You are what you eat

Serious gaming for type 1 diabetic persons

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Abstract

It is important that patients follow recommended treatment regimens and live in a healthy way. This can be summarized as self management. Serious games can help patients with this. Chronic diseases such as diabetes involve a lot of self management. We developed a game to educate diabetic children about carbohydrates using research from game design, game experience evaluation and other educational diabetic games. After this we made an online survey to see how much the average person knows about carbohydrates and how this compares to people with diabetes. We tested a prototype of our game on primary school children and adjusted the game based on the results. Finally, it was tested on diabetic children. The results show that the children really liked the game. The children filled out a written test before and after playing the game, to see if the game has a learning effect. These tests do not show big differences, there are some results that suggest an increase in knowledge, but more research is needed to be sure.

Contents

Chapter 1

Introduction

Quality health care depends on the adherence of patients to the recommended treatment regimens. A majority of patients do not comply with the treatment set by their doctor (Martin et al., 2005) (Sabaté, 2003). This can be caused by misunderstanding, forgetting or ignoring the health care advice.

Self management can be seen as the collection of all the things patients do at home that keep them healthy, this includes taking prescribed medicine, eating healthy and having regular physical activities. Self management of patients is getting more attention lately and it will only increase, because it reduces the number of visits to health care providers (Lorig et al., 1999) and it is also effective in increasing the quality of life of people with chronic diseases. The biggest problem or pitfall to self management is in the form of adherence, because keeping up with healthy behavior is a lot harder when the health care providers are not standing next to the patient. When the patient is at home and confronted with the stress of daily live, it is easy to fall back into old patterns and make unhealthy decisions.

Games can help self management, specifically in the form of education and rewarding good behavior. Even though games are historically seen as a form of entertainment, their potential is much bigger than mere entertainment. Video games are intrinsically motivating and are popular across virtually all teenagers and nearly half of the adults (DeShazo et al., 2010a). This leads to research in using games for education, so called serious games.

One of the most wide spread chronic diseases is Diabetes and it involves a lot of self management; Type 1 diabetic people need to inject insulin daily, because their body does not produce any. To know how much insulin they need to inject, they measure their blood glucose level and also have to keep track of the amount of carbohydrates in their diet (Delsink et al., 2006). So this makes an ideal candidate for a serious game.

The aim of this research is to make an educational/serious game (edutainment) for these persons. In this game the diabetic people are taught how many carbohydrates are in typical daily foods and how this is connected to the injection of insulin. The Gelderse Vallei Hospital and the university of Twente have experience in researching technology that aim to help diabetic persons. The game was tested on patients from the Gelderse Vallei.

The game targets newly diagnosed persons. These persons still need to learn how to cope with the disease and generally have no knowledge of the amount of

carbohydrates in food. Knowledge about the disease is key in self management, because if the person does not understand the consequences of bad decisions, he will not be motivated to adhere to the advice of the health care advice. As said before the amount of carbohydrates in the diet influences the amount of insulin that the person has to take, so it is important that the person knows how much carbohydrates are in certain foods.

We target type 1 diabetes because they have the most to gain with carbohydrate education, but also other types can profit from carbohydrate knowledge. Most newly diagnosed diabetics with type 1 are children, so the focus of the game will be on children with type 1 diabetes.

The next chapter explains how educational games are designed and evaluated. In chapter 3 a number of related games for diabetic persons are discussed. Chapter 4 is about the survey that was made to research the general knowledge of carbohydrates. Following this is chapter 5 describing the game developed in this research. We then present the pilot test in chapter 6 and the user test in chapter 7. We end with an overview of the completed research.

Chapter 2

Design and Evaluation of Educational games

An educational game is a game that is designed for more than merely entertainment, it provides some kind of educational value to the player. In this chapter we first research how to design a game. Then we talk about some key concepts of educational games. And finally how to evaluate such a game.

2.1 Game design

A game consists of four basic elements (see Figure 2.1): the game mechanics, the story, aesthetics and technology. All four elements are essential in any game and each element strengthens the others (Schell, 2008). In the following sections each element will be described more fully.

2.1.1 Game mechanics

Game mechanics are the rules of the game, they describe the goal of the game and how the players are allowed to try to reach the goal. Schell (2008) describes 6 different game mechanics that need to be in balance:

- Space: the abstract areas in which the game takes place

- Objects, Attributes, and states: the space contains objects. Each object has attributes and in turn each attribute has different states

- Actions: the things players can do

- Rules: the rules and goals of the game

- Skill: how much skill is involved in playing the game

- Chance: what parts of the game are determined by chance and what is the probability of each outcome
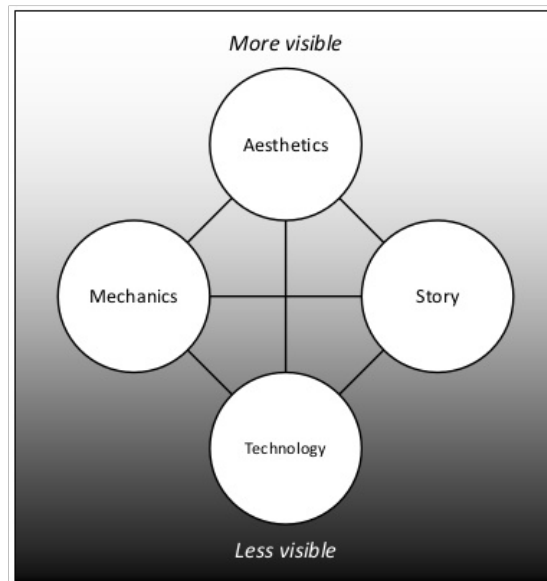
Figure 2.1: Jesse Schell's Elemental Tetrad (Schell, 2008)

2.1.2 The story

This is a narrative of the sequence of events that unfold in the game, it can be linear or it can depend on choices made by the player. The story is what gives the game context meaning. It keeps players interested in the game and makes them coming back for more.

Baranowski et al. (2008) also mentions that the story of a game is important in the context of an educational game, because it can enhance behavior-change. For example the protagonist of the story can face and overcome common barriers to make a healthy behavior change, the player in turn can use this experience to overcome their own barriers in a similar way.

2.1.3 Aesthetics

This is how the game looks, sounds and feels. The aesthetics help the player to feel part of the world that the story describes, creating a feeling of immersion. In electronic games this includes computer graphics, background music, sound effects and the user interface.

2.1.4 Technology

The technology can be either something material like cards or a wooden board, but also a computer or a tablet. It is the medium in which the aesthetics and mechanics take place and through which the story is told.

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More specifically to computer games, Fisch (2005) argues that for a successful educational game, the designer has to think about the electronic medium it is on. Especially the constraints that the medium has. The authors quote an example about a building a tower out of blocks to learn about balance. Mapping this lesson to a computer game is difficult because seeing a block fall on the screen is not the same as actually feeling the physical blocks and feeling the tower become unbalanced. Another example is the Didget monitoring and gaming system (see Figure 2.2); the blood glucose meter was designed so it can easily slide into the Nintendo DS (more details about Didget are in chapter 3). The ease of connecting the meter to the game console and also the portability of the system is a very important aspect of the chosen medium and directly contributes to the motivation to test the blood glucose level.
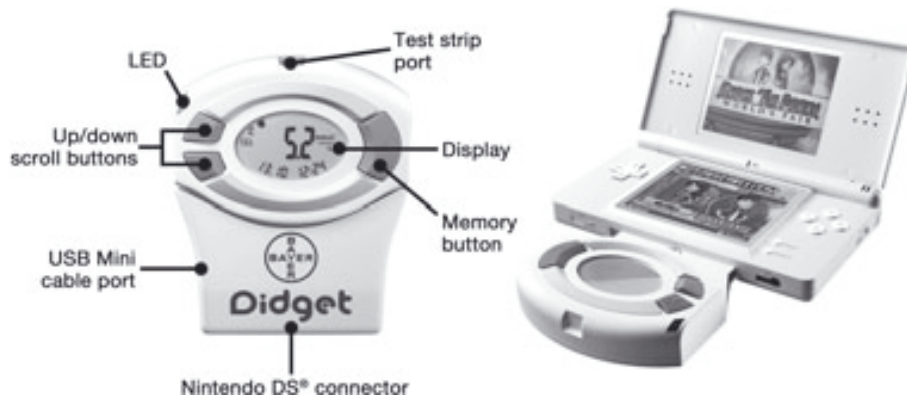

Figure 2.2: Didget combines a blood glucose meter and a Nintendo DS

2.2 Key concepts of educational games

There is relatively little literature about which design principles work to make an effective and fun educational game (Isbister et al., 2010). There are however some key concepts that keep returning in the literature:

2.2.1 Fun

Fun is an important design aspect. It is what engages the users to play the game and the learning process. An educational game should be fun foremost to be effective (Isbister et al., 2010). It is also sometimes referred to as play (Wang, 2008). Lepper and Cordova (1992) found that if an educational game can catch a players interest, then the educational topic is learned better compared to a game that does not engage. Also even long after playing the game the player is more motivated to learn the topic in for example class or at home. Learning should be considered as play and not as work. In other words, play is a willful choice to enjoy the game and learn the content and work is a forced choice by outside influences, such as external rewards.

2.2.2 Placing educational content at the heart of the game

This concept comes back in most research. The educational content should not be bolted on top of existing game, but rather should be an integral part of the game play mechanics and goals. The educational content should almost be learned as a byproduct of playing the game. This is also referred to as deep content (Isbister et al., 2010) or as content on the plotline (Fisch, 2005). Bergervoet et al. (2013) call these kind of games endogenous educational games. As opposed to exogenous educational games that have content outside of the game mechanics, such as a quiz exercise.

2.2.3 Hints and feedback

A core aspect of games is that they should be appropriately challenging (Wang, 2008). This is a difficult point since every person is different. The most effective way to keep games challenging and also not too difficult is by adding ways to get hints or help. This can be in the form a help button, but also in the way the system responds to a wrong answer. Fisch (2005) says feedback should help player's learning of unfamiliar educational content by "scaffolding" them into solving the problem and finishing the game. Important is to not give the right answer, but rather steer the player in the right direction.

Another important part of feedback is the score. The score can tell a player if their solution was fully correct and motivate them to try again. Also, Wang (2008) argues that it may lead a player to compare their own score to their peers and in this way get encouraged to discuss the educational content. Bergervoet et al. (2013) did a research to see if explicit versus implicit explanations and feedback have any influence on factual knowledge and comprehension. They found explicit messages to increase factual knowledge and exploratory behavior (regardless of the explicit or implicit message) to foster deep comprehension.

2.3 Evaluation

Calvillo-Gámez et al. (2010) present the theory of the core elements of gaming as an evaluation framework. The core elements are the necessary conditions to provide a positive gaming experience (enjoyment), but these conditions alone are not sufficient. This means that if the conditions are all present, it does not guarantee a positive experience, but rather guarantees a non negative experience. If one of the conditions is missing then the experience will definitely be negative (frustration).

The authors think of experience as both the process and the outcome of playing a game. They analyzed game reviews and used this to construct a questionnaire. This questionnaire allows us to assess the core elements in a gaming experience. The authors also show how two experiences can be compared with each other. They state that assessing a single experience takes more research.

The core elements are divided in two main groups called Puppetry and Video-game. Puppetry is the interaction between the user and the game. It consists of Control, Ownership and facilitators. Control is formed by the actions and events the player can take. Ownership is a sense of responsibility for the actions of the game. Facilitators are a wild card, they can lead to a feel-

ing of control and ownership by means of time, aesthetic values and previous experiences.

The Video-Game is the game itself and consists of game-play and the environment. Game-play can be seen as the soul of the game. It defines what the game is about, its rules and scenario. The game environment is how it is presented to the player; the graphics and sound.

The Serious Game Evaluation Framework (SG-EF) designed by GALA (Games And Learning Alliance, the network of excellence for serious games) consists of factors in five categories that might help to determine the learning impact of serious games. The categories are as follows.

- The participant that plays the game

- The Context where the game is played

- Quality of the game

- Game play

- The Learning impact

Each category has subcategories and under this are the factors. See Figure 2.3 for a detailed schema about the categories and their factors. The framework aims to support all possible stakeholders in the process of evaluating a serious game. The framework also comes with a card game called the GamEval toolkit, this game can help to formulate evaluation questions and research hypotheses. The cards correspond to the factors of the evaluation framework and by combining the cards and playing a variant on Poker the questions and hypotheses are formed (Mortara and Catalano, 2014).

The SG-EF framework is more broad than the core elements of gaming framework. The SG-EF framework gives an overview of all factors that might influence learning impact, in a concrete settings only a few factors actually affect the learning impact. In comparison the core elements of gaming framework provides a list of elements that are all necessary for a positive experience.

2.4 Summary

In this chapter we looked at how to design a serious game and how to evaluate the game after it is made. Any game needs the four basic elements and they need to be in balance. It should be fun and have the educational content at the heart of the game. Hints and feedback can be used to help the learning process of unfamiliar topics. We used this knowledge during the development of our game. Furthermore we looked at two evaluation frameworks, one that presents a questionnaire and one that helps with evaluation questions and hypotheses.
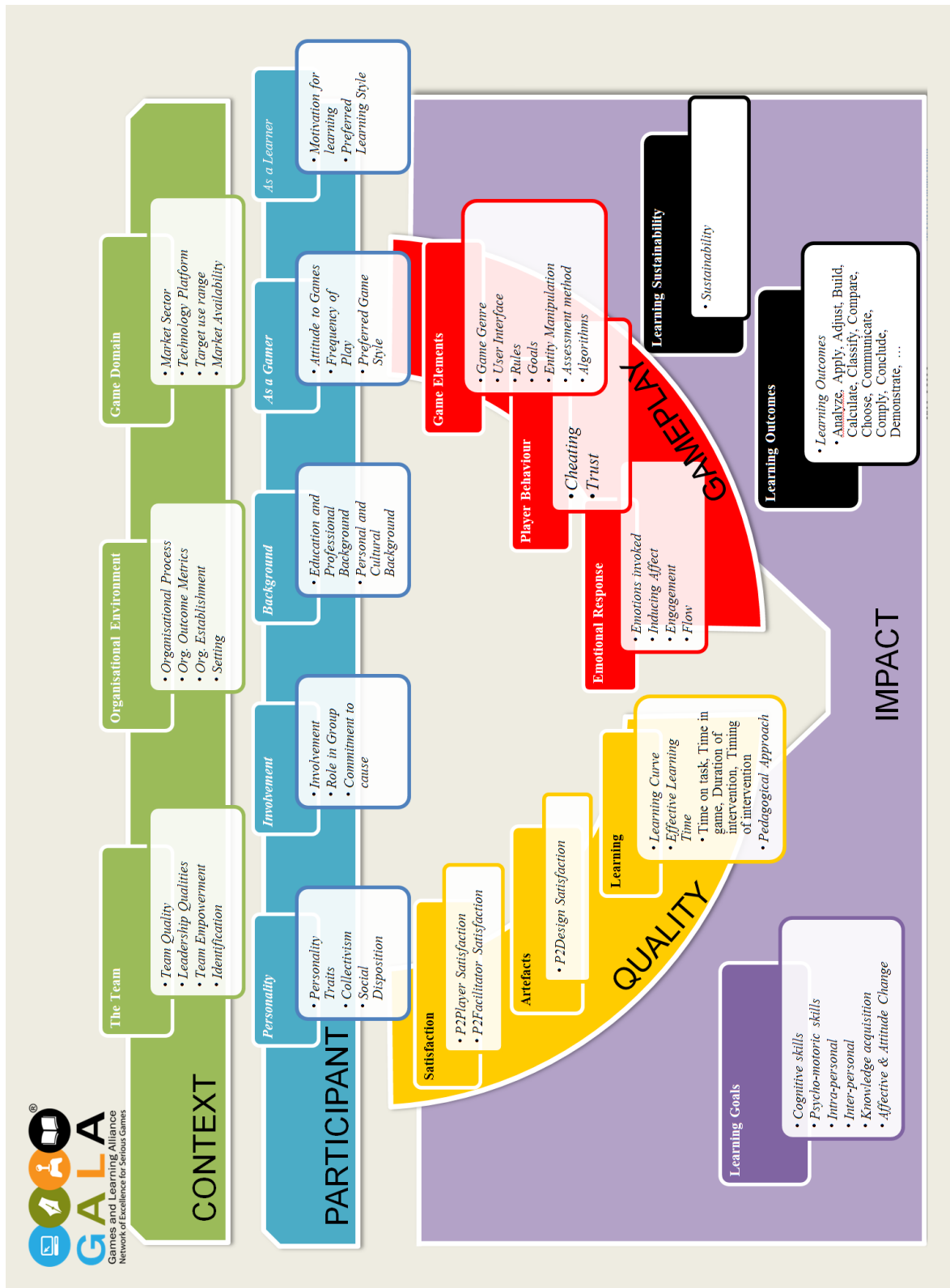
Figure 2.3: The Serious Game Evaluation Framework by GALA

Chapter 3

Video games for diabetes education

After looking at existing research in the area of educational video game design and evaluation of these games, we take a look at the diabetic video games that are available at this time. We searched for the games using Google Scholar, Scopus and regular Google search. The following search terms were used:

- Diabetes educational game

- Diabetes edutainment

- Diabetes serious game

- Diabetes game

Whenever a game was referenced in a paper that was not in our list we also included that game in our analyses.

This chapter first describes the found games and then compares them with the help of an extensive table.

3.1 Overview of current games

Aoki et al. (2004) created three games on PC and Game Boy Advance to teach type 1 diabetic persons the relationship between food (carbohydrates), plasma glucose level, exercise, and insulin dose. The first game involves a diabetic egg that needs to be taken care of (see Figure 3.1). In the second game, one plays a diabetic detective that has to chase a criminal while remembering to take food and insulin (see Figure 3.2). The last game consists of choosing the right food depending on the current glucose level. They tested these games with a total of 58 diabetic patient and health care professionals. They found that their games were fun and easy to use. Also over 90 percent of the testers liked the edutainment approach for health care education.

In another paper, Aoki et al. (2005) created a game for the cell phone for type 1 diabetic persons between 12 and 24 years of age; this game is called Insulot, which denotes "insulin" and "slot machine". The game teaches the
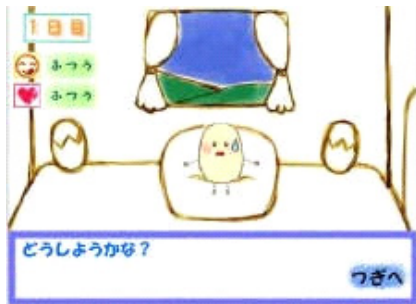
Figure 3.1: Egg breeder

Figure 3.2: Detective

relationship between plasma glucose level, food and insulin dose. It is played like a slot machine with three windows. It was tested on 30 persons. Most testers thought the game was interesting and useful as a learning tool.

Dbaza Diabetes Education for Kids (DeShazo et al., 2010a) is an interactive CD-ROM game where children are taught diabetes management skills by making choices and learning the consequences of those choices. The researchers tested 83 kids and found a significant gain in diabetes knowledge even for the children that had been living with diabetes for four years or longer [1].

Star Bright Life Adventures is also a CD-ROM game. It teaches diabetes management skills and nutritional education. The researchers found greater knowledge acquisition than conventional instruction as well as better metabolic control (DeShazo et al., 2010a).

DeShazo et al. (2010b) designed three games; Hangman, QuizShow and Countdown (Figure 3.3), that are played on mobile phones (iPhone, blackberry

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[1]http://www.dbaza.com/dek/testing.html (retrieved 2015-06-17)

Figure 3.3: Hangman, QuizShow and Countdown (DeShazo et al., 2010b)

and windows phone). In Hangman the player has six guesses to estimate the amount of carbohydrates in a food item. QuizShow gives multiple choice questions about nutrition and has three hint options like the quiz show *Who Wants to Be a Millionaire.* In the last game, Countdown the player needs to choose one of two food items that has less or more calories depending on the question. The players get more points for fast correct responses. In the design process the authors first made mock-ups of the games and discussed these with two focus groups. Then they alpha tested with some local students and finally did a remote usability test with ten subjects including persons that had type 1 and also persons that had type 2 diabetes. The games were liked, but the test subjects said they would prefer the games to be more difficult. The authors concluded that remote testing is cheaper than conventional testing in a laboratory, but also has downsides like helping with technical issues or responding to questions by the test subjects.

Captain Novolin (Lieberman, 2013) is a self-management video game that demonstrates the relationship between food, insulin and blood glucose control. The main character is a super hero that must save plane crash victims from a mountain while fighting enemies and avoiding donuts, ice-cream and soda. The player has to make food and insulin choices and monitor the super hero's blood glucose level. The game was evaluated by 8-14 year old children with diabetes alongside their parents. The authors found that the game was easy to play and it promotes discussion of diabetes between parent and child as well as the child's peers (DeShazo et al., 2010a).

Packy and Marlon (Brown et al., 1997) is a game for the super Nintendo (see Figure 3.4). It can be played by one or two players at a time. The game consists of one or two diabetic elephants that have to collect food, while taking insulin shots and sticking to their meal plan. It was tested by diabetic children between 8 and 16 years of age. They found that the number of urgent care visits declined after playing the game and differ marginally compared to the control group.

Kumar et al. (2004) researched Blood glucose monitoring with and without a motivational game. The trial was dubbed DAILY (Daily Automated Intensive Log for Youth) and involved forty children of 8-18 years old. Nearly half of them tested the game and the others were the control group. The motivational game, DiaBetNet, consists of a PDA that displays previous Blood glucose levels, insulin dosages and carbohydrates consumed. It asks the user to predict the upcoming glucose level based on the information provided (see Figure 3.5). The game gives point for playing the game and also for correctly guessing the blood glucose level. The children in the game group transmitted significantly more glucose values, had less hyperglycemia and more diabetes knowledge.

Glucoboy was a blood glucose testing device that can be connected to a Game Boy Advance or Game Boy DS. It has two full games and three mini arcade games. It was only released in Australia[2]. This version was never formally tested. (DeShazo et al., 2010a)

The same creator later developed Didget, which is a similar device only compatible with Game Boy DS. This time there was one main game and 12 mini arcade games. The idea of both devices was to unlock items and power-

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[2]http://assemblergames.com/l/threads/glucoboy-for-gameboy-is-this-the-rarest-game-accessory-for-gameboy-advance.41853/page-2 (retrieved 2015-06-17)
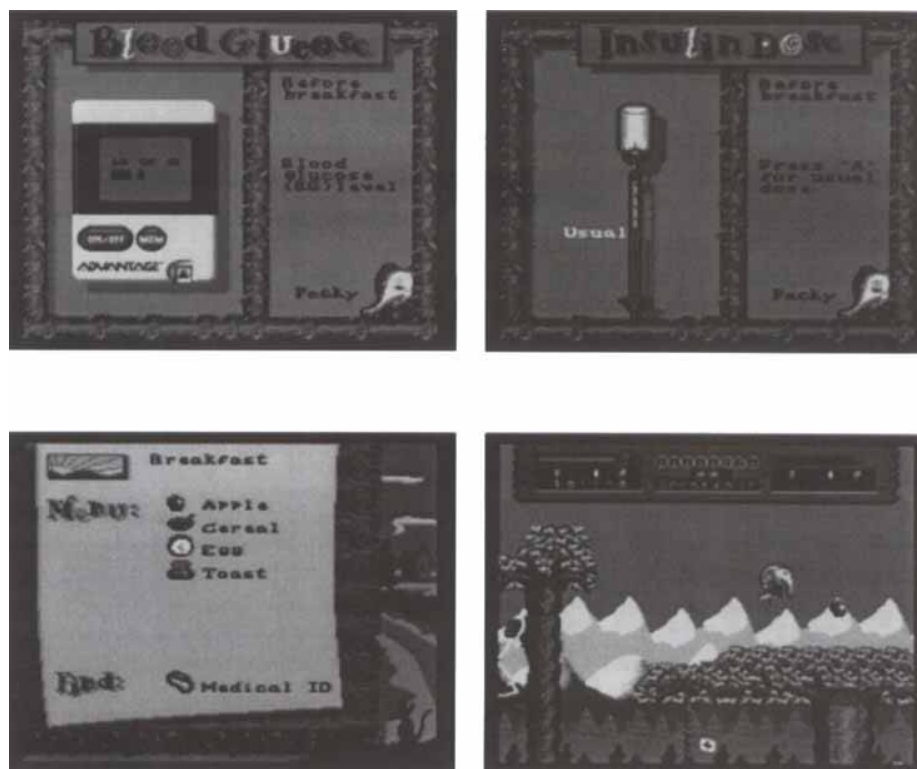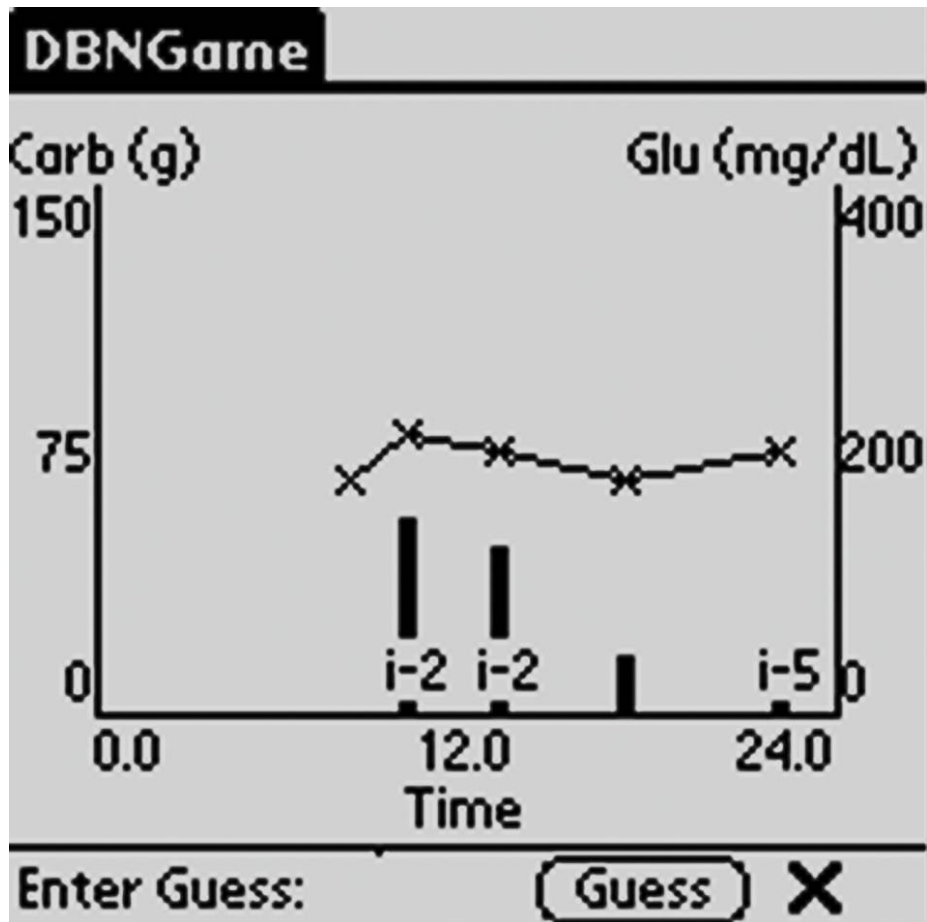
Figure 3.4: Packy and Marlon (Brown et al., 1997)

Figure 3.5: The DiaBetNet game on a PDA. The insulin doses are noted as i-2 (meaning 2 units of insulin), the bars are carbohydrates and the line graph is the glucose level. (Kumar et al., 2004)

ups as well as the mini games by regularly checking your blood sugar. This game was formally tested by Klingensmith et al. (2013). The researchers first tested in a clinic if the test-results of the device were accurate. Secondly they tested the device with 58 subjects at home. They found the device precise and clinically accurate when operated by children.

They also conducted surveys with the subjects, their parents and the health care staff. The conclusion was that subject satisfaction was good to excellent; most subjects found the system easy to use, motivating, and helpful for building good blood glucose monitoring habits, while most of health care staff agreed that the system fulfilled a need in diabetes management.

Escape from Diab is a game about a middle school soccer star that lives in a place where the king does not allow the people to eat fruits and vegetables or allow them to do any physical activity. The player has to lead a group of renegade high-schoolers to oppress the king and escape from the kingdom (Baranowski et al., 2008). Nanoswarm is a game made by the same authors. It is about an accident where nanobots infect humans and make them have diabetic symptoms. The player has to feed the infected fruits and vegetables and keep them physically active, while also finding out the cause of the infection (Baranowski et al., 2008). Baranowski et al. (2011) tested these two games with 133 children in the age of 10-12 year old. The testers each tested both games in a randomized order. Each game had 9 sessions. Each session was about 40 minutes. The children could take as long as they wanted. There were three assessments: one between games, one after second, and one after two months. The researchers found an increased fruit and vegetable intake, but they found no change in water, body composition or activity. Additionally, they observed that after two months the fruit and vegetable intake, the water consumption and physical activity were all still below the minimum recommendations.

The Diabetic Dog is an online flash game where the user has to take care of their pet dog that has diabetes. The audience is Type 1 diabetic children. The game involves managing its blood glucose through testing, insulin, and proper diet (Lieberman, 2012). The game was not properly tested.

Glymetrix Diabetes Game provides quiz games and card games that test user's knowledge about diabetes self-management. It gives a reward if the user enters its blood sugar level[3]. It was not formally tested (Lieberman, 2012).

GRIP is a Dutch self-management game designed by Ranj. It is a side scrolling flash game. It connects health information from the user's personal electronic medical record file to help learn players to make decisions and develop skills based on their current personal health information. The game enables parents and clinicians to monitor the user's status daily (Lieberman, 2012). It was not tested.

HealthSeeker is a game on Facebook that enables friends to support their friends with diabetes. By bringing people together, it is intended to reduce the isolation that people with diabetes often experience[4]. It uses achievements, virtual prizes and gifting to reward healthy behavior. It was not tested (Lieberman, 2012).

The Magi and The Sleeping Star is an action-adventure diabetes simulation video game that was announced in 2009. It failed to collect enough funding on

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[3]http://www.scribd.com/doc/14799737/Glymetrix-Diabetes-Mine-2009-Design-Challenge-Entry (retrieved 2015-06-17)

[4]http://ayogo.com/blog/case-study-healthseeker/ (retrieved 2015-06-17)

Kickstarter and there has been no news since 2013. In the game the player is a wizard with type 1 diabetes. He goes on a quest to save the world while using his magical abilities to defeat enemies. In the game the wizard cannot use any magic if he does not have a balanced blood glucose level (Lieberman, 2012).

3.2 Comparison

To be able to compare the different games we made a table (see Table 3.1). As one can see, most games are focused on diabetic type 1 children. Also almost half of the games are not properly tested. Most games are designed for a computer, followed by mobile devices and lastly consoles. For educational content, it seems that diet and self management are popular topics.

One thing to note is that most of these games are quite old. Most games are older than five years and the oldest is from 1992. This makes most games not easily playable, for example some games only work on old Phones or old consoles that cannot be bought anymore. This is why we developed our game for android phones. Android phones are backwards compatible so all phones and tablets in the foreseeable future can run our game. There is also a problem with distribution. Most games are only made as an academic exercise and are not released to the public after completion and evaluation. We put our game in the Google play store, in this way we hope that diabetic children and parents can find our game more easily.

In terms of design, the approach differs greatly per game. Some use trivia style questions during play while others really integrate the educational content in the heart of the game. Our game follows the latter approach, in accordance with the key concepts of chapter 2.

Game title	Platform	Target group	Educational content	Evaluation
Egg Breeder, Building Blocks, Detective	PC, Game Boy Advance	Type 1 diabetic children	self management, diet, exercise	Tested by 58 type-1 diabetic patients and health care professionals
Insulot	Mobile phone	Type 1 diabetic children	diet, exercise	Tested by 30 diabetic patients
Dbaza Diabetes Education for Kids	PC	Type 1 diabetic children	self management	83 diabetic kids
Star Bright Life Adventures	PC	Type 1 diabetic children	diet, self management	76 children
Hangman, QuizShow and Countdown	iPhone, blackberry and windows phone	Type 1 and type 2 adults	Diet	8 diabetic adults
Captain Novolin	Super Nintendo Entertainment System	Type 1 children	diet, self management	23 diabetic children
Packy and Marlon	Super Nintendo Entertainment System	Type 1 children	diet, exercise, self management	31 diabetic children
The DAILY/DiaBetNet	Pda	Type 1 and 2 children	Estimate own blood glucose level	19 diabetic children
Escape from Diab	PC	Older children	Diet, exercise	Not tested
Diabetic dog	PC	Type 1 diabetic children	self management	Not tested
Didget	Nintendo DS	Type 1 children and young adults	Test blood glucose level and get rewarded	147 subjects in-clinic, 58 subjects at home
Glymetrix Diabetes Game	PC	Diabetic children and adults	Diet, quiz questions	Not tested
GRIP	PC	Diabetic children	self management, diet, exercise	Not tested
HealthSeeker	Facebook / PC	diabetic persons	diet, weight control, social help	Not tested
The Magi and The Sleeping Star	PC	Type 1 diabetic children	self management	Game is not finished yet

Table 3.1: A comparison of the diabetes games.

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Chapter 4

Online survey

In order to get a general view of the knowledge of carbohydrates in modern society, we composed an online survey. We want to know this for two reasons; one being that if everybody knows about carbohydrates, there is no need for an educational game about it. Secondly, we want to see which factors influence carbohydrate knowledge. The survey was made in Google Forms, in both Dutch and English. A print-out of the English version is included in Appendix A. We then distributed the survey via friends, family, Facebook and mailing lists.

4.1 Questions

We composed the questions and then consulted a diabetes doctor if the questions and their answers were valid. The make-up is as follows: first we ask a basic age and gender question. This is to be able to check for correlations between them and knowledge of carbohydrates. We then ask three questions that may explain why someone knows a lot about carbohydrates. Namely: are you an expert, do you have diabetes and are you on a diet?

Following that are five open questions and four closed questions about carbohydrates. The closed questions were handpicked and start off relatively easy and progress to fairly hard. They are:

- Question 1: Which of the following foods does NOT have carbohydrates? Options: Milk, Chicken, Bread, Potatoes

- Question 2: Which of the following foods does NOT have carbohydrates? Options: Tomato, Egg, Popcorn, Apple

- Question 3: Which of the following foods contains the most carbohydrates? Options: Butter, Cheese, Tomato, Banana

- Question 4: Which of the following foods contains the most carbohydrates? Options: Onion, Duck, Rice, Green beans

- Question 5: Which of the following foods contains the most carbohydrates? Options: A pizza with tuna, A plate of spaghetti with tomato sauce and meat, A plate of pea soup, A plate of spinach, potatoes and meat

Each closed question is followed by a confidence rating. This was added to see if people are just guessing at random or if they think they know the correct answer. The open questions are below, they involve estimating a specific amount of carbohydrates for a given food. These questions were added to see if people are good at guessing relative amounts of carbohydrates (the closed questions) or good at guessing exact figures (the open questions).

- How many grams of carbohydrates are in one bar (60 grams) of snickers?

- How many grams of carbohydrates are in one serving (150 grams) of French fries?

- How many grams of carbohydrates are in one bag (100 grams) of salted popcorn?

- How many grams of carbohydrates are in one bag (50 grams) of M&M's peanut?

4.2 Participants

108 people filled out the survey, 20 in English, the rest in Dutch. 43.5% is male and 56.5% is female. Fifteen people consider themselves an expert in carbohydrates and three people have diabetes. All three people with diabetes consider themselves and expert in carbohydrates. 10.2% of the people are on a diet.

2.8% of people were below 18. 19.4% fall in the age group of 19-25. 42.6% were between 26 and 50 years old. Finally 35.2% were older than 50.

4.3 Closed-Questions

	Question 1	Question 2	Question 3	Question 4	Question 5
Correct	73.1 %	54.6 %	79.6 %	87.0 %	18.5 %
Confidence	M=3.65,s=1.21	M=3.49,s=1.19	M=3.43,s=1.31	M=3.58,s=1.12	M=3.36,s=1.04

Table 4.1: Overview of closed question results

No significant differences were found between the different age groups on the total correct closed answers. ($M_{10\text{-}18}$=3.33, $M_{19\text{-}25}$=3.00, $M_{26\text{-}50}$=3.07, $M_{>50}$=3.26, all t was between -1 and 1, all P's were above 0.33)

The people who consider themselves an expert are significantly more sure of their answers ($M_{\text{expert}} = 21.80$, $M_{\text{noExpert}} = 16.82$; $t(106) = 4.26$, $p < .01$).

The people with diabetes are slightly significantly more accurate in the total correct closed answers. ($M_{\text{diabetes}} = 4.33$, $M_{\text{nonDiabetes}} = 3.10$; $t(106) = 1.83$, $p < .07$).

No significant differences were found between people on a diet and those that are not on the total correct closed answers.

	N	Minimum	Maximum	Mean	Std. Deviation	Correct Answer
How many grams of carbohydrates are in one bar (60 grams) of snickers?	108	,0	300,0	48,685	62,3712	32
How many grams of carbohydrates are in one serving (150 grams) of French fries?	108	,0	800,0	108,824	138,0190	57
How many grams of carbohydrates are in one bag (100 grams) of salted popcorn?	108	,0	1000,0	65,296	116,5255	48
How many grams of carbohydrates are in one bag (50 grams) of M&M's peanut?	108	,0	400,0	52,120	74,3065	29

Table 4.2: Overview of open question spread

4.4 Open-Questions

See Table 4.2 for the Mean and spread of the open questions. The last column has the correct answer. As can be seen in the table, the answers given were not accurate and spread quite broadly. Interestingly, quite a few people answered with an amount of grams that exceed the total weight of the food, this shows that carbohydrates are quite untouchable and misunderstood by people. We also checked if there was any relation of age, gender or diabetes to the estimation of the values, but could not find any.

4.5 Discussion

Overall the relative knowledge about carbohydrates is pretty good, most people know that rice contains carbohydrates (question 4). Also the questions 1 and 3 have high percentages. Question 5, which combines multiple foods on one plate was estimated badly. The exact guessing of the amount of grams was quite bad, even including people that have diabetes. This shows that the general knowledge of carbohydrates and by extension newly diagnosed children have a lot to learn.

Chapter 5

Carb counter

In this chapter we first provide an overview of the game and then talk about the design choices that were made while developing the game.

5.1 Overview of the game

Figure 5.1: Intro screen

When the user starts the Carb Counter application, the first screen that is shown is the intro screen (see Figure 5.1). This screen shows a short story that tells the child that a fox has stolen grandmother's recipes. It then asks the child's help for retrieving the lost recipes. If yes is selected, the level screen is shown. If stop is selected the game ends.

The level screen (see Figure 5.2) shows a table with dinner plates. Each plate represents a level. In the middle of the plate is a number that shows the level

Figure 5.2: The level screen

number. When the user first starts the game only level 1 is unlocked. After a level has successfully been completed, the next level is unlocked. Red numbers are locked. Green is unlocked and completed, yellow is the most recent level that was unlocked.

Below each level are zero to three gold stars. If the user completes the level in under 3 minutes one gold star is earned. Under 2 minutes earns 2 stars and finally under 1 minute is three stars. When the user clicks on a green or yellow number the player is taken to the main screen of the game.

On the left side of the main screen (see Figure 5.3) is displayed the goal amount of points and the current score. The goal of the game is to find three food items in the 5 by 5 grid on the right with a total amount of carbohydrates that corresponds to the goal amount. If the player does this right he earns 30 points, a message is displayed "Well done!" and a short sound is played. When he makes a mistake another sound is played, there is a message in the bottom and player gets minus points. The message alternates between "Too bad, try again" and "Sum up the carbohydrates to reach the goal amount" (in game these messages are in Dutch). Whenever there are five identical food icons in a row the player get bonus points.

Next to the grid there is a vertical progress bar that shows how much more points wins the game. When the user has enough points and the progress bar is filled up the victory screen is shown. Also a victory music tune is played and there is simulated fireworks in the top part of the screen.

The game has a total of three playable levels. In the first level, players have to select three separate food items (see Figure 5.4). In levels two and three, the player has to swipe three items in a row (see Figure 5.5). Each level has different food items. The food items per level are as follows:

- Level 1: Tomato, Banana, Egg

Figure 5.3: The main screen

Figure 5.4: Select three items

Figure 5.5: Swipe three in a row

Figure 5.6: The instructive screen

- Level 2: Cheese, Watermelon, Apple

- Level 3: Grapes, Hamburger, Popcorn

At any time during the level the user can press the instructions button in the lower left corner of the main screen to get an instructive text pop-up (see Figure 5.6). This pop-up shows a brief explanation of the goal of the level as well as a list of each of the food items in the level and their respective carbohydrate counts. The user can click on the OK button or just touch on the area outside of the pop-up to go back to the main screen.

The victory screen shows the amount of time that the player took to finish the level. It shows the number of earned gold stars. This can be from zero to three stars depending on the time taken. It also shows a picture representing the reward for that level. The reward is a recipe for a delicious food item that is shown with an stylized icon (see Figure 5.7).

5.2 Game design

In the previous section we gave an overview of the prototype game that was made. Here we will talk about the design choices that were made. We discussed in chapter 2 that a game consists of four basic elements, namely the game mechanics, the story, aesthetics and technology. In the following subsections we will take a closer look at each element.

5.2.1 Game mechanics

The aim of the game is to combine three food items to a given number of carbo- hydrates. The idea is that adding carbohydrates and remembering how much

25

Figure 5.7: The victory screen

carbohydrates are in a specific food item is very similar to the tasks a diabetic person has to perform in daily life. Furthermore we hope that by repeatedly remembering the number of carbohydrates the players will subconsciously learn how much carbohydrates are in certain types of food.

In terms of the six game mechanics described by (Schell, 2008), our game can be categorized as follows:

- Space: 5x5 discrete two dimensional space

- Objects, Attributes, and states: 25 objects, with attributes: food item, carbohydrates. The states are the different food items like tomato and egg and the number of carbohydrates.

- Actions: Select three food items, the food items disappear. New food items appear when there is space. Get 5 items on a line. Try to align 5 to get bonus points.

- Rules: The three selected food items must total a number of carbohydrates that is indicated as the goal. After obtaining a set number of points the game ends and the player can go to the next level.

- Skill: There is mental skill involved: remembering the carbohydrate values and adding them up as quick as possible. Also some physical skill is needed: selecting the right food options using the touch screen.

- Chance: The appearance of new food items is a random pick from a set of allowed items for that level.

The specific food items were described in the last section. The items were selected so that the first level is easy, the second level is harder and the last

is the most difficult. This was achieved by making the first two levels have one item that has zero grams of carbohydrates, this makes calculations easier. Furthermore the first level has food items that are quite far apart in terms of number of grams of carbohydrates, while level two has items that are closer together. The last level has no food items that are zero grams of carbohydrates and also items that are close together.

5.2.2 Story

As mentioned in the overview; the story is that grandmother's recipes were stolen by a fox. The player has to help grandma to get her recipes back. We chose this story so that there is a clear objective, collect as much recipes as possible. The main reason for this story is that we hope the grandmother in distress will attract the player's sympathy and make him motivated to play the game. Also we chose food as a theme for the game and this story nicely fits inside this theme.

5.2.3 Aesthetics

We designed the feel of the game to be playful, full of colors, while also being true to the food theme. The background of the level screen shows a wooden table, while each level is styled like a dinner plate. The main screen also features a wooden table in the background. To make the victory screen feel extra rewarding, we added an up-tempo song with trumpets, digital fireworks and a per level reward icon that shows what kind of food recipe the user retrieved. We hope the food theme and bright colors will make an immersive experience for the children.

5.2.4 Technology

We chose to develop the game for android phones and tablets, to make it easily accessible for patients on the road or at home. At first we designed the game to be playable on a ten inch tablet. Even though the android framework uses density independent pixels this does not mean it looks the same on a seven inch tablet or a phone. To be able to make the game playable on all screen sizes we created three different layouts for differently sized screens. On the smallest screens we hide the exit button to be able to provide a bigger playing field. See Figure 5.8 for an overview of the differences in screen sizes.
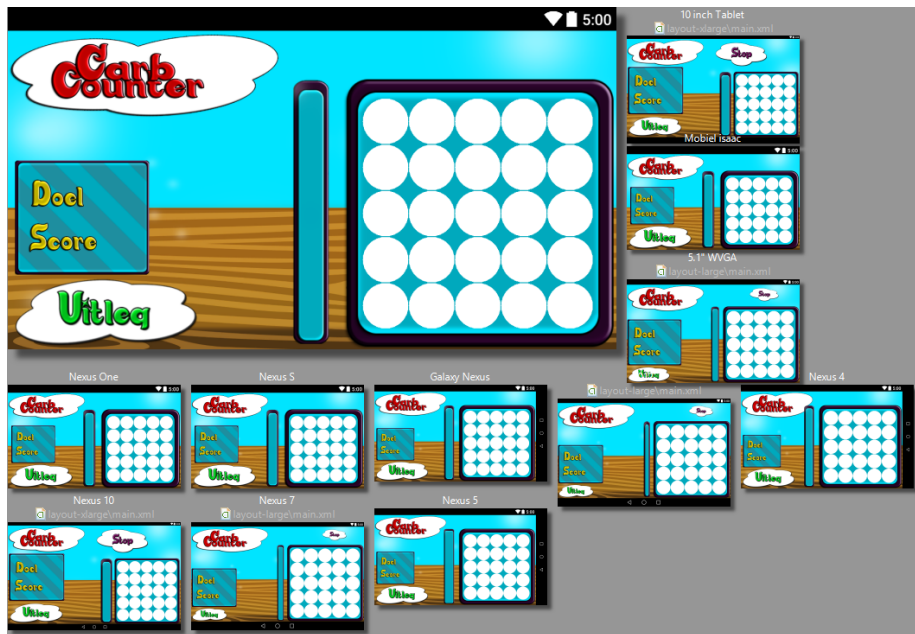
Figure 5.8: The main screen on different screen sizes

Chapter 6

Pilot test and design changes

After making a prototype we tested the game with children to see if the design choices made in the previous chapter work in the real world. Specifically we wanted to see if the game was not too hard for children, because it involves calculating the sum of three numbers without writing anything down. Also involving children in the design process will hopefully make a better and more suited game. The test consisted of observing the children while they played and an interview afterwards.

6.1 Pilot test

We tested the prototype at a local primary school. The game was played by six children in the highest grade (12 years old), two children were female, the rest was male. The children played in groups of two. One of the children has diabetes.

The first thing that became clear is that the children read the first instructional message with focus, but in level two, they only look at the pictures and ignored the message. Also we noticed that the wording of the instructional screen in some cases was using difficult words.

We asked the children if they found the game too difficult or too easy and which way of selecting food items (separate or swipe in a row) they preferred. Interestingly, some children preferred one way and some the other. One of the children offered a suggestion to give the player the choice to either play a level in easy mode (separate selection) or in hard mode (swipe three in a row).

The level screen was a bit confusing to children, the first time they saw it. Everybody asked; "Do I just press the 1?". When we did not reply, they did select the right level.

The children liked the finish screen, including the reward graphics. However, because there is no button at the screen, they were confused where to touch the screen and when.

The sound was noticed by the children and they liked it, one of the children said "oh cool, there is sound". One of the children and also the teacher remarked

Figure 6.1: Pop-up: Easy or hard mode?

that they would like more food items and specifically more items they would actually eat in everyday life.

One of the girls gave the suggestion to give some kind of visible reward for breaking your old high score. The child with diabetes remarked that he found the game fun and thought it would be useful to both children with and without diabetes. The teacher added that it might also be interesting to use the game to teach mathematics to lower grades.

6.2   Design changes

To make it more clear what the aim of the game is, we always show the instructional screen at the start of a level. Additionally we changed the text of the instructional screen to simpler words[1]. We also added the names of the food items below the picture for more clarity.

We liked the suggestion about the easy and hard mode and implemented this (see Figure 6.1). Completing an easy level rewards silver stars. Gold stars are earned for completing a hard level (see Figure 6.2). Additionally hard levels are allowed to take twice as much time than easy levels, so completing a hard level in under two minutes equals three gold stars, under 4 minutes is two stars and under six minutes is one star.

Even though the children did select the right level, we want to reduce any confusion and added a sparkly animation to the level button the first time it is shown. This way the button pops out and makes it more clear it is supposed to be pressed.

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[1]For example the word "aaneengesloten" (connected) was replaced by "op een rij" (in a row)

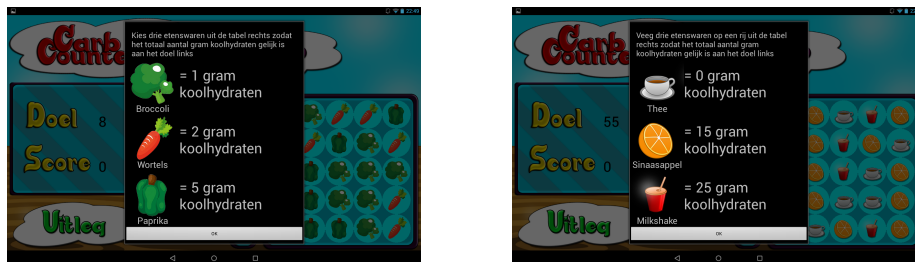Figure 6.2: The level screen shows gold and silver stars

Figure 6.3: Left: level 3, right: level 4. The old level 3 was moved to level 5

To combat the confusion of how to close the finish screen, we added a close button. The user can still press anywhere to close the screen though. In response to the remarks of the teacher and the children, we added two more levels and more everyday food items: Broccoli, Carrot, Green pepper, Tea, Orange, Milkshake (see Figure 6.3). Even though we liked the suggestion about the reward for breaking your old high score we did not include it because of time constraints.

Chapter 7

Evaluation

The evaluation was performed at the Gelderse Vallei hospital in Ede. The diabetes team of the hospital invited children in the ages of 8 to 16 years to participate in the user test. The procedure of the test was as follows: We started with a five minute introduction, then a five minute questionnaire. Directly after the questionnaire we helped the subjects download and install the game. There was then half an hour of playing and testing the game. Afterwards there was a ten minute questionnaire. Lastly we had a ten minute discussion. The goal of this evaluation was to see if the children liked the game and if the educational content was picked up.

7.1 Methodology

The pre-test questionnaire was based on the Online survey in chapter 4, because the children never saw this questionnaire and it provides a good basis for testing carbohydrate knowledge. We removed the question about diabetes, and added two questions specifically for diabetic children: "Do you use an insulin pen or pump?" and "Do you use a bolus calculator?". The latter is a tool that can calculate the needed insulin, based on time of day previous taken insulin and the number of eaten carbohydrates. We added these questions, because they might influence the knowledge of carbohydrates. See Appendix B for the questionnaire (in Dutch).

The post-test questionnaire includes the same survey, minus the personal characteristics questions, such as age and gender. This way we can see if the subjects changed their minds on any of the questions. The idea is that if a subject changes their answer from a wrong answer in pre-test to a right answer in post-test this might be because of renewed insight into the matter in consequence of the educational game. We also included questions about the user experience in the post game questionnaire.

The user experience questions were based on the research of Calvillo-Gámez et al. (2010), because this research specifically targets evaluation of games with a questionnaire. They constructed a framework called CEGE (Core Elements of the Gaming Experience) to test user experience with a questionnaire of 38 items with a 7-point Likert scale. The CEGE questionnaire contains the following scales: Puppetry, Video-game, Control, Facilitators, Ownership, Game-play and

Environment. Each question can belong to more than one scale.

We chose not to include all the questions because this would cause our test to exceed the maximum time that the hospital and the parents could give us. The following questions were included:

- Enjoyment: 4, 5.

- Puppetry / Control: 9, 11, 38.

- Puppetry / Facilitators: 13, 15, 17.

- Puppetry / Ownership: 20, 21.

- Video-Game / Environment: 26, 27, 30, 31.

- Video-Game / Game-play: 33, 34, 35.

We also added a questions about the usefulness of the game for people with diabetes. See Appendix C for the post-test questionnaire (in Dutch).

7.2 Participants

This test included four participants with diabetes. One of the subjects had a sister which also played our game.

The children were aged between 9 to 12 years. Two were female and three male. 40% of the children considered themselves an expert. One child was on a diet. All of the subjects use a bolus calculator. One child uses an insulin pen, the others use a pump.

We also showed the game to two health care professionals on the Gelderse Vallei diabetes team. They played the game and joined in on the discussion at the end.

7.3 Results

7.3.1 Carb knowledge

The participants did quite well on the closed questions during the pre-test questionnaire, see Table 7.1. In the post-test questionnaire, one question scored 40 percent points better, while three other questions scored 20 percent points less. All of the kids were more confident in the second round of questioning. When we compare the pre-test open questions (Table 7.2) with the post-test questions (Table 7.3) we see improvements in the third question and the fourth. Please note that two children did not want to give an answer to a question they did not know the answer of. This is why not all N's are five.

7.3.2 User experience

Four out of the five children really liked the game. One liked it a bit less, he told us that he prefers other types of games. See Table 7.4 for the results, this includes one health care professional. The health care professional played without sound and skipped the questions about sound. Looking at these results,

	Question 1	Question 2	Question 3	Question 4	Question 5
Pre: Correct	100 %	60 %	100 %	60 %	60 %
Pre: Confidence	M=4.40,s=0.89	M=4.40,s=0.55	M=4.00,s=1.00	M=1.80,s=0.84	M=3.00,s=1.23
Post: Correct	80 %	100%	100%	40%	40 %
Post: Confidence	M=4.80,s=0.45	M=5.00,s=0.00	M=4.80,s=0.45	M=2.60,s=1.52	M=3.60,s=0.89

Table 7.1: Closed Questions

	N	Minimum	Maximum	Mean	Std. Deviation	Correct Answer
How many grams of carbohydrates are in one bar (60 grams) of snickers?	4	7,0	35,0	16,000	12,8323	32
How many grams of carbohydrates are in one serving (150 grams) of French fries?	4	33,0	110,0	57,000	35,6745	57
How many grams of carbohydrates are in one bag (100 grams) of salted popcorn?	4	7,0	58,0	39,250	22,7651	48
How many grams of carbohydrates are in one bag (50 grams) of M&M's peanut?	5	8,0	30,0	19,800	8,7293	29

Table 7.2: Open Questions: Pre

	N	Minimum	Maximum	Mean	Std. Deviation	Correct Answer
How many grams of carbohydrates are in one bar (60 grams) of snickers?	4	7,0	35,0	15,500	13,0767	32
How many grams of carbohydrates are in one serving (150 grams) of French fries?	5	30,0	130,0	55,600	42,0036	57
How many grams of carbohydrates are in one bag (100 grams) of salted popcorn?	4	50,0	58,0	52,500	3,7859	48
How many grams of carbohydrates are in one bag (50 grams) of M&M's peanut?	4	13,0	30,0	22,250	7,4106	29

Table 7.3: Open Questions: Post

the means of all the questions is above 4.3 with most between five and six. Two questions were marked with a mean of 2.00 and 3.33, but these questions were phrased negatively.

7.3.3 Observations and Discussion

One of the children remarked that he found level three the hardest level, because the broccoli and the green pepper are both green and are hard to keep apart. Another child told us that he was sad that if you first get silver stars at the easy difficulty and then get some gold stars at the hard difficulty that you then lose your earned silver stars. The children indicated that they wanted to keep playing and wanted more levels. They also took the game home, so that they can play it again. We observed that the children were comparing scores with one and other, trying to get more stars than their friend or sibling.

One of the children was using a 7-inch tablet and complained that his finger was selecting the wrong food item. When we swapped his tablet with a 10-inch one he did not have the problem anymore. The other players did not have any problems selecting food items.

We observed that all of the parents and children were using a bolus calculator, but did not know it was called this way.

A health care professional mentioned that they teach the children that a banana is twenty one grams of carbohydrates instead of the thirty that was in the game. Of course this also depends on the size of the banana, the brand and the type. Following this, the health care professional concluded that it might be beneficial to be able to customize the amount of carbohydrates per food items, so that the game is an accurate representation of the current teaching method.

The players mentioned that they liked the victory screen and music and we also noticed that were visibly happy when they reached it.

7.4 Conclusion

We saw in this chapter a description of how the evaluation was performed and the characteristics of the participants. The results show that the closed questions do not differ much between pre-test and post-test, open questions three and four are slightly better in the post-test. The problem with these results is mainly that because of the low sample count we cannot infer any strong conclusions. When we look at the User experience questions we see that on average all the questions were given high ratings.

	N	Minimum	Maximum	Mean	Std. Deviation
Ik vond het spel leuk	6	3	7	5,67	1,506
Ik wil het spel nog een keer spelen	6	1	7	5,00	2,280
Alles wat ik nodig had om het spel te kunnen spelen was te zien op het scherm	6	4	7	5,50	1,378
Ik wist wat ik moest doen om te winnen	6	4	7	6,00	1,265
Ik weet alle dingen die je kan doen in het spel	6	4	7	5,83	1,169
Het spel zag er mooi uit	6	4	7	5,67	1,033
Ik speel graag dit soort spellen	6	1	7	4,83	2,041
Ik verveelde me tijdens het spelen	6	1	3	2,00	,894
Het spel bleef me motiveren om te blijven spelen	6	2	7	4,83	1,835
Ik had het gevoel dat alles wat er gebeurde kwam door mijn keuzes	6	1	6	4,33	1,862
Het uiterlijk van het spel past goed bij het type spel	6	3	7	5,33	1,366
De geluidjes van het spel passen goed bij het type spel	5	4	7	5,20	1,095
De geluidjes en het uiterlijk passen goed bij elkaar	6	4	7	5,33	1,211
Het geluid was van invloed op de manier waarop ik speelde	5	4	7	5,20	1,304
Ik begreep de regels van het spel	6	5	7	6,00	,894
Het spel was uitdagend	6	4	7	5,67	1,033
Het spel was te moeilijk	6	2	5	3,33	1,211
Het spel is nuttig voor mensen met diabetes	6	4	7	5,50	1,225

Table 7.4: User experience Questions

Chapter 8

Summary

In this report, we first explained why serious games can help with managing chronic diseases and diabetes in particular. We then researched game design and game experience evaluation. Next we presented an overview of all the educational diabetic games that exist and how they were evaluated. This information was distilled into a table. After this we made an online survey to see how much the average person knows about carbohydrates and how this compares to people with diabetes.

We then developed our own game, using the knowledge found in the previous chapters. A pilot test was organized and executed at a local primary school. Following this, we improved our game with the found results. Finally we did a real test with diabetic children.

The test shows that the children really liked the game. The Core elements of gaming experience questions received high ratings from the children. The pre-test and post-test do not show big differences on the closed questions, two of the four open questions indicate a slight increase in knowledge, but more research is needed to be sure.

8.1   Future work

Future work includes improvements to the design and functionality of the Carb Counter game. At the moment the game heavily relies on mathematical skills and memory of food to carbohydrate combinations. This may become boring after a while and especially for really small children, it might be beneficial to research if there are others ways to teach the same educational content without using mathematics. Furthermore, one can research if the current game is better for teaching children how to do math instead of teaching them carbohydrate values.

The game currently contains five levels. Each level can be played in two ways; the easy difficulty mode with selecting separate food items and the hard difficulty mode where the food items have to be in a row. Adding more levels will add more diversity, include new food items, increase the educational content and will make the total playing time longer. Also one can consider adding more difficulty modes or special levels (for example a boss level) or upgrades (for example inverted gravity) that change the game flow.

Also the evaluation could benefit from a bigger sample size of diabetic children. Additionally it needs to be investigated if there is a difference in recently diagnosed diabetic children that still need to learn about the disease versus children that already have it for multiple years. Another direction for future research is to see if education for diabetic children differs per country or culture. Furthermore in this evaluation we did not use all questions from the CEGE framework, because we had a strict time slot for testing with the diabetic children and asking all the questions would take up too much time. However it would be better to use the full set of the questions, because the authors used a grounded approach to reach this full set.

Finally more research can be done in letting users add their own food items to the game. Some of the parents and health care professionals mentioned they would like to do this, so that the kid's game can consist of a representational overview of typical things the child would normally eat. Also there are small differences between the amount of carbohydrates that books, lists on the internet and health care professionals teach to the children. An example of this is that a banana is thirty carbohydrates in the game, but the staff of the hospital in Ede teaches the children it is actually twenty one. This difference depends on the size of the banana, but also on the brand and type. An idea might be to show how much the banana weighs, however this might also distract from the game by making the interface to cluttered with information.

Chapter 9

Acknowledgments

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Appendix A

Questionnaire 1

This appendix contains the online questionnaire.

Survey carbohydrates

What are carbohydrates and what do they do?
The goal of the following survey is to get an overall picture about the current knowledge on carbohydrates.
So please don't ask your friends for help or search the answers on google.
Please fill out the form completely. Your answers will be handled anonymously.
* Required

How old are you? *
o < 10
o 10-18
o 19-25
o 26-50
o 50

What is your gender? *
o Male
o Female
o Other

Do you consider yourself an expert on carbohydrates? *
o Yes
o No

Do you have diabetes? *
o Yes
o No

Are you on a diet? *
o Yes
o No

Which of the following foods does NOT have carbohydrates? *
o Milk
o Chicken
o Bread
o Potatoes

How sure are you about the previous answer? *

1 2 3 4 5

It was a guess o o o o o I'm sure

Which of the following foods does NOT have carbohydrates? *
o Tomato
o Egg
o Popcorn
o Apple

How sure are you about the previous answer? *

        1 2 3 4 5

It was a guess ○ ○ ○ ○ ○ I'm sure

Which of the following foods contains the most carbohydrates? *
- ○ Butter
- ○ Cheese
- ○ Tomato
- ○ Banana

How sure are you about the previous answer? *

        1 2 3 4 5

It was a guess ○ ○ ○ ○ ○ I'm sure

Which of the following foods contains the most carbohydrates? *
- ○ Onion
- ○ Duck
- ○ Rice
- ○ Green beans

How sure are you about the previous answer? *

        1 2 3 4 5

It was a guess ○ ○ ○ ○ ○ I'm sure

Which of the following foods contains the most carbohydrates? *
- ○ A pizza with tuna
- ○ A plate of sphagetti with tomatosauce and meat
- ○ A plate of pea soup
- ○ A plate of spinach, potatoes and meat

How sure are you about the previous answer? *

        1 2 3 4 5

It was a guess ○ ○ ○ ○ ○ I'm sure

How many grams of carbohydrates are in one bar (60 grams) of snickers? *
_____

How many grams of carbohydrates are in one serving (150 grams) of French fries? *
_____

How many grams of carbohydrates are in one bag (100 grams) of salted popcorn? *
_____

How many grams of carbohydrates are in one bag (50 grams) of M&M's peanut? *
_____

Appendix B

Pre-test questionnaire

Vragenlijst koolhydraten

Wat zijn koolhydraten eigenlijk en wat heb je er aan?
De volgende vragenlijst is bedoeld om een beeld te krijgen hoeveel jij weet over koolhydraten.

Naam
_____

Hoe oud bent u?
_____

Wat is uw geslacht?
- o Man
- o Vrouw

Vindt u uzelf een expert in koolhydraten?
- o Ja
- o Nee

Bent u op een dieet?
- o Ja
- o Nee

Gebruikt u een insulinepen of pomp?
- o Pen
- o Pomp

Gebruikt u een boluscalculator?
- o Ja
- o Nee

Welk voedingsmiddel bevat GEEN koolhydraten?
- o Melk
- o Kip
- o Brood
- o Aardappels

Hoe zeker bent u over het vorige antwoord?

1 2 3 4 5

Het was een gok o o o o o Heel zeker

Welk voedingsmiddel bevat GEEN koolhydraten?
- o Ei
- o Tomaat
- o Appel
- o Popcorn

Hoe zeker bent u over het vorige antwoord?

               1 2 3 4 5

Het was een gok ○ ○ ○ ○ ○ Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- ○ Boter
- ○ Kaas
- ○ Tomaat
- ○ Banaan

Hoe zeker bent u over het vorige antwoord?

               1 2 3 4 5

Het was een gok ○ ○ ○ ○ ○ Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- ○ Eend
- ○ Rijst
- ○ Sperziebonen
- ○ Ui

Hoe zeker bent u over het vorige antwoord?

               1 2 3 4 5

Het was een gok ○ ○ ○ ○ ○ Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- ○ Een bord spinaziestamppot
- ○ Een bord spaghetti met tomatensaus en gehakt
- ○ Een pizza met tonijn
- ○ Een bord erwtensoep

Hoe zeker bent u over het vorige antwoord?

               1 2 3 4 5

Het was een gok ○ ○ ○ ○ ○ Heel zeker

Hoeveel gram koolhydraten zitten er in een reep (60 gram) snickers?
_____

Hoeveel gram koolhydraten zitten er in een bakje (150 gram) patat?
_____

Hoeveel gram koolhydraten zitten er in een zak (100 grams) zoute popcorn?
_____

Hoeveel gram koolhydraten zitten er in een zakje (50 grams) M&M's met pinda's?
_____

Appendix C

Post-test questionnaire

Vragen koolhydraten + vragen over het spel

Naam

_____

Welk voedingsmiddel bevat GEEN koolhydraten?
- o Melk
- o Kip
- o Brood
- o Aardappels

Hoe zeker bent u over het vorige antwoord?

1 2 3 4 5

Het was een gok o o o o o Heel zeker

Welk voedingsmiddel bevat GEEN koolhydraten?
- o Ei
- o Tomaat
- o Appel
- o Popcorn

Hoe zeker bent u over het vorige antwoord?

1 2 3 4 5

Het was een gok o o o o o Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- o Boter
- o Kaas
- o Tomaat
- o Banaan

Hoe zeker bent u over het vorige antwoord?

1 2 3 4 5

Het was een gok o o o o o Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- o Eend
- o Rijst
- o Sperziebonen
- o Ui

Hoe zeker bent u over het vorige antwoord?

                1 2 3 4 5

Het was een gok o o o o o Heel zeker

Welk voedingsmiddel bevat de meeste koolhydraten?
- o Een bord spinaziestamppot
- o Een bord spaghetti met tomatensaus en gehakt
- o Een pizza met tonijn
- o Een bord erwtensoep

Hoe zeker bent u over het vorige antwoord?

                1 2 3 4 5

Het was een gok o o o o o Heel zeker

Hoeveel gram koolhydraten zitten er in een reep (60 gram) snickers?
_____

Hoeveel gram koolhydraten zitten er in een bakje (150 gram) patat?
_____

Hoeveel gram koolhydraten zitten er in een zak (100 grams) zoute popcorn?
_____

Hoeveel gram koolhydraten zitten er in een zakje (50 grams) M&M's met pinda's?
_____

Vragen over het spel

Ik vond het spel leuk

                1 2 3 4 5 6 7
Helemaal oneens o o o o o o o Helemaal eens

Ik wil het spel nog een keer spelen

                1 2 3 4 5 6 7
Helemaal oneens o o o o o o o Helemaal eens

Alles wat ik nodig had om het spel te kunnen spelen was te zien op het scherm

                1 2 3 4 5 6 7
Helemaal oneens o o o o o o o Helemaal eens

Ik wist wat ik moest doen om te winnen

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Ik weet alle dingen die je kan doen in het spel

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het spel zag er mooi uit

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Ik speel graag dit soort spellen

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Ik verveelde me tijdens het spelen

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het spel bleef me motiveren om te blijven spelen

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Ik had het gevoel dat alles wat er gebeurde kwam door mijn keuzes

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het uiterlijk van het spel past goed bij het type spel

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

De geluidjes van het spel passen goed bij het type spel

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

De geluidjes en het uiterlijk passen goed bij elkaar

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het geluid was van invloed op de manier waarop ik speelde

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Ik begreep de regels van het spel

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het spel was uitdagend

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het spel was te moeilijk

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens

Het spel is nuttig voor mensen met diabetes

	1	2	3	4	5	6	7	
Helemaal oneens	○	○	○	○	○	○	○	Helemaal eens