe'. 16.98% thought it could even help them lose weight while 22.64% voted 'maybe'. 16.98% thought the game was stimulating enough while 22.64% voted 'maybe'. The main reason for not thinking it would stimulate enough was that it would become boring after a while. This is something to take into consideration when improving the game. As for endurance of playing the game, the results were excellent as the main goal was to let people become more physically active with the idea to induce a behavioral change, even when it is only minimal. From the participants, 5.66% would play it

less than a week, 7.55% a week, 9.43% 2 weeks, 7.55% 3 weeks, 18.87% 1 month, 9.43% 2 months, 1.89% 3 months, 5.66% more than 3 months and 33.96% did not know. This means that 60.38% would play the game for more than a week of which 35.85% would play it more than a month. If the game would be launched, 79.25% would download it and 13.73% of the participants would even pay for it. The final grading of the Healthy Weight Game was a 7.57 from both sexes. From the final comments the following ideas need to be noted: using social media as Facebook, giving helpful tips to the users on how to be physically active and keep on schedule, having more personalities for the character and more emotions, and finally the addition of assignments like sit-ups or cycling.

9 Discussion, Conclusion and Recommendation

9.1 Conclusion

9.1.1 Introduction

In this thesis the research question proposed in the introduction was:

How can a 'serious game' be designed which improves the physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods?

To answer this question it needed to be divided into several sub-questions which were answered during the literature studies and game comparison. The following sub-questions were defined:

- *What are effective methods for treating and preventing overweight and obesity to contribute to a healthier lifestyle with view on implementation in serious gaming?*
- *What are effective methods to cause positive behavioral changes in the lives of overweight and obese people to contribute to a healthier lifestyle with view on implementation in serious gaming?*
- *What defines a serious game and is of importance to improve the adherence and to achieve positive behavioral changes when designing a health improving serious game to treat and prevent overweight and obesity?*
- *What research-based serious games are currently available for treating and preventing overweight and obesity and what can be used from these games to design a health improving serious game to treat and prevent overweight and obesity?*

In this part a summarizing overview of these sub-questions and their answers will be given followed by answering the researching question at hand. And finally the conclusions drawn from the held survey will be given.

9.1.2 Sub-question: *What are effective methods for treating and preventing overweight and obesity to contribute to a healthier lifestyle with view on implementation in serious gaming?*

To answer this question a literature study on 'Overweight, Obesity and Weight management' was conducted. It was concluded from this study that using the body mass index (BMI) is an easy and good method for measuring overweight and obesity in adolescents and adults. It also showed that treating overweight and obesity during adolescence is important as there is an 80% chance of being obese as an adult when being obese as an adolescent. When defining the target group, the main goal should be addressing to overweight and obese adolescents and adults overall. Most of these people do not meet the norms 'NNGB', 'Fitnrom' or 'Combinorm' or are just inactive. They are often uninspired by their environment to be physically active and/or do not enjoy it.
Also was stated that the environmental and individual factors are the most important determinants for overweight and obesity. Having a sedentary lifestyle and/or being part of a family where there are overweight or obesity problems weight increase is promoted. Using multiplayer options in a serious game could address to this problem by involving the environment in the game and stimulate individual and commonly physical activity. Achieving a weight-loss of 10-15% is seen as a successful treatment for people with obesity, as in the United Kingdom the NICE-guideline called 5% already clinical relevant. The use or addition of diets for treating and preventing overweight and obesity is with the current knowledge and time-table not optional. There are many types of diets which should be accompanied by a qualified dietician as it could do more harm than good when applied incorrectly. Therefore is concluded that using physical activity to treat and prevent overweight and obesity is the best choice for this research. Within physical activity the best option is to let normal-weight people be 30 minutes moderate strenuous physical active for five days a week in order not to become overweight. For overweight people this should be at least 60 minutes and for obese people 60 or if possible 90 minutes. It is also shown that daily exercises of

moderate intensity are more important than very high intensive exercises which lead to exertion. It is important to get physical activity build in into daily life, like walking for an hour after work but also being more physical active during the day though opportunistic exercises. With use of a serious game being physical active can become less of a burden and more enjoyable, preferably together with people in the environment as multiplayer options can give stimulants to stay physically active. The physical activities have to embrace work/school like being able to play during breaks, but is should also embrace the free-time of the player afterwards. Using MET scores can help setting goals for the serious game in the design-phase or during the game itself.

9.1.3 Sub-question: *What are effective methods to cause positive behavioral changes in the lives of overweight and obese people to contribute to a healthier lifestyle with view on implementation in serious gaming?*

To answer this question a literature study on 'Behavioral Change' was conducted. It can be concluded that the target population are people who find themselves in the 'Preparation' state of the TTM. With use of the serious game they would switch to the 'Action' stage and then even to the 'Maintenance' stage. To prevent relapse and stimulate people social networks are important. This could be social support from therapists but also buddy systems for example. In the serious game this can be done by using multiplayer aspects. People also need to learn healthy behaviors to replace problem behavior which in this case would be replacing a sedentary lifestyle with a more active one. For example by doing physical activities and doing opportunistic exercises. Another important aspect is 'Reinforcement Management' or 'Reinforcements' which means rewarding good behavior. The possibility to earn things or receive group recognition would comply for this aspect. And finally it is important to change behavior in small steps to ensure success ('Self-efficacy').

9.1.4 Sub-question: *What defines a serious game and is of importance to improve the adherence and to achieve positive behavioral changes when designing a health improving serious game to treat and prevent overweight and obesity?*

To answer this question a literature study on 'Serious Gaming' was conducted. It can be concluded that the serious game should become a game for Smartphones and if possible definitely with usage of mobile internet. It has to be easy to understand and with learning contents that are divided in small parts so people can play whenever and wherever they like for short and long periods of time. The game has to be challenging and exciting and fun should be a priority in order to keep the player interested. The game has to give feedback, even after short tasks and has to be easy accessible and available. Short tasks should be rewarded by gaining things or getting approval from peers. Adding a multiplayer aspect to a serious game can provide deeper play experience and more important, can be used to encourage physical activity and work as additional stimulation. Using friendly competitions are preferable for this. Being informed on other players, e.g. friends or colleagues, is an important motivational factor and should be implemented if possible. For the design of a game using the internet, a remote server would definitely be preferred. Also using an avatar in the game can enhance game play.

9.1.5 Sub-question: *What research-based serious games are currently available for treating and preventing overweight and obesity and what can be used from these games to design a health improving serious game to treat and prevent overweight and obesity?*

To answer this question a 'Game Comparison' on existing research-based serious games was conducted. The research-based serious games Chick Clique[36], Houston[37], Fish'n Steps[17], OrderUP![38], Neat-o-Games[3], MPTrain[39], Shakra[2] and UbiFit Garden[4] were selected for the comparison. It can be concluded that the following things can be of importance for a serious game: when designing a serious game for usage on a Smartphone it should definitely be using the build-in (tri-axial) accelerometer (and

possibly gyroscope) for measuring physical activity. The received data should be automatically saved to avoid cheating or forget data-logging. The goal setting should be done with use of the given norms (NNGB, Fitnorm or the Combinorm). The game should have a multiplayer mode in order to stimulate physical activity which can be played by several players. The data which is shared should be controlled by the players themselves in a way that they decide who is getting what information. The interface should have different kinds of overviews from the player his own game, but also from other players to stimulate gameplay. Besides showing steps, it is also important to show how much calories are burned by doing those steps. Using an avatar is important for stimulating physical activity. People can bond to their avatar if it benefits from the player his activity an also having human emotions can help stimulating. For the multiplayer option it is important that players can contact each other in order to give positive feedback or discuss things. The possibility of a chat besides a message system is optional but not necessary. And finally the idea of using music during the physical activity shows to be a good stimulating option for being physical active.

9.1.6 **Research question:** *How can a 'serious game' be designed which improves the physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods?*

With use of the outcome of the sub-questions a serious game, the 'Healthy Weight Game!' was designed to answer to the research question. To evaluate the designed game a survey was held to find out how the game is received among potential users and what aspects of the game can be improved. The conclusion drawn from this survey is given in 9.1.7.

9.1.7 Survey

The game was well understood after seeing the game tutorial video, meaning the game has no open parts. Also came clear that people think serious gaming can be a good method to treat or prevent overweight. The majority also thinks that the Healthy Weight Game is one of those games that can help losing weight and even induce positive behavioral changes. The ´Healthy Weight Game´ is a good addition to own initiatives to exercises and also could work well as addition to dieting and physical therapy. According to the participants, physical activity, competition, rewarding, displaying current information (e.g. steps and calories) and the possibility to review results are of importance for a serious game which is also applicable on the ´Healthy Weight Game´. A remarkable outcome was that only 16.98% of the participants found characters an added value for serious gaming in general. Displaying information like steps and calories is, when focusing on women as the target-group, quite important.

The home screen was well received and the large majority would not change it. The daily goals should remain on weekdays which especially fell good with women. The characters were overall well accepted and do not need change according to the fast majority. Looking at the earlier question of using characters this gives a contradictory feeling. That characters are adjusted to the weight of the user and can lose weight by achieving weekly-goals is also well received and should remain. Especially the part of losing weight fell good with women. The mood changes of the character are also found useful and liked by the majority, of which again women were the fondest.

The race screen was well received and the fast majority would not change it. The same applies to the race track which occasionally should be changed according to some participants. The possibility to race against other players was well received, but it shows that women liked and fond this idea a bit more than men.

The view screen was well received and also here the large majority would not change it. Slightly more than half of the votes stated that the characters of other players should be shown of which men were the fondest of this idea. The option to hide the character from other players was mainly desired by women as most men thought it should be obligated to show the character. The option to see own results is definitely liked by women. Almost every woman voted 'yes' for this option compared to half of the men. The large

majority of participants also thought the result-viewing opportunities were fine and not too much or too little.
The shop screen was well received and also here the large majority would not change it. The idea of earning credits was exceptionally well received and also changing the characters appearance as reward was good. Hereby should be noted that often was stated that this needs to be kept interesting by having rewards which were more interesting for the player, e.g. earning songs. In the design of the Healthy Weight Game this was already thought of to keep players stimulated.
From the participants 30.19% thought the ´Healthy Weight Game´ could help them become more physical active while 18.78% voted 'maybe'. 16.98% thought it could even help them lose weight while 22.64% thought maybe. Speaking of stimulation, 16.98% thought the game was stimulating enough while 22.64% voted 'maybe'. The main reason for thinking it would not stimulate enough was that it would become boring after a while. As for endurance of playing the game, the results were excellent as the main goal was to let people become more physically active with the idea to induce a behavioral change, even when it is only minimal. From the participants, 5.66% would play it less than a week, 7.55% a week, 9.43% 2 weeks, 7.55% 3 weeks, 18.87% 1 month, 9.43% 2 months, 1.89% 3 months, 5.66% more than 3 months and 33.96% did not know. This means that 60.38% would play the game for more than a week of which 35.85% would play it more than a month. If the game would be developed and launched, 79.25% would download it and 13.73% of the participants would even pay for it. The final grading of the Healthy Weight Game was a 7.35 given by the men and a 7.70 given by the women. Combining these grades gives a final grade of 7.57 for the ´Healthy Weight Game´.

9.1.8 Conclusion

The designed serious game, 'Healthy Weight Game´, includes most of the valuable additions found in literature and research-based games and is well evaluated by potential users. Therefore can be concluded that the 'Healthy Weight Game' lives up to the research question, meaning that it is a game that shows potential for improving physical, and indirectly mental, health of people who deal with overweight and obesity by focusing on increasing the adherence and achieving positive behavioral changes with a view on contributing to or replacing of current methods.

9.2 Discussion and recommendation

The 'Healthy Weight Game' is based on the use of physical activity which in literature findings is indicated as a good way to achieve weight loss. The place of diet in weight loss is also important but was not included in the scope of this research due to time constraints. The literature indicates that diet also plays an important role in the struggle for weight loss; the survey results show that this was also the perception of the respondents. Therefore for future work it is recommended to implement diets or other food-related health stimulating methods into the Healthy Weight Game, possibly by introducing a new tab, implementing it in existing tabs or by changing the game otherwise. Examples given by participants are implementation of a calorie intake and consumption measurement system, and implementing the idea to buy food for the character with the goal to teach users what good food choices are. This last idea could also be used as a stimulant for being physically active if the character depends on being fed. For the 'Healthy Weight Game' it could be an addition to the store where players then also can buy food for their character and additionally the current items like clothing if their earnings are up to it. The food section in the game could then also give additional information on healthy food choices and perhaps even introduce diets which users themselves can also follow. In addition it could be very helpful to show the calories of the bought food and also to use the calorie burning system which the 'Healthy Weight Game' already has.

The 'Healthy Weight Game' is based on having an accelerometer in the Smartphone to measure step counting which means that in this game walking, jogging and running can be measured accurately.

Another main reason for using step count is because it is a readily easy way of physical activity which can be performed by almost everybody. For future work it could be optional to optimize the Healthy Weight Game also for other activities like cycling in order to reach a broader group of people and to meet current users who also like to have other physical activities measured. Using the MET-scores would then be of great help.

When looking at the participants of the survey it needs to be discussed that these participants were mainly of young age (mainly between 18 and 25 year) and were well-educated. The advantage of such a specific group (of age and education) is that the results give a good representation of this group. Another advantage is the acquisition of the insight that younger (well-educated) people have in applications and gaming as this is nowadays already highly integrated into their lives. The biggest advantage although is that with this feedback the Healthy Weight Game can be improved or even used for this young aged category. That would be highly preferred over older people because a chronic disease like obesity needs to be treated as early as possible. The disadvantage however is that there cannot be drawn any concrete conclusions based on other ages or lower educations because of the lack of participants in those categories. For future work it would therefore be highly recommended to hold surveys among different age and educational groups with enough participants to research whether they share the same opinion as the young well-educated group that is analyzed here.
As for the BMI score of the participants it showed that 69.81% had a normal weight, 22.64% were pre-obese and 7.55% were obese. The advantage of this outcome is that it can be reasonable seen as a representation of the Dutch population corresponding with this age and education group. It also profits from containing participants with all the desired weight classes (normal weight, overweight, obesity). However, a possible great disadvantage in this research is that the BMI scores are not linked or associated to the other survey questions, meaning there cannot be drawn any conclusions to these outcomes based on people being normally-weight, overweight or obese. For future work this could be researched by using the results of this survey, although it is advised to do another survey among normal-weight, overweight and obese groups separately because in this survey the number of participants of obese participants for example is not large enough to define solid conclusions.
In the survey a remarkable outcome was that only 16.98% of the participants found the use of characters an added value for serious games in general. Shortly after that, the survey questions regarding to the used characters in the 'Healthy Weight Game' came up. There the participants were quite fond of the designed characters and the idea of characters showing the player his weight-class and loses weight by reaching a weakly goal. Also having the character changing his mood depending on the player his schedule was mainly liked and found useful. Based on the positive outcome in literature, game comparison and these survey questions relating to the characters of the Healthy Weight Game the advice is to remain using characters for serious games additionally with weight-loss possibilities and mood changes of the character. For future research however it is advised to find out, perhaps with better questioning, if characters are appreciated and useful for serious gaming because in this survey the outcome is a bit dual.

Participants also indicated that the 'Healthy Weight Game' would be a good addition on dieting and physical therapy, besides being a good addition on own initiatives for exercising. The game is designed to be self-explanatory with the intention to be generally used, although perhaps it could be a good addition for dieticians and physical therapists to use in their treatment programs. Whether this is optionally or not could be a good future research through questioning these professionals.

Other discussable parts which participants came up with were the implementation of a message board for participants to share information, having more race track levels which alternate, and showing the own step count next to the player his pawn as well as showing the remaining steps between the player and his predecessor. As for the message board, it could be a good addition to keep players socially interacted,

although it would be good to test this with a survey. The idea of showing step count next to the player his pawn is a great idea, just like showing the gap between the player and the predecessor. This will give users a better overview and more importantly, stimulate physical activity through competitiveness. Also is it discussable whether hiding the character for other players should be optional or not. Doing so can take away the stimulating effect of showing off to other players because they hid them or it could take away the effect of being stimulated to earn points because other players do have great looking characters. On the other hand, obligating the visibility of the characters can cause fall-out from people who are overweight or obese because their character will show that. From this point the advice would be to do have the option to hide the character to other players, although future research should reveal whether this choice was the right one. Another participant had the idea of selling or trading items with other players to stimulate game-play. He also liked to occasionally receive random rewards instead of always the possibility to choose his buying. In the 'Healthy Weight Game' players now have to unlock items before they can see and buy it. The idea of occasionally receiving random rewards could be a good addition to the game, although these rewards then should be chosen wisely by the designer because it is unwanted that players receive much higher rewards than they level wise deserve. The same counts for the idea of selling and trading, which can make the game more interesting, but also can make it more difficult. Another addition was using social media like Facebook and giving helpful tips for being physically active and how to keep on schedule. The idea of using social media seems with the current popularity of websites like Facebook a good idea. However, it should be researched in future work what is optional to share, if it possibly can be implemented in some way and how to use social media to optimize the goal of increasing physical activity and achieving positive behavioral changes. A participant also liked to have more personalities for the character and also more emotions. For future work and implementation of the game it would not affect the desired effect and perhaps would attract even more users. And finally adding assignments to the game like sit-ups or cycling to earn extra points and increase physical activity. Also for future work, this could be a welcome variation to the game for earning extra points, perhaps by giving weekly some assignment with which extra points can be earned.

Concluded, there are quite some good additions for future work which most definitely could improve the Healthy Weight Game, although serious cautions need to be taken not to overdo it and put people off. The overall recommendation would be to research the possible implementation of these given suggestions and also to conduct new surveys with in any case more participants to get stronger results and more solid conclusions.

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11 Appendix

11.1 Survey

Pagina: 1

Beste respondent,

U gaat zo deelnemen aan een onderzoek gericht op een Smartphone applicatie die helpt bij het behandelen en/of voorkomen van overgewicht en obesitas. Het gaat hier om een zogenaamde 'serious game' waarin gebruikers zelf of met anderen (familie, vrienden, collega's, et cetera) fysiek actief kunnen zijn om zo een gezond lichaamsgewicht te bereiken en/of te handhaven. Om deze game applicatie te kunnen verbeteren is daarom jouw mening zeer waardevol.

Alle gegevens die worden verkregen middels dit onderzoek zullen anoniem worden behandeld en niet worden doorgegeven aan derden. De gegevens zullen als onderdeel van mijn BSC studie Biomedische Technologie aan de Universiteit van Twente worden geanalyseerd. Dit onderzoek wordt in samenspraak met MobiHealth B.V. (http://www.mobihealth.com) uitgevoerd.

Alvast hartelijk bedankt voor het invullen,

Stefan Lentelink

Submit

Pagina: 2

Inleiding

In deze enquête zullen eerst wat persoonlijke vragen gesteld worden. (Dit is geheel anoniem!)

Vervolgens krijgt u de tutorial van de ontworpen game applicatie te zien waarna hierover enkele algemene en specifieke vragen gesteld zullen worden.

Dit zal samen ongeveer 15 tot 20 minuten van uw tijd kosten.

Alvast hartelijk bedankt!

Volgende

Pagina: 3

1.

Wat is uw geslacht? *

● Man

- Vrouw

2.

Wat is uw leeftijd? *

3.

Wat is uw lengte? (in meters, bijvoorbeeld: 1,80) *

4.

Wat is uw gewicht? (in kilogram, bijvoorbeeld: 80) *

5.

Wat is de hoogst genoten opleiding die u volgt/ heeft gevolgd? *

- Basisonderwijs
- Lager beroepsonderwijs
- Voorbereidend middelbaar beroepsonderwijs (VMBO)
- Middelbaar voortgezet onderwijs (Mavo, MULO)
- Middelbaar beroepsonderwijs (MBO)
- Hoger voortgezet onderwijs (Havo, VWO)
- Hoger beroepsonderwijs (HBO)
- Wetenschappelijk onderwijs (WO)

Volgende

Pagina: 4

Game tutorial

Hieronder is de tutorial van de game weergegeven. Om de daarna volgende vragen goed te kunnen beantwoorden wordt u gevraagd de

video aandachtig en geheel te bekijken. De video is helaas wel Engelstalig waarvoor mijn excuses indien dit tot ongemak leidt.

U wordt aangeraden de video in 'Volledig scherm' of via Youtube te bekijken (deze opties staan rechtsonder de video).

****
Als het beeld onscherp is, klik dan met de muis op het begin van de afspeel balk zodat de video opnieuw afspeelt.
****

Volgende

Pagina: 5

Algemene vragen

Een serious game is simpel gezegd een spel waarbij het primaire doel is om er wat van te leren. Het secundaire doel is dat dit op een spelende manier gedaan wordt. In deze game wordt geprobeerd om lichamelijke activiteiten in de vorm van lopen (wandelen, hardlopen et cetera) plezierig te maken om zo een gezonde gewichtsklasse te bereiken en een gedragsverandering in levensstijl teweeg te brengen.

7.

Allereerst, heeft de tutorial video goed duidelijk gemaakt hoe de game werkt? *

- ● Ja.
- ● Nee, want:
- ● Grotendeels, want:

8.

Wat vindt u van het algehele idee om een serious game te gebruiken voor overgewicht/obesitas?

Antwoord:

Slecht ● ● ● ● ● **Goed**

9.

Denkt u dat mensen met behulp van deze game een gezonde gewichtsklasse kunnen bereiken? *

- Ja.
- Nee, want:
- Misschien, want:

10.

Denkt u dat deze game bij mensen (uiteindelijk) een positieve gedragsverandering teweeg zal brengen?
(Bijvoorbeeld het eerder nemen van de trap dan de lift) *

- Ja.
- Nee, want:
- Misschien, want:

11.

Welke van de volgende opties zijn van toepassing volgens u?
(meerdere selecteren is mogelijk)

- Deze game is een goede aanvulling op eigen initiatieven om meer te bewegen.
- Deze game is een goede vervanging voor diëten.
- Deze game is een goede aanvulling op diëten.
- Deze game is een goede vervanging voor bewegingstherapie.
- Deze game is een goede aanvulling op bewegingstherapie.
- Deze game biedt geen toegevoegde waarde.
- Geen van bovenstaande.

12.

Welke van de volgende elementen zijn volgens u belangrijk in een serious game voor overgewicht/obesitas?
(meerdere selecteren is mogelijk)

- Lichaamsbeweging als essentie van de game.
- Competitie.
- Beloningen.
- Sparen voor bepaalde dingen i.p.v. meteen ontvangen.
- Weergave van huidige informatie (stappen, kilocalorieën et cetera).
- Gebruik van een character.
- Mogelijkheid tot inzage van behaalde resultaten.
- Anders:

Volgende

Pagina: 6

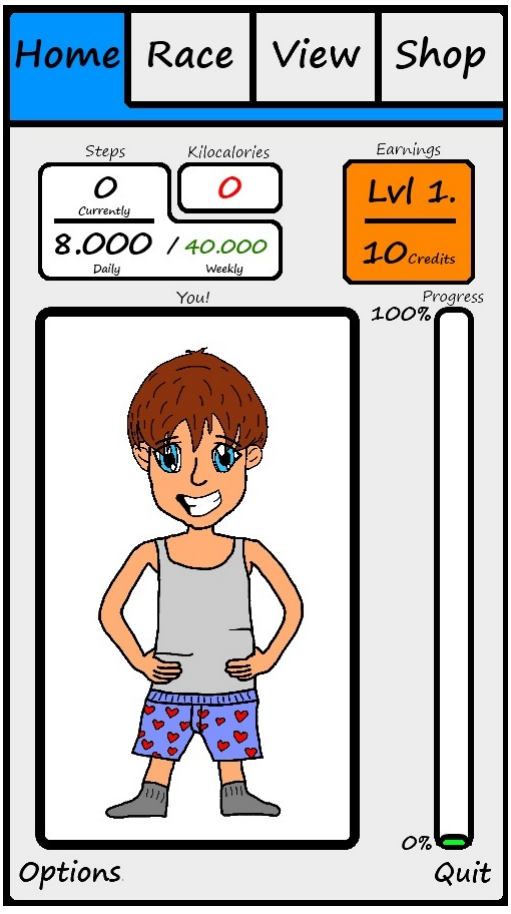
Specifieke vragen

Dan komen nu de specifieke vragen over de game. Ik zou u willen vragen om deze eerlijk en zo compleet mogelijk te beantwoorden.

Bij sommige vragen wordt eerst de bijbehorende afbeelding weergegeven ter ondersteuning.

Volgende

Pagina: 7



13.

Wat vindt u van het 'Home' scherm?

Antwoord:	Slecht				Goed
	●	●	●	●	●

14.

Ontbreekt of is er iets overbodig in het 'Home' scherm? *

- ● Nee.
- ● Ja, namelijk:

15.

Wat vindt u er van dat de dagelijkse goals doordeweeks zijn (ma/di/wo/do/vr) en dat het weekend (za/zo) gebruikt kan worden voor het inhalen van achterstand?

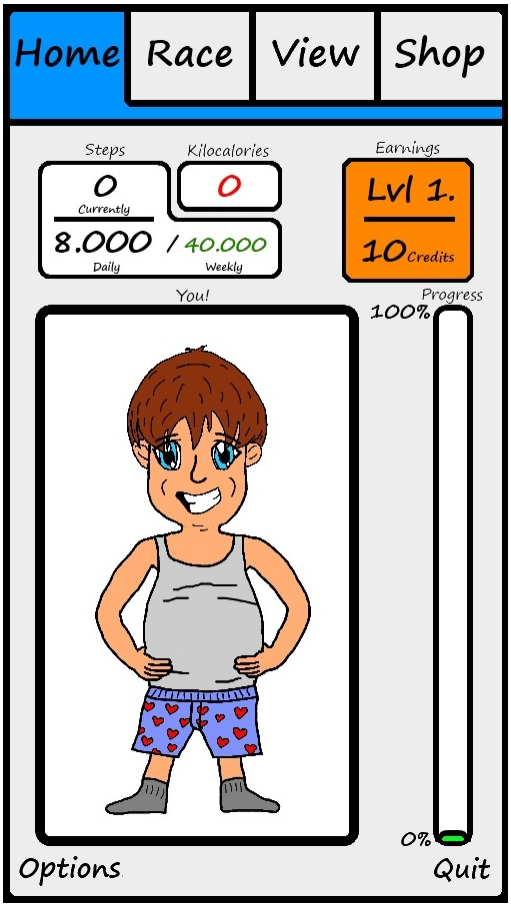
Antwoord:	Slecht				Goed
	●	●	●	●	●

16.

Wat vindt u van de characters?

Antwoord:

Niet leuk ● ● ● ● ● **Leuk**



17.

Wat vindt u ervan dat het lichaam van de character weergeeft wat de gewichtsklasse van de speler is?
(in het filmpje werd dit weergegeven met het dikker worden van de character)

Antwoord:

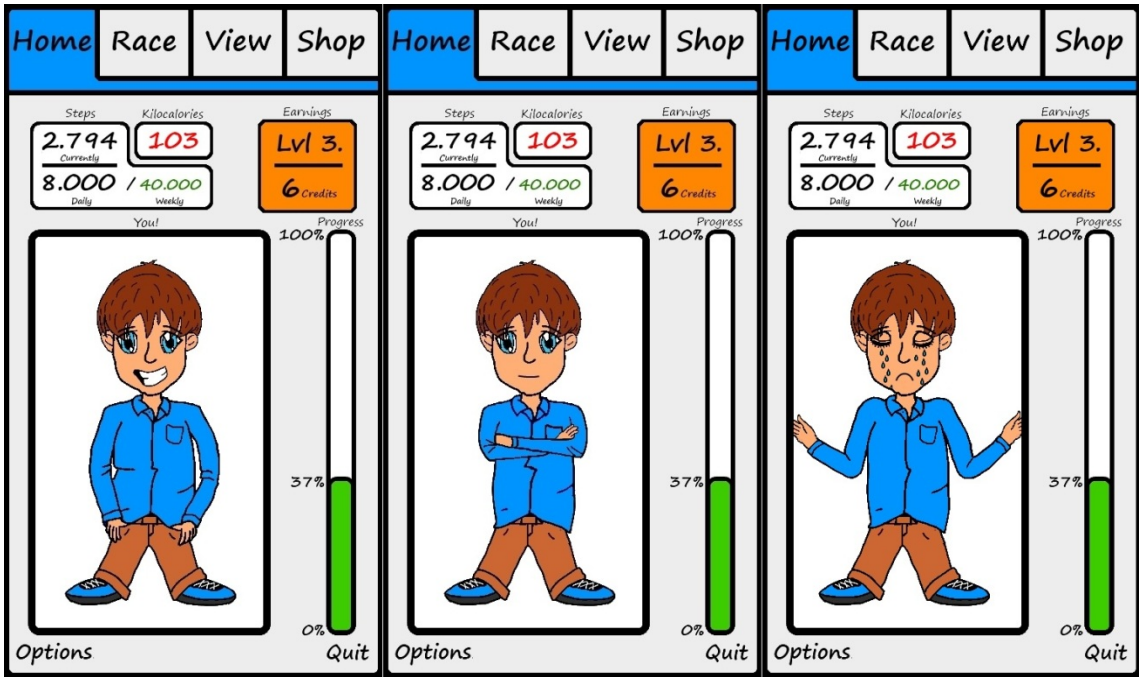
Slecht ● ● ● ● ● **Goed**

18.

Wat vindt u er van dat de character van de speler gewicht kan verliezen door het behalen van wekelijkse goals?

Slecht **Goed**

Antwoord:



19.

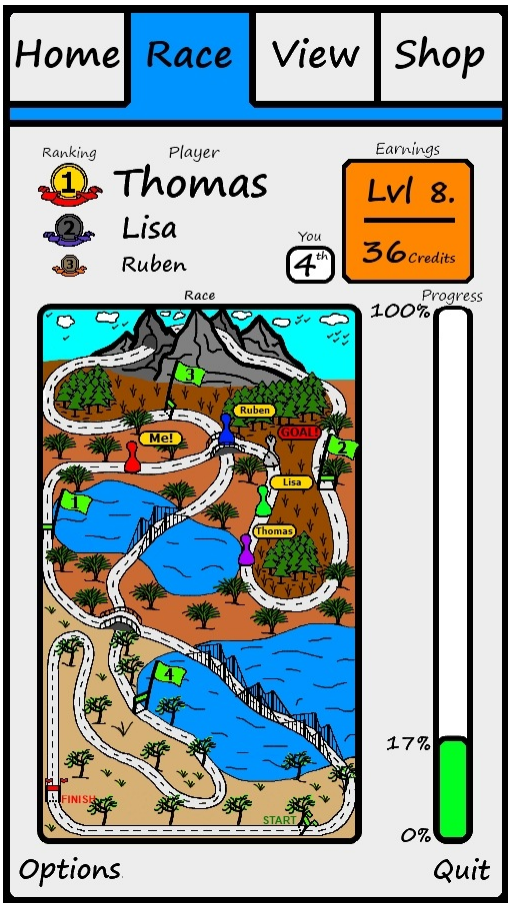
Wat vindt u er van dat de character van stemming wisselt afhankelijk van hoe goed de speler op schema ligt? (graag beide schalen invullen)

Antwoord:

Overbodig **Nuttig** **Niet leuk** **Leuk**

Volgende

Pagina: 8



20.

Wat vindt u van het 'Race' scherm?

Antwoord:

Slecht **Goed**

21.

Ontbreekt of is er iets overbodig in het 'Race' scherm? *

- Nee.
- Ja, namelijk:

22.

Wat vindt u van het race parcour?

Antwoord:	**Niet leuk** ●	●	●	●	● **Leuk**

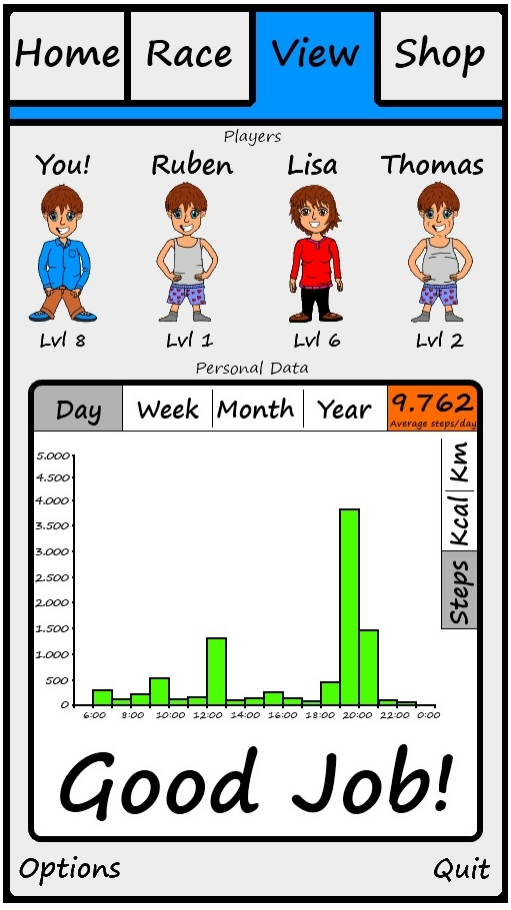
23.

Wat vindt u van de mogelijkheid om als het ware tegen elkaar te kunnen racen?
(graag beide schalen invullen)

Antwoord:	**Slecht** ●	●	●	●	● **Goed**	**Niet leuk** ●	●	●	●	● **Leuk**

Volgende

Pagina: 9



24.

Wat vindt u van het 'View' scherm?

Antwoord:	**Slecht** ● ● ● ● ● **Goed**

25.

Ontbreekt of is er iets overbodig in het 'View' scherm? *

- ● Nee.
- ● Ja, namelijk: [ ]

26.

Werkt het volgens u stimulerend dat de characters van uw medespelers zichtbaar zijn? *

- ● Ja
- ● Nee
- ● Misschien

27.

Zou u de mogelijkheid willen hebben om uw character te kunnen verbergen voor andere spelers? *

- ● Ja.
- ● Nee.
- ● Misschien.

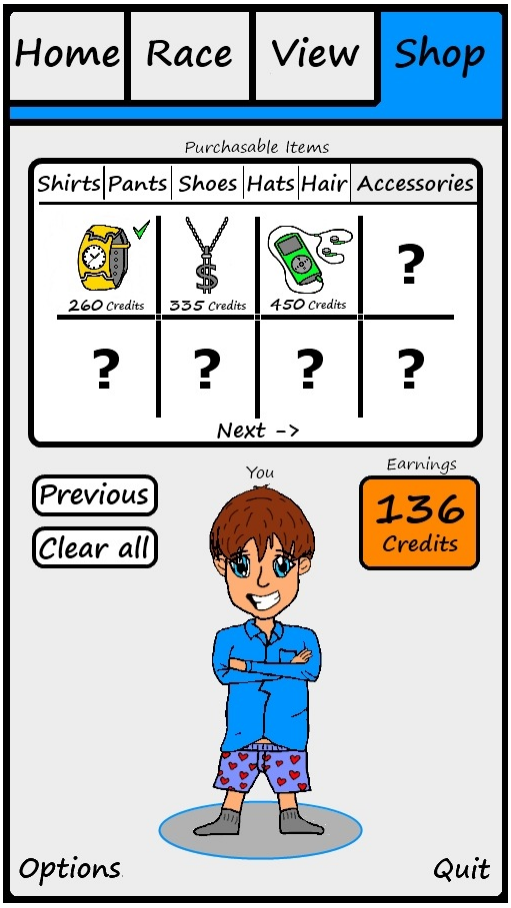
28.

Wat vind u van de mogelijkheid om uw eigen behaalde resultaten te kunnen zien?
(graag beide schalen invullen)

Antwoord:	**Slecht** ● ● ● ● ● **Goed**	**Te weinig mogelijkheden** ● ● ● ● ● **Te veel mogelijkheden**

Volgende

Pagina: 10



29.

Wat vindt u van het 'Shop' scherm?

Antwoord:

Slecht **Goed**

30.

Ontbreekt of is er iets overbodig in het 'Shop' scherm? *

Nee.

- Ja, namelijk:

31.

Wat vindt u van de mogelijkheid om credits te kunnen verdienen?

	Slecht				Goed
Antwoord:					

32.

Wat vindt u er van dat de beloning bestaat uit het kunnen veranderen van de character zijn uiterlijk?

	Niet leuk				Leuk
Antwoord:					

Volgende

Pagina: 11

33.

Zou deze game kunnen bijdragen aan een actievere levensstijl voor uzelf? *

- Ja.
- Misschien.
- Nee.

34.

Zou deze game u kunnen helpen met het verliezen en/of handhaven van uw gewicht? *

- Ja.
- Misschien.
- Nee, want:

35.

Biedt de game volgens u genoeg stimulatie om door te blijven spelen? *

- Ja.
- Misschien.
- Nee, want:

36.

Indien u de game zou proberen, hoelang verwacht u dit te blijven spelen? *

- Minder dan een week
- 1 week
- 2 weken
- 3 weken
- 1 maand
- 2 maanden
- 3 maanden
- Meer dan 3 maanden
- Weet ik niet

37.

Zou u deze game downloaden en spelen als het beschikbaar was? *

- Ja.
- Nee.

38.

Zou u deze game kopen als het niet gratis was? *

- Ja.
- Nee.

39.

Wat is uw eindcijfer voor deze game?

Antwoord:

0 ● ● ● ● ● ● ● ● ● ● 10

40.

Hebt u nog op- en of aanmerkingen? *

Verzenden!

Pagina: 12

Hartelijk bedankt voor het invullen van deze enquête. Mede dankzij uw mening kan deze game verbeterd worden om tot een nog betere oplossing voor overgewicht en obesitas te komen.

11.2 Survey outcome

The bold values in this table are the number of participants that voted on the options shown in the first column. Behind the bold values are the percentages given to give a better impression and overview.

Table 17; Appendix: Survey outcome overview.

	Total	Men	Women
Participants			
• Quantity	**53** (100.00%)	**20** (37.74%)	**33** (62.26%)
Age (years)			
• Average:	25	25	25
• *Range:*	*14 – 60*	*19 – 35*	*14 – 60*
• *0 – 18*	**4** (7.55%)	**0** (0.00%)	**4** (12.12%)
• *18 -25*	**41** (77.36%)	**18** (90.00%)	**23** (69.70%)
• *25 – 50*	**5** (9.43%)	**1** (5.00%)	**4** (12.12%)
• *50+*	**3** (5.66%)	**1** (5.00%)	**2** (6.06%)
Height (meter)			
• Average	1,76	1,85	1,71
• *Range:*	*1.50 – 1.98*	*1.70 – 1.98*	*1.50 – 1.88*
Weight (kilogram)			
• Average	74	85	67
• *Range:*	*51 – 130*	*63 – 130*	*51 – 110*
BMI			
• Average	23.77	25.27	22,96
• Underweight *(0>=x<18.5)*	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• Normal weight *(18.5>=x<25.0)*	**37** (69.81%)	**10** (50.00%)	**26** (78.79%)
• Pre-obese *(25.0>=x<30.0)*	**12** (22.64%)	**8** (40.00%)	**5** (15.15%)
• Obese *(30>=x<100)*	**4** (7.55%)	**2** (10.00%)	**2** (6.06%)
Education (Netherlands – in Dutch)			
• Basisonderwijs	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• Lager beroepsonderwijs	**1** (1.89%)	**1** (5.00%)	**0** (0.00%)
• Voorbereidend middelbaar beroepsonderwijs (VMBO)	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• Middelbaar voortgezet onderwijs (Mavo, MULO)	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• Middelbaar beroepsonderwijs (MBO)	**3** (5.66%)	**0** (0.00%)	**3** (9.09%)
• Hoger voortgezet onderwijs (Havo, VWO)	**6** (11.32%)	**1** (5.00%)	**5** (15.15%)
• Hoger beroepsonderwijs (HBO)	**13** (24.53%)	**4** (20.00%)	**9** (27.27%)
• Wetenschappelijk onderwijs (WO)	**30** (56.60%)	**14** (70.00%)	**16** (48.48%)
The tutorial made the game clear.			
• Yes	**47** (88.68%)	**17** (85.00%)	**30** (90.91%)
• No	**1** (1.89%)	**0** (0.00%)	**1** (3.03%)

• Mainly	**5** (9.43%)	**3** (15.00%)	**2** (6.06%)
The idea of using a serious game in general for overweight/obesity.			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**1** (1.89%)	**0** (0.00%)	**1** (3.03%)
·	**9** (16.98%)	**4** (20.00%)	**5** (15.15%)
·	**19** (35.85%)	**5** (25.00%)	**14** (42.42%)
• Good	**24** (45.28%)	**11** (55.00%)	**13** (39.39%)
Users will reach a healthy weight range with use of this game.			
• Yes	**15** (29.41%)	**7** (35.00%)	**8** (25.81%)
• No	**5** (9.80%)	**0** (0.00%)	**5** (16.13%)
• Maybe	**31** (60.78%)	**13** (65.00%)	**18** (58.06%)
Users will (eventually) get a positive behavioral change by using this game.			
• Yes	**34** (65.38%)	**11** (55.00%)	**23** (71.88%)
• No	**3** (5.77%)	**2** (10.00%)	**1** (3.13%)
• Maybe	**15** (28.85%)	**7** (35.00%)	**8** (25.00%)
Options that apply to this game:			
• The game is a good addition on own initiatives for exercising.	**49** (92.45%)	**20** (100.00%)	**29** (87.88%)
• The game is a good substitute for dieting.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• The game is a good addition on dieting.	**25** (47.17%)	**8** (40.00%)	**17** (51.52%)
• The game is a good substitute for physical therapy.	**2** (3.77%)	**1** (5.00%)	**1** (3.03%)
• The game is a good addition on physical therapy.	**30** (56.6%)	**11** (55.00%)	**19** (57.58%)
• The game offers no added value.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• None of the above.	**2** (3.77%)	**0** (0.00%)	**2** (6.06%)
Elements that are of importance for serious games for overweight/obesity:			
• Physical activity as essence of the game.	**43** (81.13%)	**18** (90.00%)	**25** (75.76%)
• Competition	**32** (60.38%)	**11** (55.00%)	**21** (63.64%)
• Rewards	**35** (66.04%)	**15** (75.00%)	**20** (60.61%)
• Saving up for things instead of immediately receiving.	**15** (28.30%)	**5** (25.00%)	**10** (30.30%)
• Displaying current information (steps, calories, etc.).	**38** (71.7%)	**10** (50.00%)	**28** (84.85%)
• Use of a character.	**9** (16.98%)	**3** (15.00%)	**6** (18.18%)
• Possibility to review results.	**36** (67.92%)	**16** (80.00%)	**20** (60.61%)
The Home-screen:			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**4** (7.55%)	**2** (10.00%)	**2** (6.06%)

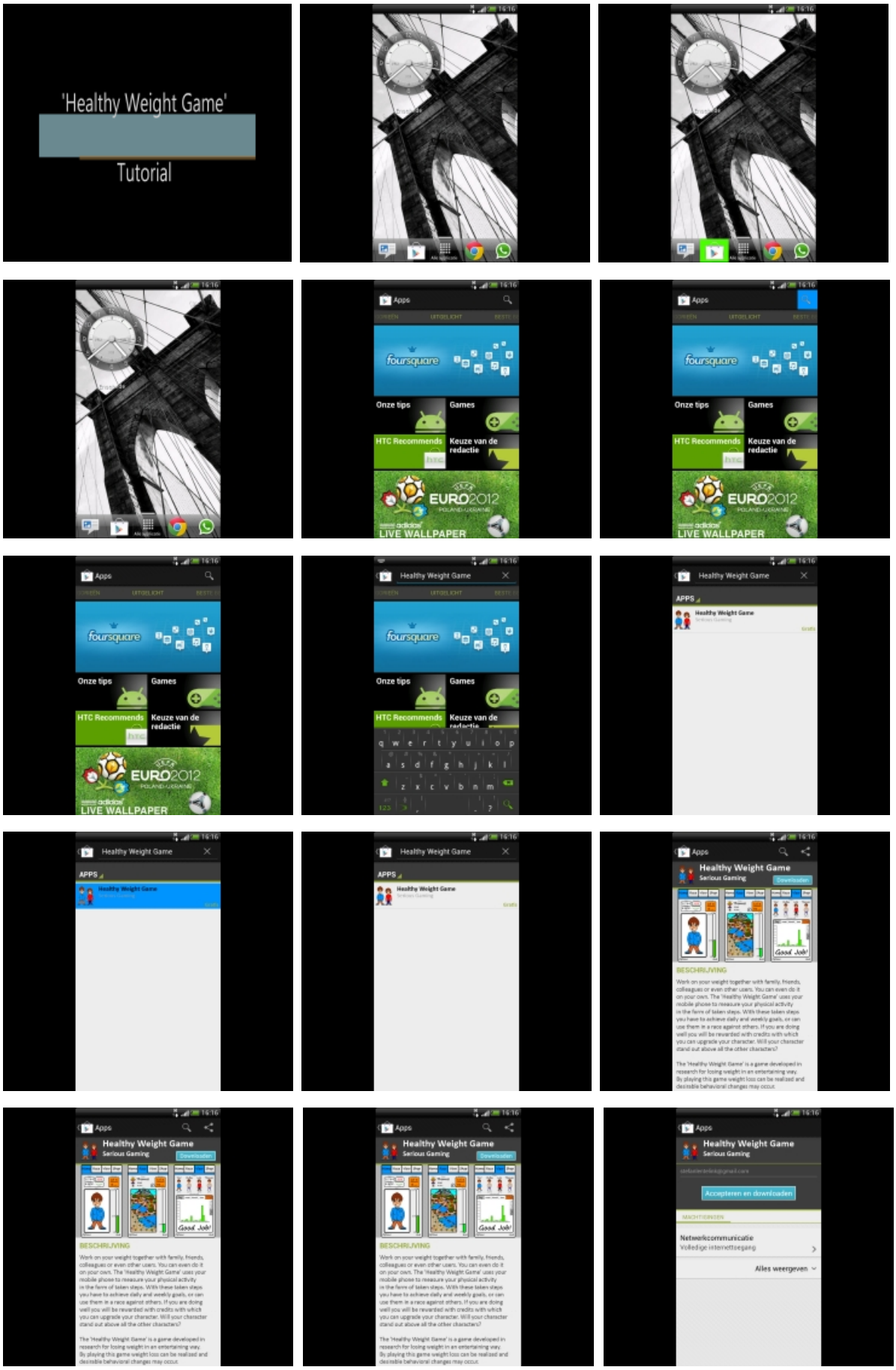
·	**5** (9.43%)	**2** (10.00%)	**3** (9.09%)
·	**28** (52.83%)	**8** (40.00%)	**20** (60.61%)
• Good	**16** (30.19%)	**8** (40.00%)	**8** (24.24%)
Something is missing or redundant in the Home-screen.			
• No	**45** (84.91%)	**17** (85.00%)	**28** (84.85%)
• Yes	**8** (15.09%)	**3** (15.00%)	**5** (15.15%)
Holding the daily goals on Mo/Tu/We/Th/Fr:			
• Bad	**3** (5.66%)	**1** (5.00%)	**2** (6.06%)
·	**6** (11.32%)	**1** (5.00%)	**5** (15.15%)
·	**8** (15.09%)	**6** (30.00%)	**2** (6.06%)
·	**19** (35.85%)	**8** (40.00%)	**11** (33.33%)
• Good	**17** (32.08%)	**4** (20.00%)	**13** (39.39%)
The characters in general:			
• Dislike	**2** (3.77%)	**2** (10.00%)	**0** (0.00%)
·	**2** (3.77%)	**1** (5.00%)	**1** (3.03%)
·	**10** (18.87%)	**2** (10.00%)	**8** (24.24%)
·	**18** (33.96%)	**9** (45.00%)	**9** (27.27%)
• Like	**21** (39.62%)	**6** (30.00%)	**15** (45.45%)
The character showing the weight-class of the player:			
• Bad	**1** (1.89%)	**0** (0.00%)	**1** (3.03%)
·	**2** (3.77%)	**1** (5.00%)	**1** (3.03%)
·	**6** (11.32%)	**2** (10.00%)	**4** (12.12%)
·	**15** (28.30%)	**9** (45.00%)	**6** (18.18%)
• Good	**29** (54.72%)	**8** (40.00%)	**21** (63.64%)
Losing weight by the character by reaching a weakly goal.			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**2** (3.92%)	**1** (5.00%)	**1** (3.23%)
·	**4** (7.84%)	**2** (10.00%)	**2** (6.45%)
·	**20** (39.22%)	**10** (50.00%)	**10** (32.26%)
• Good	**25** (49.02%)	**7** (35.00%)	**18** (85.06%)
Mood changes of the character depending on the player his schedule.			
• Redundant	**2** (3.92%)	**2** (10.53%)	**0** (0.00%)
·	**1** (1.96%)	**0** (0.00%)	**1** (3.13%)
·	**7** (13.73%)	**4** (21.05%)	**3** (9.38%)
·	**20** (39.22%)	**9** (47.37%)	**11** (34.38%)
• Useful	**21** (41.48%)	**4** (21.05%)	**17** (53.13%)
• Dislike	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**8** (15.38%)	**4** (21.05%)	**4** (12.12%)
·	**28** (53.85%)	**10** (52.63%)	**18** (54.55%)
• Like	**16** (30.77%)	**5** (26.32%)	**11** (33.33%)
The Race-screen:			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)

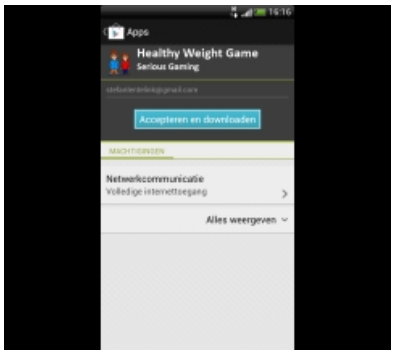
.	**2** (3.77%)	**0** (0.00%)	**2** (6.06%)
.	**7** (13.21%)	**4** (20.00%)	**3** (9.09%)
.	**25** (47.17%)	**9** (45.00%)	**16** (48.48%)
• Good	**19** (35.85%)	**7** (35.00%)	**12** (36.36%)
Something is missing or redundant in the Race-screen.			
• No	**45** (86.54%)	**17** (85.00%)	**28** (87.50%)
• Yes	**7** (13.46%)	**3** (15.00%)	**4** (12.50%)
The race track.			
• Dislike	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**3** (5.77%)	**2** (10.00%)	**1** (3.13%)
.	**10** (19.23%)	**3** (15.00%)	**7** (21.08%)
.	**23** (44.23%)	**10** (50.00%)	**13** (40.63%)
• Like	**16** (30.77%)	**5** (25.00%)	**11** (34.38%)
Possibility to race against each other			
• Bad	**1** (1.92%)	**0** (0.00%)	**1** (3.03%)
.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**5** (9.62%)	**2** (10.00%)	**3** (9.09%)
.	**17** (32.69%)	**10** (50.00%)	**7** (21.21%)
• Good	**29** (55.77%)	**7** (35.00%)	**22** (66.67%)
• Dislike	**1** (1.89%)	**0** (0.00%)	**1** (3.03%)
.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**2** (3.77%)	**0** (0.00%)	**2** (6.06%)
.	**22** (41.51%)	**12** (60.00%)	**10** (30.30%)
• Like	**28** (52.83%)	**8** (40.00%)	**20** (60.61%)
The View-screen:			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**4** (7.69%)	**1** (5.00%)	**3** (9.09%)
.	**24** (46.15%)	**13** (65.00%)	**11** (33.33%)
• Good	**24** (46.15%)	**5** (25.00%)	**19** (57.58%)
Something is missing or redundant in the View-screen.			
• No	**48** (90.57%)	**17** (85.00%)	**31** (93.94%)
• Yes	**5** (9.43%)	**3** (15.00%)	**2** (6.06%)
Seeing the characters of other players is stimulating.			
• Yes	**31** (58.49%)	**14** (70.00%)	**17** (51.52%)
• No	**3** (5.66%)	**1** (5.00%)	**2** (6.06%)
• Maybe	**19** (35.85%)	**5** (25.00%)	**14** (42.42%)
The possibility to hide the character to other players.			
• Yes	**20** (37.74%)	**5** (25.00%)	**15** (45.45%)
• No	**15** (28.30%)	**9** (45.00%)	**6** (18.18%)
• Maybe	**18** (33.96%)	**6** (30.00%)	**12** (36.36%)
Possibility of viewing own results.			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
.			

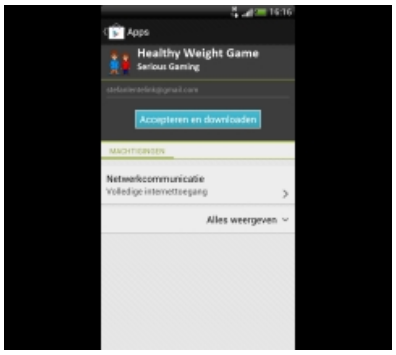
·	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
• Good	**11** (20.75%)	**9** (45.00%)	**2** (6.06%)
	42 (79.25%)	**11** (55.00%)	**31** (93.94%)
• Too few opportunities			
·	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**4** (7.55%)	**2** (10.00%)	**2** (6.06%)
·	**37** (69.81%)	**14** (70.00%)	**23** (69.70%)
• Too many opportunities	**11** (20.75%)	**4** (20.00%)	**7** (21.21%)
	1 (1.89%)	**0** (0.00%)	**1** (3.03%)
The Shop-screen:			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**4** (7.55%)	**1** (5.00%)	**3** (9.09%)
·	**8** (15.09%)	**4** (20.00%)	**4** (12.12%)
·	**23** (43.40%)	**9** (45.00%)	**14** (42.42%)
• Good	**18** (33.96%)	**6** (30.00%)	**12** (36.36%)
Something is missing or redundant in the Shop-screen.			
• No	**41** (78.85%)	**16** (84.21%)	**25** (75.76%)
• Yes	**11** (21.15%)	**3** (15.79%)	**8** (24.24%)
The possibility to earn credits.			
• Bad	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**2** (3.77%)	**1** (5.00%)	**1** (3.03%)
·	**0** (0.00%)	**0** (0.00%)	**0** (0.00%)
·	**17** (32.08%)	**7** (35.00%)	**10** (30.30%)
• Good	**34** (64.15%)	**12** (60.00%)	**22** (66.67%)
The reward exists of changing the appearance of the character.			
• Dislike	**1** (1.92%)	**1** (5.00%)	**0** (0.00%)
·	**4** (7.69%)	**1** (5.00%)	**3** (9.38%)
·	**7** (13.46%)	**1** (5.00%)	**6** (18.50%)
·	**24** (46.15%)	**10** (50.00%)	**14** (43.75%)
• Like	**16** (30.77%)	**7** (35.00%)	**9** (28.13%)
This game could contribute to a more active lifestyle for me.			
• Yes	**16** (30.19%)	**4** (20.00%)	**12** (36.36%)
• No	**27** (50.94%)	**11** (55.00%)	**16** (48.48%)
• Maybe	**10** (18.87%)	**5** (25.00%)	**5** (15.15%)
This game could help me lose and/or maintain my weight.			
• Yes	**9** (16.98%)	**4** (20.00%)	**5** (15.15%)
• No	**32** (60.38%)	**10** (50.00%)	**22** (66.67%)
• Maybe	**12** (22.64%)	**6** (30.00%)	**6** (18.18%)
This game offers enough stimulation to keep playing.			
• Yes	**17** (32.69%)	**6** (30.00%)	**11** (34.38%)
• No	**29** (55.77%)	**11** (55.00%)	**18** (56.25%)
• Maybe	**6** (11.54%)	**3** (15.00%)	**3** (9.38%)
When playing this game, I expect to play it for:			
• Less than a week	**3** (5.66%)	**1** (5.00%)	**2** (6.06%)

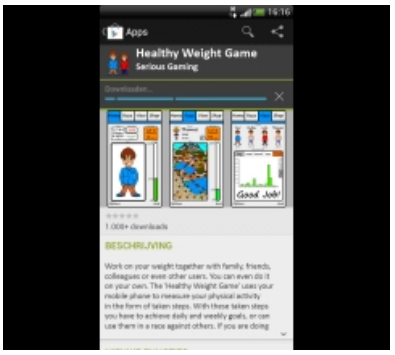
• 1 week • 2 weeks • 3 weeks • 1 month • 2 months • 3 months • More than 3 months • Unknown	**4** (7.55%) **5** (9.43%) **4** (7.55%) **10** (18.87%) **5** (9.43%) **1** (1.89%) **3** (5.66%) **18** (33.96%)	**3** (15.00%) **1** (5.00%) **1** (5.00%) **5** (25.00%) **2** (10.00%) **0** (0.00%) **1** (5.00%) **6** (30.00%)	**1** (3.03%) **4** (12.12%) **3** (9.09%) **5** (15.15%) **3** (9.09%) **1** (3.03%) **2** (6.06%) **12** (36.36%)
I would download this game if it was available.			
• Yes • No	**42** (79.25%) **11** (20.75%)	**15** (75.00%) **5** (25.00%)	**27** (81.82%) **6** (18.18%)
I would buy this game if it was not free.			
• Yes • No	**7** (13.73%) **44** (86.27%)	**1** (5.26%) **18** (94.74%)	**6** (18.75%) **26** (81.25%)
My final grade for this game is:			
• Average • *Range*	7.57 *5 – 10*	7.35 *5 – 9*	7.70 *6 – 10*

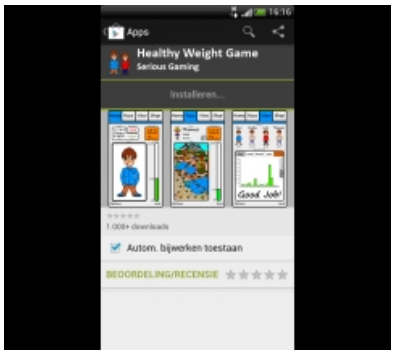
11.3 Game tutorial video-images

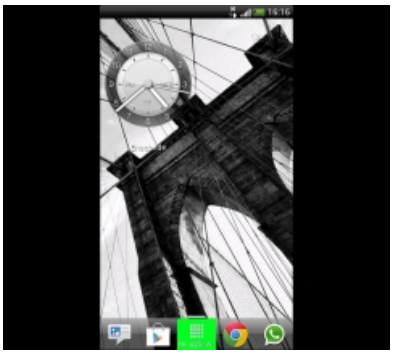


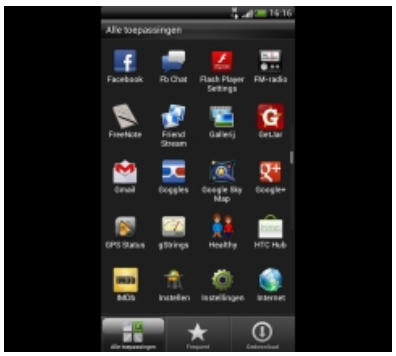

Apps
Healthy Weight Game
Serious Gaming
Accepteren en downloaden
Netwerkcommunicatie
Volledige internettoegang
Alles weergeven


Apps
Healthy Weight Game
Serious Gaming
Accepteren en downloaden
Netwerkcommunicatie
Volledige internettoegang
Alles weergeven


Apps
Healthy Weight Game
Serious Gaming
Good Job!
BESCHRIJVING


Apps
Healthy Weight Game
Serious Gaming
Installeren...
Good Job!
Autom. bijwerken toestaan
BEOORDELING/RECENSIE




Alle toepassingen
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Fb Chat
Flash Player Settings
FM-radio
FreeNote
Friend Stream
Gallerij
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GPS Status
gStrings
Healthy
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Installeren
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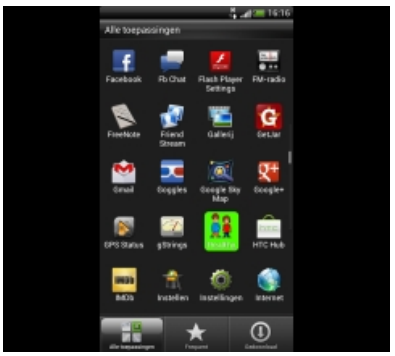
Internet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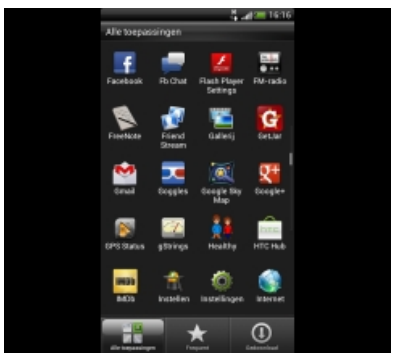
Alle toepassingen
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Gallerij
GetJar
Gmail
Goggles
Google Sky Map
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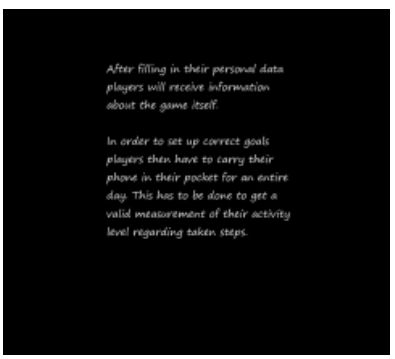
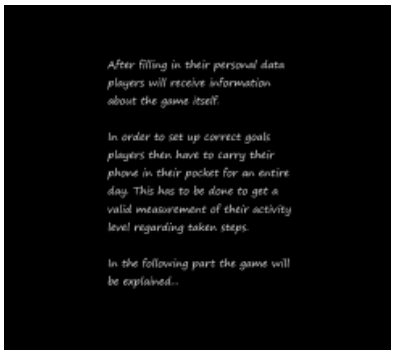
GPS Status
gStrings
Healthy
HTC Hub
IMDb
Installeren
Instellingen
Internet


Healthy Weight Game!
Lose weight together
Name:
Age:
years
Height:
meters
Weight:
kilograms
Start


Healthy Weight Game!
Lose weight together
Name:
Age:
22
years
Height:
1.80
meters
Weight:
73.0
kilograms
Start


After filling in their personal data players will receive information about the game itself.


After filling in their personal data players will receive information about the game itself.
In order to set up correct goals players then have to carry their phone in their pocket for an entire day. This has to be done to get a valid measurement of their activity level regarding taken steps.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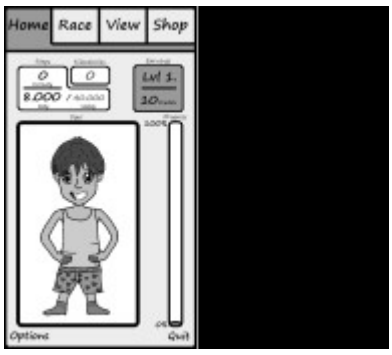
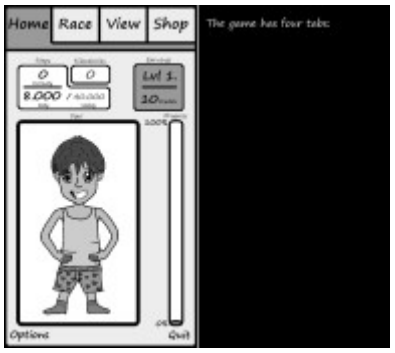
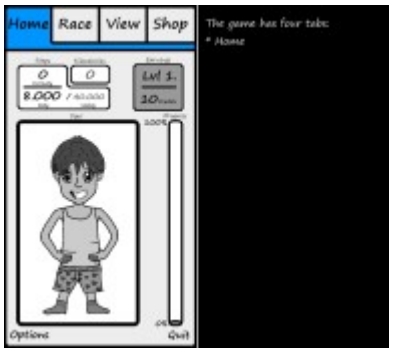
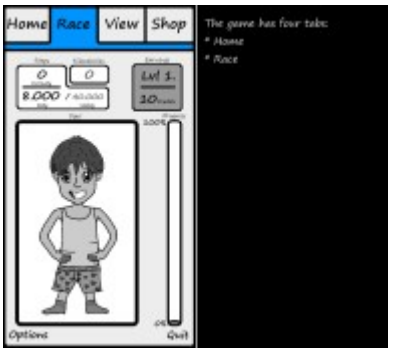
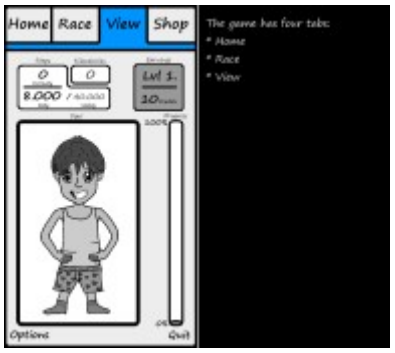
In order to set up correct goals players then have to carry their phone in their pocket for an entire day. This has to be done to get a valid measurement of their activity level regarding taken steps.
In the following part the game will be explained...


Home
Race
View
Shop
Options
Quit


Home
Race
View
Shop
The game has four tabs:
Options
Quit


Home
Race
View
Shop
The game has four tabs:
* Home
Options
Quit


Home
Race
View
Shop
The game has four tabs:
* Home
* Race
Options
Quit


Home
Race
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Shop
The game has four tabs:
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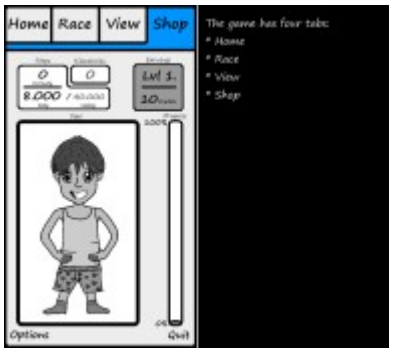
* Race
* View
Options
Quit


Home
Race
View
Shop
The game has four tabs:
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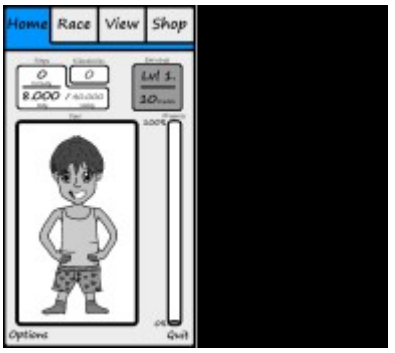
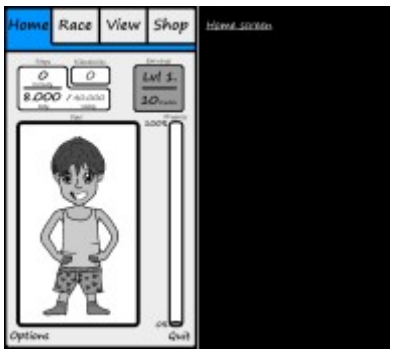
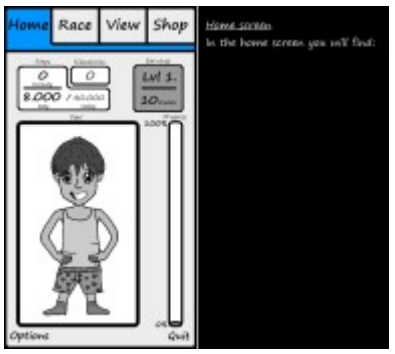
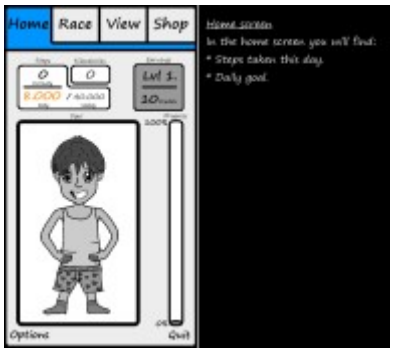
* Race
* View
* Shop
Options
Quit

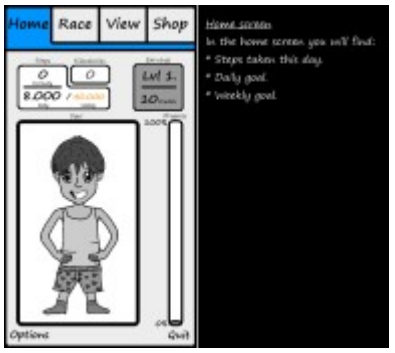

Home
Race
View
Shop
Options
Quit

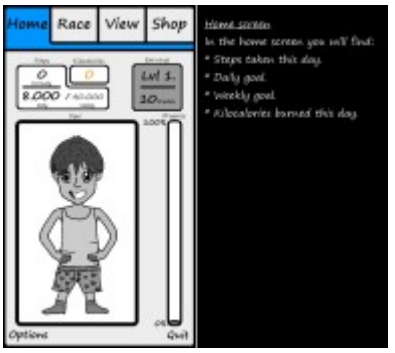

Home
Race
View
Shop
Home screen
Options
Quit

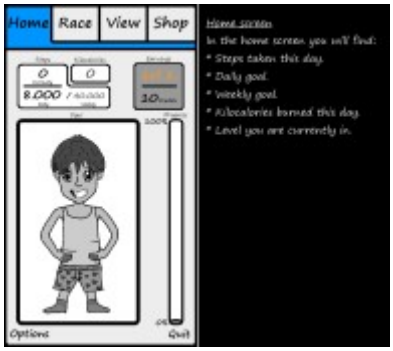

Home
Race
View
Shop
Home screen
In the home screen you will find:
Options
Quit


Home
Race
View
Shop
Home screen
In the home screen you will find:
* Steps taken this day.
Options
Quit

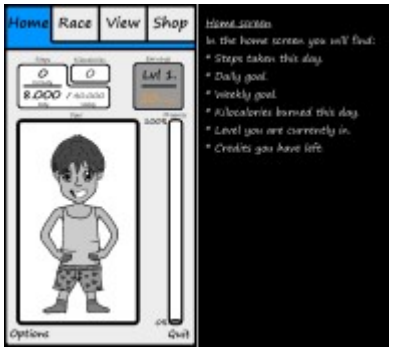

Home
Race
View
Shop
Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
Options
Quit


Home
Race
View
Shop
Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
Options
Quit

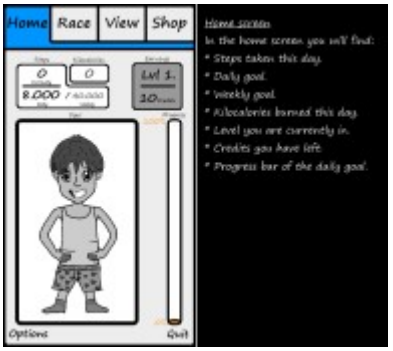

Home
Race
View
Shop
Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
* Kilocalories burned this day.
Options
Quit



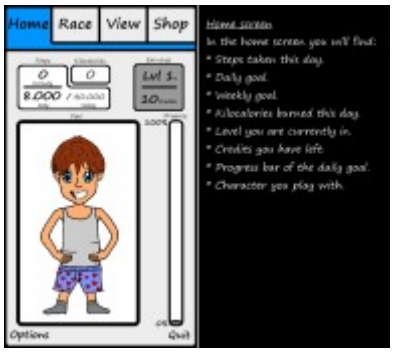
Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
* Kilocalories burned this day.
* Level you are currently in.



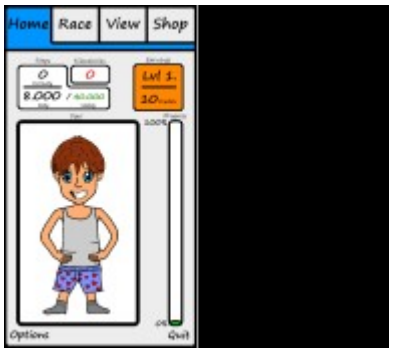
Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
* Kilocalories burned this day.
* Level you are currently in.
* Credits you have left.

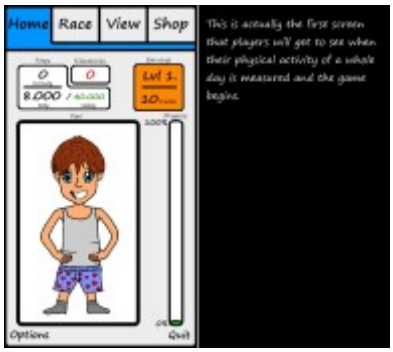


Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
* Kilocalories burned this day.
* Level you are currently in.
* Credits you have left.
* Progress bar of the daily goal.



Home screen
In the home screen you will find:
* Steps taken this day.
* Daily goal.
* Weekly goal.
* Kilocalories burned this day.
* Level you are currently in.
* Credits you have left.
* Progress bar of the daily goal.
* Character you play with.





This is actually the first screen that players will get to see when their physical activity of a whole day is measured and the game begins.

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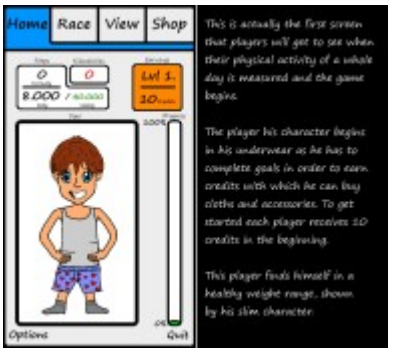
The player his character begins in his underwear as he has to complete goals in order to earn credits with which he can buy clothe and accessories. To get started each player receives 10 credits in the beginning.



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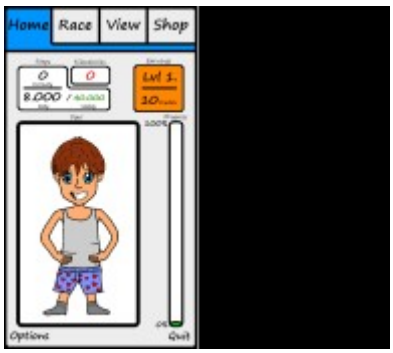
The player his character begins in his underwear as he has to complete goals in order to earn credits with which he can buy clothe and accessories. To get started each player receives 10 credits in the beginning.

This player finds himself in a healthy weight range, shown by his slim character.



When players are in a less healthy weight range their character will show this as follows...

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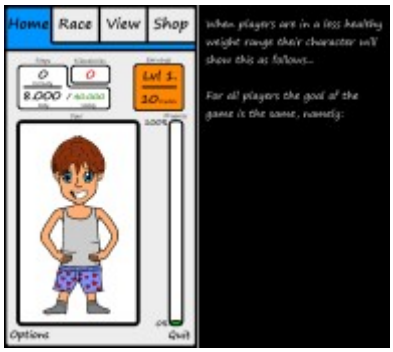
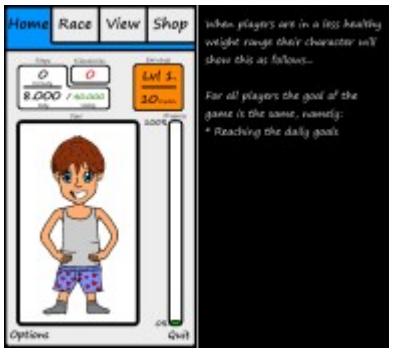


When players are in a less healthy weight range their character will show this as follows...

For all players the goal of the game is the same, namely:



When players are in a less healthy weight range their character will show this as follows...

For all players the goal of the game is the same, namely:
* Reaching the daily goals

When players are in a less healthy weight range their character will show this as follows...

For all players the goal of the game is the same, namely:
* Reaching the daily goals (held on Monday/Tuesday/Wednesday/Thursday/Friday).

When players are in a less healthy weight range their character will show this as follows...

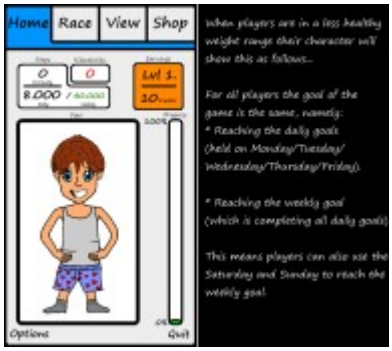
For all players the goal of the game is the same, namely:
* Reaching the daily goals (held on Monday/Tuesday/ Wednesday/Thursday/Friday).

* Reaching the weekly goal

When players are in a less healthy weight range their character will show this as follows...

For all players the goal of the game is the same, namely:
* Reaching the daily goals (held on Monday/Tuesday/ Wednesday/Thursday/Friday).

* Reaching the weekly goal (which is completing all daily goals)



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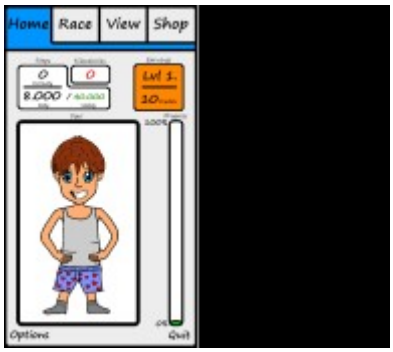
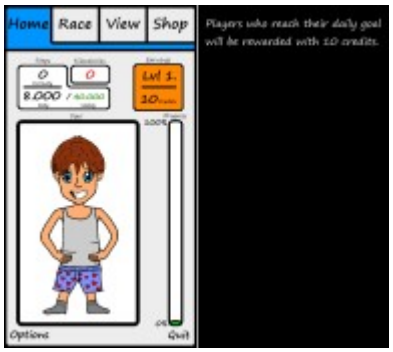
For all players the goal of the game is the same, namely:
* Reaching the daily goals (held on Monday/Tuesday/ Wednesday/Thursday/Friday).

* Reaching the weekly goal (which is completing all daily goals)

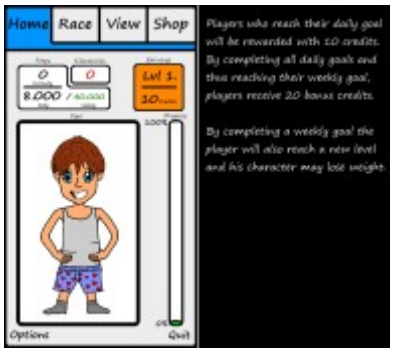
This means players can also use the Saturday and Sunday to reach the weekly goal





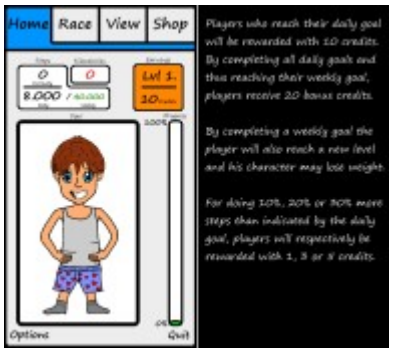
Players who reach their daily goal will be rewarded with 10 credits.

Players who reach their daily goal will be rewarded with 10 credits. By completing all daily goals and thus reaching their weekly goal, players receive 20 bonus credits.



Players who reach their daily goal will be rewarded with 10 credits. By completing all daily goals and thus reaching their weekly goal, players receive 20 bonus credits.

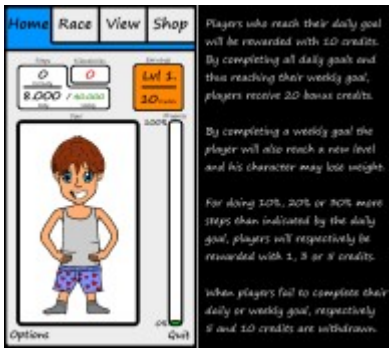
By completing a weekly goal the player will also reach a new level and his character may lose weight.



Players who reach their daily goal will be rewarded with 10 credits. By completing all daily goals and thus reaching their weekly goal, players receive 20 bonus credits.

By completing a weekly goal the player will also reach a new level and his character may lose weight.

For doing 10%, 20% or 30% more steps than indicated by the daily goal, players will respectively be rewarded with 1, 3 or 5 credits.



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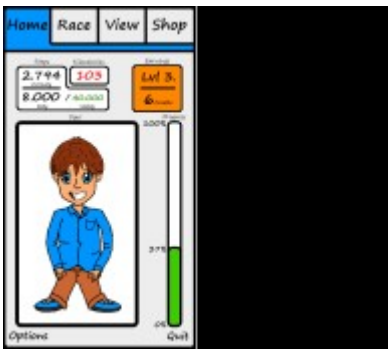
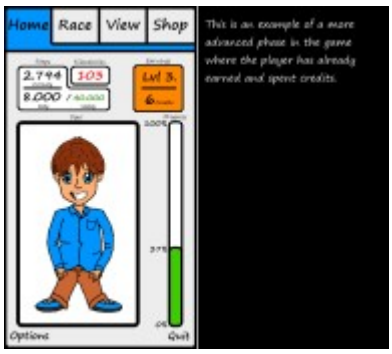
By completing a weekly goal the player will also reach a new level and his character may lose weight.

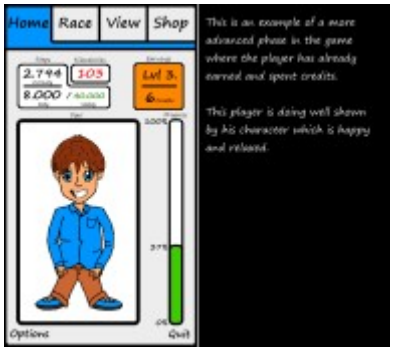
For doing 10%, 20% or 30% more steps than indicated by the daily goal, players will respectively be rewarded with 1, 3 or 5 credits.

When players fail to complete their daily or weekly goal, respectively 5 and 10 credits are withdrawn.



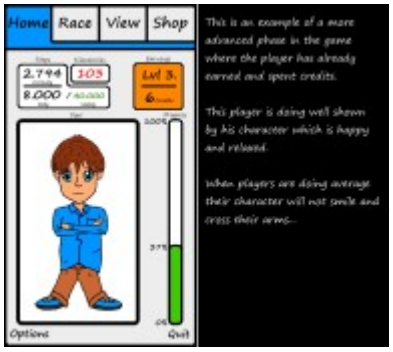


This is an example of a more advanced phase in the game where the player has already earned and spent credits.



This is an example of a more advanced phase in the game where the player has already earned and spent credits.

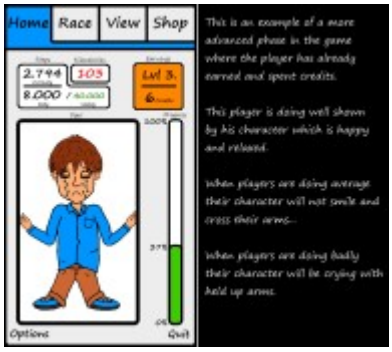
This player is doing well shown by his character which is happy and relaxed.



This is an example of a more advanced phase in the game where the player has already earned and spent credits.

This player is doing well shown by his character which is happy and relaxed.

When players are doing average their character will not smile and cross their arms...

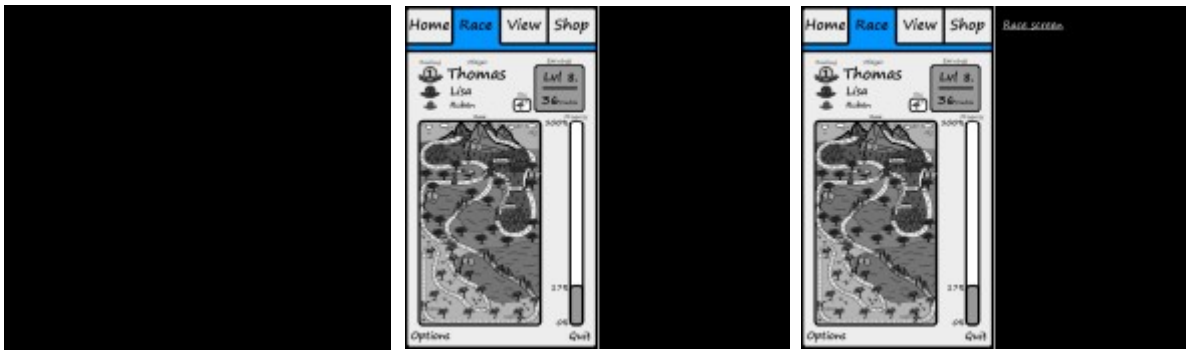


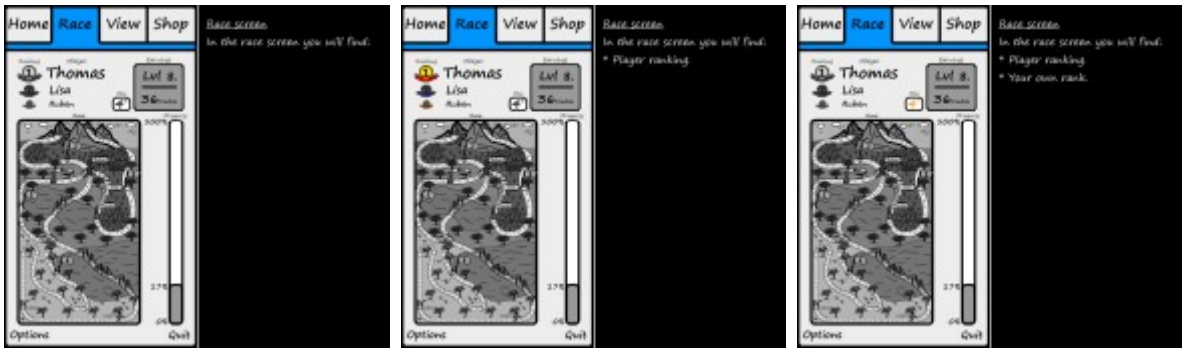
This is an example of a more advanced phase in the game where the player has already earned and spent credits.

This player is doing well shown by his character which is happy and relaxed.

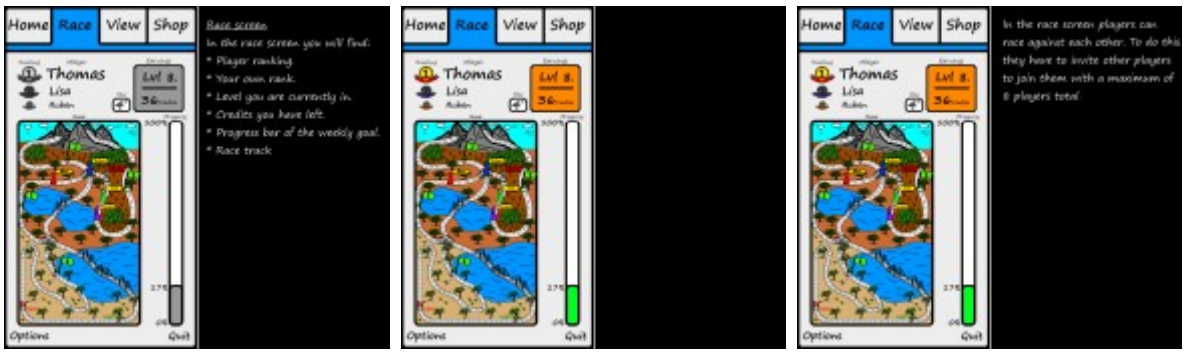
When players are doing average their character will not smile and cross their arms...

When players are doing badly their character will be crying with hold up arms.


Home Race View Shop
Thomas
Lisa
Lvl 8.
Options
Quit
Race screen


Home Race View Shop
Thomas
Lisa
Lvl 8.
Options
Quit
Race screen
In the race screen you will find:
* Player ranking
* Your own rank.


Home Race View Shop
Thomas
Lisa
Lvl 8.
Options
Quit
Race screen
In the race screen you will find:
* Player ranking
* Your own rank.
* Level you are currently in.
* Credits you have left.


Home Race View Shop
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Options
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Race screen
In the race screen you will find:
* Player ranking
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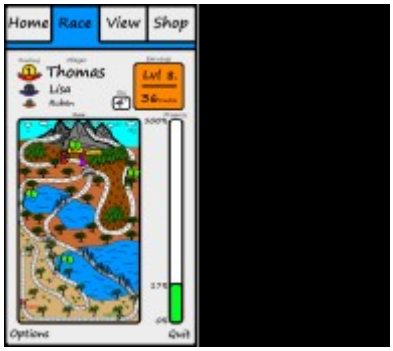
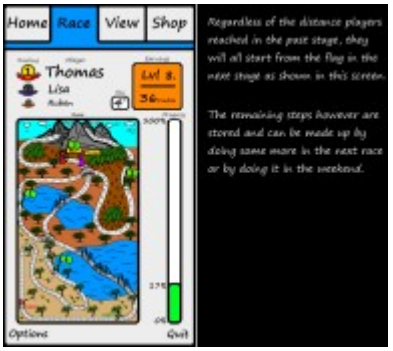
* Credits you have left.
* Progress bar of the weekly goal.
* Race track


Home Race View Shop
Thomas
Lisa
Lvl 8.
Options
Quit
In the race screen players can race against each other. To do this they have to invite other players to join them with a maximum of 8 players total.
The race has 8 stages which are corresponding with the 8 daily goals.
In this race the players are racing in the second stage which is the Tuesday. Thomas is in front while the player self stands last.
The ghost pawn shows the place where the player actually should be according to the schedule.



Regardless of the distance players reached in the past stage, they will all start from the flag in the next stage as shown in this screen.



Regardless of the distance players reached in the past stage, they will all start from the flag in the next stage as shown in this screen.

The remaining steps however are stored and can be made up by doing some more in the next race or by doing it in the weekend.

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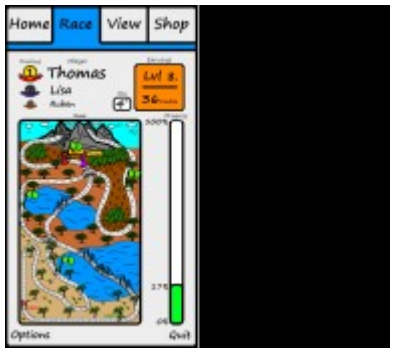
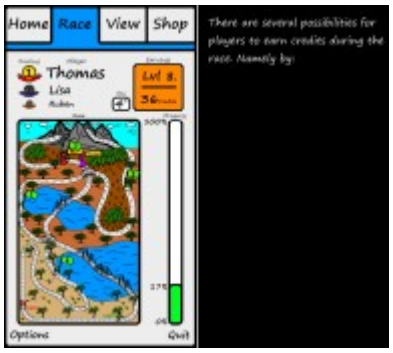
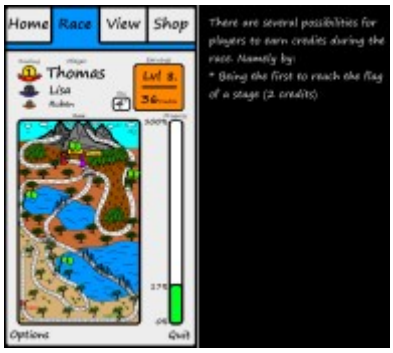
The remaining steps however are stored and can be made up by doing some more in the next race or by doing it in the weekend.

Players who did more steps than their daily goal required, and thus gone past the flag, will get beside bonus credits also a head start (like Thomas). For doing 10%, 20% or 30% more steps they will receive respectively a 2%, 5% or 10% head start in the race.



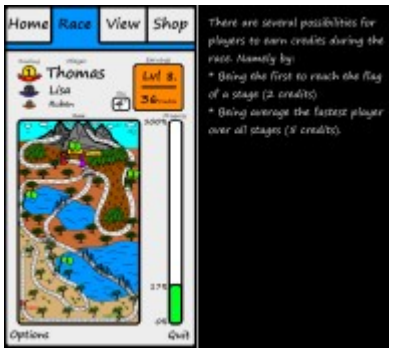


There are several possibilities for players to earn credits during the race. Namely by:



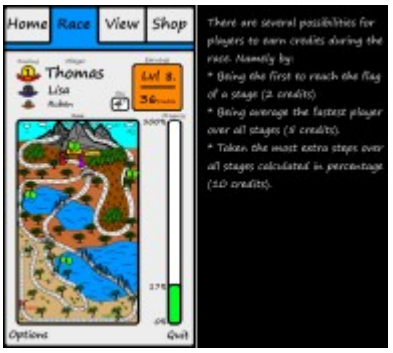
There are several possibilities for players to earn credits during the race. Namely by:

* Being the first to reach the flag of a stage (2 credits)



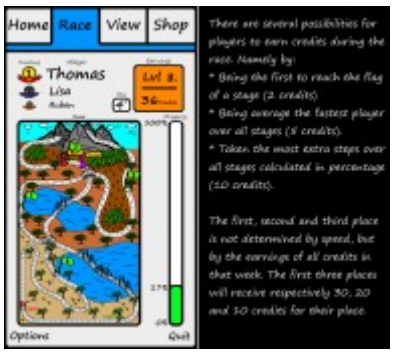
There are several possibilities for players to earn credits during the race. Namely by:

* Being the first to reach the flag of a stage (2 credits)
* Being average the fastest player over all stages (5 credits).



There are several possibilities for players to earn credits during the race. Namely by:

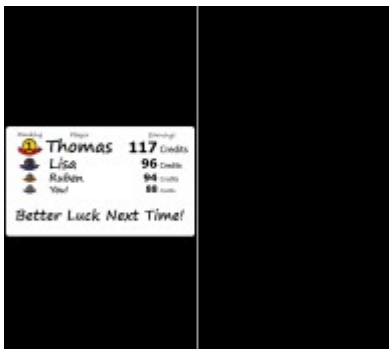
* Being the first to reach the flag of a stage (2 credits)
* Being average the fastest player over all stages (5 credits).
* Taken the most extra steps over all stages calculated in percentage (10 credits).

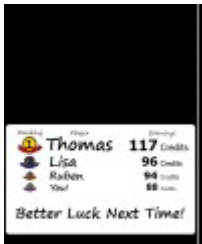


There are several possibilities for players to earn credits during the race. Namely by:

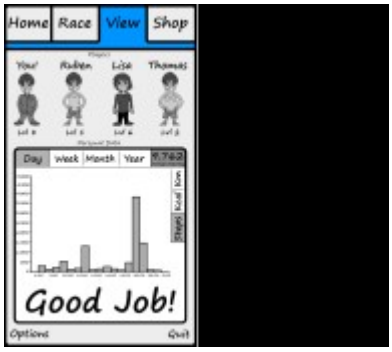
* Being the first to reach the flag of a stage (2 credits)
* Being average the fastest player over all stages (5 credits).
* Taken the most extra steps over all stages calculated in percentage (10 credits).

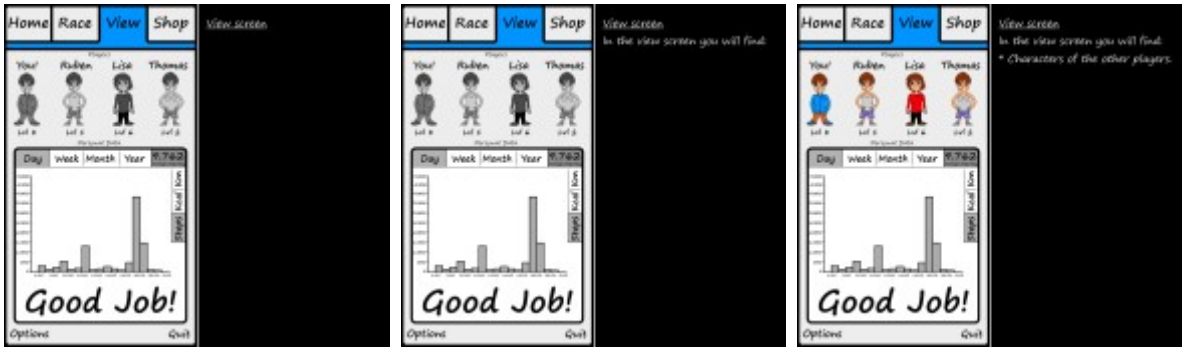
The first, second and third place is not determined by speed, but by the earnings of all credits in that week. The first three places will receive respectively 30, 20 and 10 credits for their place.





At the end of the week when the race is completely over, an overview of all scores will be shown. These scores are the sum off all the credits earned that week by each player (including spent credits).




Home Race View Shop
View screen
Good Job!
Options Quit

Home Race View Shop
View screen
In the view screen you will find:
Good Job!
Options Quit

Home Race View Shop
View screen
In the view screen you will find:
* Characters of the other players.
Good Job!
Options Quit

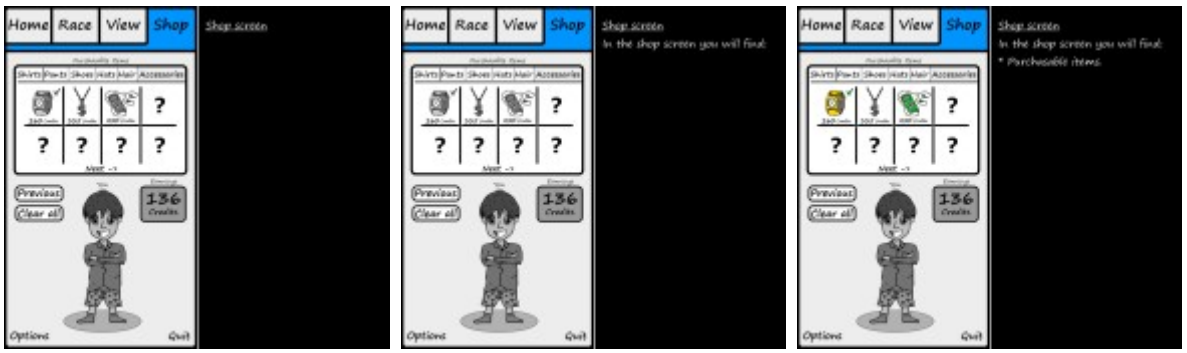

Home Race View Shop
View screen
In the view screen you will find:
* Characters of the other players.
* Personal data.
Good Job!
Options Quit

Home Race View Shop
Good Job!
Options Quit

Home Race View Shop
This is an example of the view screen where players can see their progress. Each player can also see the characters of other players competing in the race.
Good Job!
Options Quit

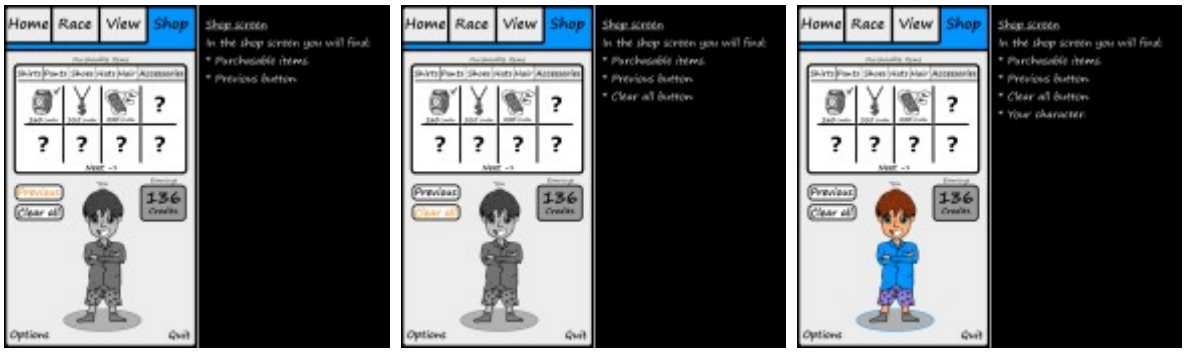

Home Race View Shop
This is an example of the view screen where players can see their progress. Each player can also see the characters of other players competing in the race.
In this example a graph is given of the steps that have been taken this particular day. The player is able to change the parameters to get other detailed information.
Good Job!
Options Quit

Home Race View Shop
Previous
Clear all
136
Options Quit


Home Race View Shop
Shop screen
Previous
Clear all
136
Options Quit

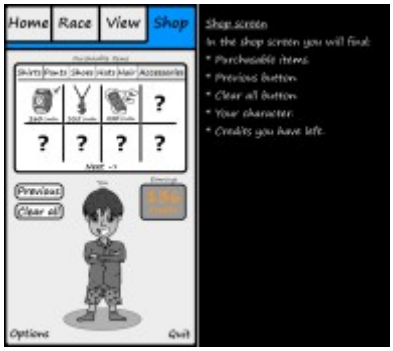
Home Race View Shop
Shop screen
In the shop screen you will find:
Previous
Clear all
136
Options Quit

Home Race View Shop
Shop screen
In the shop screen you will find:
* Purchasable items.
Previous
Clear all
136
Options Quit

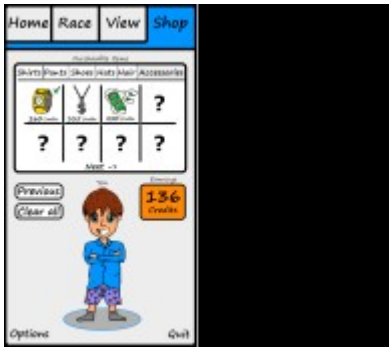

Home Race View Shop
Shop screen
In the shop screen you will find:
* Purchasable items.
* Previous button.
Previous
Clear all
136
Options Quit

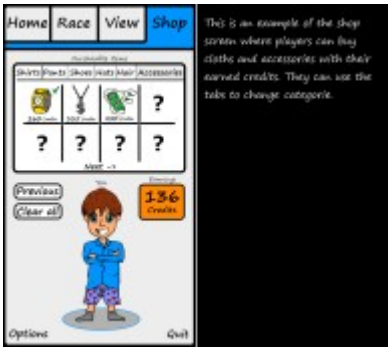
Home Race View Shop
Shop screen
In the shop screen you will find:
* Purchasable items.
* Previous button.
* Clear all button.
Previous
Clear all
136
Options Quit

Home Race View Shop
Shop screen
In the shop screen you will find:
* Purchasable items.
* Previous button.
* Clear all button.
* Your character.
Previous
Clear all
136
Options Quit

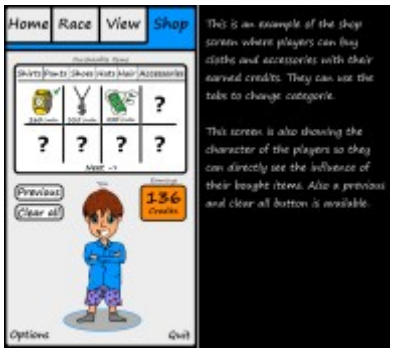


Shop screen
In the shop screen you will find:
* Purchasable items
* Previous button
* Clear all button
* Your character
* Credits you have left





This is an example of the shop screen where players can buy cloths and accessories with their earned credits. They can use the tabs to change categorie.



This is an example of the shop screen where players can buy cloths and accessories with their earned credits. They can use the tabs to change categorie.

This screen is also showing the character of the players so they can directly see the influence of their bought items. Also a previous and clear all button is available.