A Pedagogical Tool for Lifestyle Intervention in Children at Risk of Developing Type 2 Diabetes

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Title:
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Abstract

Type 2 diabetes is emerging among children all around in the world. It is estimated that Type 2 diabetes represents 8-45% of pediatric patients with diabetes currently diagnosed in USA. However, the incidence of Type 2 diabetes among children is believed to be rising. This situation is emerged because of the modern lifestyle. This is characterized with a primary high caloric intake and little physical activity resulting in a positive energy balance, weight gain and ultimatively obesity and increased risk for developing Type 2 diabetes.

It is not known, if Type 2 diabetes can be prevented by using a computerized pedagogical tool to intervene with children's current lifestyle.

Four test participants (2 girls and 2 boys; mean age=9.75; mean Body Mass Index=15.6) to conduct a heuristic evaluation of the system over two courses. The first test was conducted, where the test subjects went through the program's user interface by reading on their own accord. In the second test the reading was done by the experimenter.

The mean point (out of 100 point) achieved after the first test was 70 point and second test was 81.25 point.

The results indicate that it is possible for children to gain knowledge about Type 2 diabetes and lifestyle using a pedagogical tool. It is believed that knowledge is the first step towards lifestyle changing behaviour and finally improved health.

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Preface

The master's thesis has been written by group 1086i during 9th and 10th semester of the Biomedical Engineering and Informatics education at Aalborg University, in the period from September 21st 2008 to June 4th 2009.

This thesis is the product of the study abroad on the 9th semester at the Centre of Health Informatics (CHI) at City University London and the study at Aalborg University on the 10th semester. The author would like to thank Professor Abdul Roudsari and the people in CHI, for help and supervision during the thesis.
The project aims primarily at fellow students and others who share interests.

Aalborg University, spring 2009

Nishanthi Kathirgamarajah

Reading guidance

The master's thesis is divided in four parts: Problem and motivation, System development, Conclusions and Appendix.

Part one also called 'Problem and motivation' is the introduction, which leads to the problem statement. It contains literature studies related to children, Type 2 diabetes and prevention.

Part two or 'System development' describes how the problem statement of this study has been solved. It includes requirement, analysis, design and implementation and test. The next version of the system is placed at the end of this part.

The third part or 'Conclusions' contains the discussion of the results obtained in this project, the conclusion and future aspects related to Type 2 diabetes, children and prevention.

The fourth part also called 'Appendix' contains the methodology used during the system development process, UML2 diagrams, test results and screenshots of the system, version 1 (before the test) and 2 (after the test).

Citations are noted according to Harvard style. The author's name and year of publishing are noted in squared brackets for example [Despopoulos and Silbernagl, 2003]. The bibliography is placed after the part 'Conclusions'.

Contents

Part I

Problem and motivation

Chapter 1

Introduction

Issues concerning Type 2 diabetes and children are presented in this chapter.

Diabetes Mellitus (referred as diabetes) is a chronic disorder, where the level of blood glucose in a group of individuals reaches higher levels than seen in normal individuals. Blood glucose is a vital fuel for the organism, especially the muscular system and the brain. [Statens Institut for Folkesundhed, 2007]

Diabetes can generally be divided in two common types, Type 1 and Type 2 diabetes.
Type 1 diabetes is also called Insulin Dependent Diabetes Mellitus (IDDM). This disorder is caused by insulin deficiency and is potentially life-threatening, where the patient would die within weeks or months if no insulin treatment is initiated.
Type 2 diabetes or Non Insulin Dependent Diabetes Mellitus (NIDDM) is caused by the decreased efficacy of insulin and sometimes this condition occurs even with conjunction with increased insulin concentrations.
Diabetes is as a disease characterized with abnormal high levels of blood glucose (called hyperglycemia), which results in symptoms such as thirst, fatigue and frequent urination. [Despopoulos and Silbernagl, 2003] [Statens Institut for Folkesundhed, 2007]

The World Health Organization (WHO) has in 2003 estimated that there were 150 million worldwide with diabetes and furthermore predicted this number to rise to 300 million people by 2025. These is based on a study, where King and colleagues (1998) linked data from a WHO-developed global database on diabetes with United Nations (UN) demographic projections in order to estimate the number of people with diabetes in all countries of the world. [King et al., 1998]
Type 2 diabetes is generally believed to counter 90% of the cases of diabetes and Type 1 diabetes, secondary diabetes etc. the remaining 10%. [Shaw and Chrisholm, 2003]

1.1 Type 2 diabetes and children

In the last couple of years the number of children diagnosed with Type 2 diabetes has globally been rising, in both developed and developing countries [Haines et al., 2007].

The global perspective

Pinhas-Hamiel and colleagues (1996) have shown that the number of children and adolescents diagnosed with Type 2 diabetes in the United States of America (USA) have grown dramatically in the period, 1992 to 1994. In 1992 4% of newly diagnosed between birth and 19 years were diagnosed with Type 2 diabetes and this number was two years later in 1994 grown to 16%. [Pinhas-Hamiel et al., 1996]

Recent studies indicate that 8-45% of new-onset pediatric diabetes cases in USA may be Type 2 diabetes. [Copeland et al., 2005] [Desmangles, 2007] [Fagot-Campagna et al., 2000] [Gahagan and Silverstein, 2003] [Kaufmann, 2002] [Permutt et al., 2005] [Zeitler, 2007]
As seen among adults, there may also be many childhood cases, which go unrecognized. [Rosenbloom et al., 1999]

Gahagan and Silverstein (2003) state that the prevalence of Type 2 diabetes in American children is expected to exceed that of Type 1 diabetes within 10 years
[Gahagan and Silverstein, 2003].

Japan has, similar to USA, had a severe increase in Type 2 diabetes among children and adolescents. Type 2 diabetes is among Japanese school children seven times more common than Type 1. Furthermore the incidence has increased more than 30-fold over the past 20 years. [Rosenbloom et al., 1999]
Yokoyama and co-workers (1998) reports, that the incidence of NIDDM is higher in young Japanese than in young Caucasians [Yokoyama et al., 1998]. In a recent review there has been revealed that about 80% of Japanese children with diabetes has Type 2 diabetes [Yoon et al., 2006].

In other developed countries, Type 2 diabetes among children and adolescents are lesser dominant, these are countries such as Austria, United Kingdom (UK), France, Western Australia and Denmark. [Haines et al., 2007] [McMahon et al., 2004]
Haines and co-workers (2007) has in the period between October 2004-05 observed a minimum incidence of Type 2 diabetes of 0.53/100.000 per year in children $<$17 years in UK. Type 2 diabetes was representing 40% of all non-Type 1 diabetes cases reported in children. The incidence data from this study was 2.5 times higher compared to data from 2003. [Haines et al., 2007].
In Denmark $<$1% of children and adolescents are diagnosed with Type 2 diabetes
[Poulsen and Jacobsen, 2005] [Borrild and Musaeus, 2001].
The trend has however shown that there also has been an increase of the prevalence of childhood Type 2 diabetes in these countries.

In developing countries, the rise in the prevalence of Type 2 diabetes among the pediatric population has occurred in lesser time than in developed countries.
In Asia the cases of Type 2 diabetes greatly outnumber the cases of Type 1 diabetes in children and adolescents. Here, populous countries such as India and China contribute with the greatest number of people with diabetes. [Yoon et al., 2006] In 1995, the countries with the largest number of people with diabetes were, and are projected to be in the year 2025, India (19 and 57 million respectively), and China (16 and 38 million). The greatest

increase between 1995 and 2025 is expected to occur in India (195%) [King et al., 1998].

1.2 Risk factors

Type 2 diabetes has until recently not been considered as a pediatric disease, because of the known risk factors of the family history of diabetes, obesity and sedentary lifestyle [Copeland et al., 2005] [Rewers and Hamman, 1995] [Scott et al., 1997] [Sinha et al., 2002] [Statens Institut for Folkesundhed, 2007].

The risk factors of Type 2 diabetes is shown in figure 1.1.

Modifiable risk factors	**Non modifiable risk factors**
Obesity	Ethnicity
Central obesity	Family history of type 2 diabetes
Lack of physical activity	Low birth weight
High saturated fat in the diet	

Figure 1.1: *Illustration showing the non modifiable and modifiable risk factors of Type 2 diabetes. Modified from [Laakso, 2003]*

Non modifiable risk factors

Ethnicity is one of the non modifiable risk factors of Type 2 diabetes. Studies have shown that a Body Mass Index (BMI) over 30 is a Type 2 diabetes risk factor for Caucasians. However the same degree of risk is already applicable for non-Caucasians, when the BMI exceeds 25.

This difference can particularly be explained by the distribution of body fat, here should be noted that central or abdominal obesity is closely linked with Type 2 diabetes than generalised or peripheral obesity.

South Asian people are more hereditary strained with central obesity and are therefore more likely to develop Type 2 diabetes than Caucasians (see figure 1.2) [Fall, 2001] [Yajnik, 2004]. Caucasians are more sensitive for the development of Type 1 diabetes [Yokoyama et al., 1997] [Yoon et al., 2006].

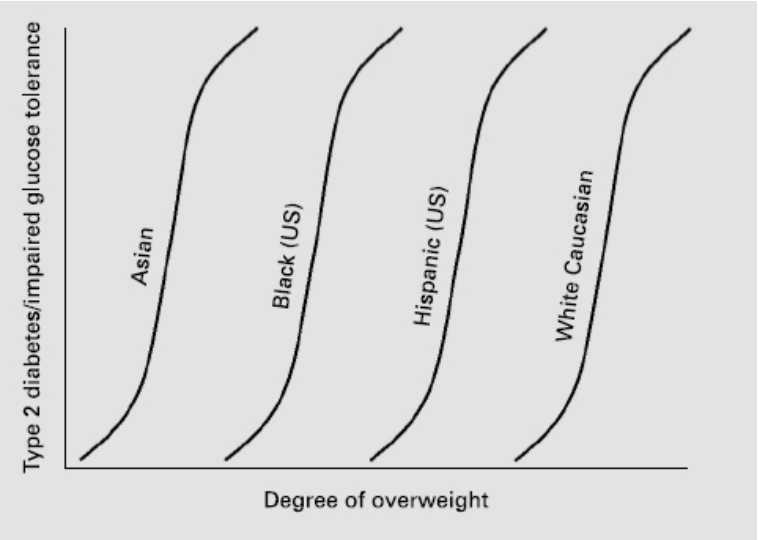

Figure 1.2: *Illustration showing the relationship between the degrees of overweight and Type 2 diabetes/impaired glucose tolerance in children and adolescents, dependence on ethnicity. [Blüher et al., 2003]*

Another non modifiable risk factor is the family history of diabetes. Twin studies have indicated that genetic factors play a major role in the aetiology of Type 2 diabetes [Rewers and Hamman, 1995].

The trend of inheritance however remains uncertain. 45-80% of children diagnosed with Type 2 diabetes have parents with the same illness and 74-90% of the children report at least one affected first- or second-degree relative diagnosed with the Type 2 diabetes [Kaufmann, 2002].

Twin studies does indeed support the role for non-genetic factors, because there haven't in these studies been shown that Type 2 diabetes is 100% due to genetics
[Rewers and Hamman, 1995].

Modifiable risk factors

The modifiable Type 2 diabetes risk factors are those which can be altered in such way so Type 2 diabetes can be prevented.

Obesity is a modifiable risk factor. The modern lifestyle of today is characterized with primary a high caloric intake and little physical activity are resulting in a positive energy balance, weight gain and ultimately obesity [Gahagan and Silverstein, 2003] [Kiess et al., 2004] [Laakso, 2003].

There has been shown a clear association between obesity, insulin resistance and the development of Type 2 diabetes [Fall, 2001] [Guyton and Hall, 2006] [Keen and Ekoe, 1984].

Fall (2001) has in a study shown that the prevalence for Type 2 diabetes increased with

increasing BMI for all the included populations (India, Mauritius, Bolivia, Iran, Chile and Jamaica) [Fall, 2001]. And obesity is seen as a risk factor, especially when starting in childhood [Fall, 2001] [Gahagan and Silverstein, 2003] [Kaufmann, 2002] [Kiess et al., 2004].

1.3 Complications

If diabetes is diagnosed it is important for the diabetic patient to maintain constant blood glucose levels. This is because glucose is the only nutrient used by the brain, retina and germinal epithelium of the gonads. If the blood glucose concentration become too high, this will cause four major damages [Guyton and Hall, 2006]:

- The glucose will exert a large amount of osmotic pressure in the extracellular fluid, which can cause considerable cellular dehydration.
- The high levels of blood glucose concentrations can cause loss of glucose in the urine.
- The loss of glucose in the urine will cause osmotic diuresis by the kidneys. This can deplete the body of its fluids and electrolytes.
- The long term effects of the condition can result in damages to many tissues, especially blood vessels. Vascular injury along with uncontrolled diabetes can lead to increased risk for heart attack, stroke, end-stage renal disease and blindness.

The long term effects of Type 2 diabetes in children, opposite to adults, are seen only after a brief period of time. Yokoyama and colleagues (1997) have shown that 12.7% patients with early onset NIDDM (here defined as diabetes diagnosed before the age of 30) developed proliferative retinopathy before the age of 35. Statistic for these patients [Yokoyama et al., 1997]:

- 60% developed diabetic nephropathy at a mean age of 31 years.
- 23% developed renal failure requiring dialysis at a mean age of 35 years.
- 24% became blind at a mean age of 32 years.
- 10% developed atherosclerotic vascular disease at a mean age of 36 years.

A hypothesis concerning this matter suggests that the development of Type 2 diabetes normally takes decades in adults, before the β-cells fail to compensate for the patient's state of insulin resistance. And it is hypothesized that the same progress of the disease is thought to happen in a few years in adolescents, see figure 1.3. [Goran et al., 2003]

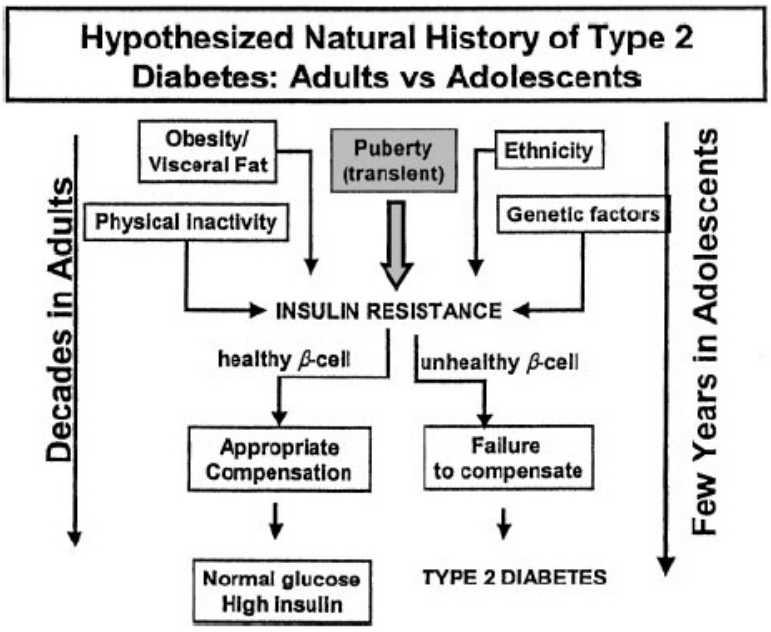

Figure 1.3: *Figure showing a hypothesized natural history of Type 2 diabetes in adults and adolescents. [Goran et al., 2003]*

Type 2 diabetes is a chronic disease, therefore if an individual is diagnosed with this disease as early as the childhood; a straightforward consequence of the early diagnosis is the amount of time the individual have to live with the disease.

Type 2 diabetes which normally is diagnosed due to advanced age, the age of diagnosis would have been 60+, and these individuals would roughly live with Type 2 diabetes for 20-30 years of their lifetime. However, when a child is diagnosed with diabetes, due to bad eating habits and sedentary lifestyle, and if the age of diagnosis is thought to be 10+, then these individuals would have to live 70-80 years with Type 2 diabetes.

This worst case scenario would cause health and economical problems, for the individual and society.

1.4 Summary

Type 2 diabetes is emerging among children all around the world. It is estimated that Type 2 diabetes represents 8-45% of pediatric patients with diabetes currently diagnosed in USA. However, the incidence of Type 2 diabetes among children is believed to be rising.

The children in risk of Type 2 diabetes are generally overweight, have a strong family history of Type 2 diabetes and often have signs of insulin resistance. The ethnicity plays a vital role as a risk factor for causing Type 2 diabetes, where non-Caucasian are at high risk for Type 2 diabetes.

Studies suggest a high prevalence of micro vascular and macro vascular complications among adolescents who developed Type 2 diabetes during childhood. Type 2 diabetes in children has recently been recognized as a potential public health problem.

Chapter 2

Prevention of Type 2 diabetes

This chapter is dedicated to find the areas in which the preventive precautions for Type 2 diabetes can be made.

2.1 The Danish perspective

Type 2 diabetes in children is not of current interest in Denmark but it is thought to be a major health issue of the future Denmark.
However it is of crucial importance to accept the worst case scenario of tomorrow, where the health situation in Denmark as a possible outcome can turn to be an imitation of the current health situation seen in countries such as USA.

If this happens, then it will not be a one-off event. For just 10 years ago, the possibility of people with BMI>30 in Denmark was unbelievable. This health issue is unfortunately of highly current interest, influencing the society from the health care to transport sector.
In the hospitals there are basic considerations to be made about the need to actually invest in bigger hospital beds, and airline companies, such as Ryan air, have recently considered charging obese passengers more, because they use bigger flight seats.

Preventive precautions are therefore needed in order to change the reality of tomorrow. The current government of Denmark has also presented some objectives in 1999 in order to improve the health of the people.
Objective 5 was about the topic 'Diet and exercise'. Here the goal was to improve the eating habits and physical activity level of the Danes. This goal was thought to be achieved through the following [Sundhedsministeriet, 1999]:

- Information.
- Provide easy access to a healthier lifestyle.

The information needed to prevent diabetes in children are information that in a child-friendly way explain, what diabetes is, and what they can do to prevent it.
When the issue is preventing Type 2 diabetes some of the same factors used when treating Type 2 diabetes should be considered. These are especially nutrition education and lifestyle/behaviour modifications [Blüher et al., 2003].

2.2 Diet

Studies from wars, where the caloric intake was reduced severely, have provided evidence of declined diabetes mortality and morbidity. High-fat diets have been associated with obesity, and implicit Type 2 diabetes. [Rewers and Hamman, 1995] This factor is important, due to the excess access to food in the world of today, especially in the developed countries.

The diets are therefore the main weapon in diabetes prevention. Research findings in this area will in the following be presented along with the diet recommendations given by authorities in the healthcare area. These recommendations will appear in italic.

Carbohydrate and fibre

Studies have supported suggestions that food rich in slowly digested starch or high in fibre might be protective against Type 2 diabetes. Furthermore the ratio of whole grain to refined grain was related to a lower risk of diabetes, suggesting a potential benefit for replacing refined grains with whole grains.
It seems to be prudent to encourage an increased consumption of total dietary fibre from different sources; whole grains, fruits, vegetables and legumes. [Toeller and Mann, 2003]

Recommendations

- *Eat lots of vegetables and fruits - minimum 6 every day.*
- *Choose whole grain foods over processed grain products. Eat potatoes, brown rice or whole wheat spaghetti.*
- *Choose water and calorie-free "diet" drinks instead of regular soda, sweet tea and other sugar-sweetened drinks.*

[Sundhedsstyrelsen, 2009b] [American Diabetes Association, 2009]

Fat

High intake of fat has been associated with increased risk of Type 2 diabetes. Conversely a high intake of vegetable fat was inversely associated with the risk of Type 2 diabetes.

Dietary recommendations included advice to appreciably reduce saturated fatty acids. A study showed that habitual fish eaters had 50% lower risk of developing glucose intolerance compared with a control group of people who were not regular fish eaters.

According to the available data, modifying intake of dietary fats towards consuming less saturated and more unsaturated fats may reduce the risk of developing Type 2 diabetes. [Toeller and Mann, 2003]

Recommendations

- *Cut back on high calorie snack foods and desserts like chips, cookies, cakes, and full-fat ice cream.*

- *Choose lean meats like cuts of beef and pork. Eat chicken, and turkey.*
- *Choose non-fat dairy such as skim milk, non-fat yogurt and cheese.*
- *Choose liquid oils for cooking instead of solid fats that can be high in saturated and trans fats.*
- *Eating too much of even healthful foods can lead to weight gain. Watch your portion sizes.*

[Sundhedsstyrelsen, 2009b] [American Diabetes Association, 2009]

2.3 Exercise

Both exercise and physical activity have an effect on body weight reduction and insulin sensitivity. [Shaw and Chrisholm, 2003] Any prevention protocol for Type 2 diabetes should therefore include exercise programs and physical training.

Exercise is therefore seen as another key factor in diabetes prevention. The prevention should follow the recommendations given by the Danish public authority [Sundhedsstyrelsen, 2009a]:

- *Children should exercise minimum 60 minutes every day.*

In this context it is important to emphasize that lifestyle intervention programs have shown more effective than pharmacotherapy for the prevention of progression of Type 2 diabetes in adults. [Blüher et al., 2003] [Shaw and Chrisholm, 2003]

The prevention topics are chosen to be diabetes, the non modifiable and modifiable risk factors of Type 2 diabetes. The next step is to find out how the learning opportunities are in the area of Type 2 diabetes and children.

2.4 Education

There are some potential barriers related to education, this is e.g. the individuals' access to education.
As it is today the education of diabetes are directed solely for patients diagnosed with Type 2 diabetes. And these patients receive some of their diabetes education in the hospital, but approximately 90% of the diabetic patients are treated by the general practitioner [Siminerio et al., 2008]. And there is in the current practice no time for profound diabetes education, particular adjusted for children.

The resources in the health care system are limited for covering the area 'Prevention of Type 2 diabetes among children'. But there are some available sources for Type 2 diabetes education, these are:

- Books.
- Web pages.

- Lectures.

When considering the above mentioned sources for Type 2 diabetes, there are some issues, which have to be emphasized. The most important issue is that there aren't many books and web pages written in a child friendly way about Type 2 diabetes. This is mainly because, Type 2 diabetes as a pediatric disease is relatively new, and the diabetes literature for children are therefore mainly covering the topic of Type 1 diabetes.
And the material of Type 1 diabetes can't directly be transferred to the field of Type 2 education.

In this study it is believed that the first step towards influencing the children's lifestyle is through the gain of knowledge of the optimal lifestyle and how unhealthy lifestyle can increase the risk of Type 2 diabetes. The steps towards improved health are shown in figure 2.1.

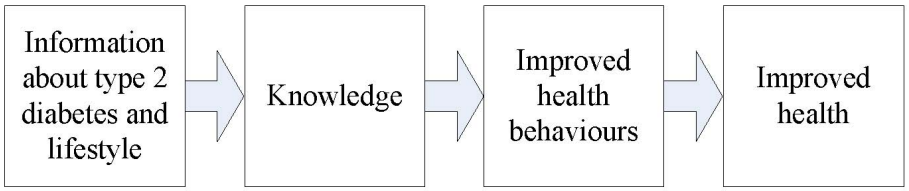

Figure 2.1: *Illustration showing the steps towards improved health.*

2.5 Summary

As obesity is currently on the increase in several industrialized or industrializing countries, a similar increase in Type 2 diabetes in children may soon emerge in Denmark, and this will require preventative measures.

The preventive precautions have to influence the non modifiable Type 2 diabetes risk factors; Diet and exercise.

Chapter 3

Educating Type 2 diabetes

One of the choices that has to be made in this chapter, it is which age group that would be appropriate as a target group for preventing Type 2 diabetes. Furthermore the media to reach the specific age group is also defined in this chapter.

3.1 Learner specification

Children have different cognitive abilities, which are related to their age. Children are defined to be between the age of 4 and 12 [Kiess et al., 2004].

Several researchers do not recommend the use of computers to children under 3 years [Hohmann, 1998]. Furthermore Haugland (2000) state that children aged 3 and 4 uses computers in a fundamentally different way than computers are used by children in kindergarten and the elementary grades [Haugland, 2000].
According to Piaget's developmentally theory, a Concrete operational stage is defined for children aged 7 to 12 years. Piaget state that children in this age group possessed conservation abilities unlike children in the earlier stage. A similar division is seen in Freud's developmental theory. [Lerner, 2002]
These theoretical divisions are consistent with the physiological growth of the brain, where children aged 7-11 years has volumetric obtained approximately 95% of the adult brain [Caviness et al., 1996].

Furthermore the preventive precautions have to be made before the children enter puberty. This is mainly because pubertal children are more insulin resistant compared to pre- and post pubertal children. This insulin resistance occurs during a time of profound change in body composition and hormone levels. [Moran et al., 1999]
The age of puberty is thought to be 12.8 ± 1 SD [Rosenfield et al., 2000]. And the time of peak insulin resistance during puberty is between 13 and 14 years [McMahon et al., 2004].

On the basis of the above-mentioned it is decided that the age group for the target group of children is defined between 7 and 12 years.

Children aged 7 to 12 years

There are some common characteristic of children aged 7 to 12 years, which has been described in the cognitive theory. These are that children in this age group are beginning to gain the capacity of classifying object by size, shape and colour on the mental level. [McGraw, 1994]
Furthermore the same theory suggest that the combinative use of visual and auditory are more beneficial for children in this age group, because of the immaturity of the children limits their comprehension of abstract concepts. [Valla et al., 2000]

It is furthermore important to keep in mind that 7 to 12 years old children have a short attention time span between 15 to 20 minutes [Johnson, 1993].

The objects that children are generally fond are object such as LEGO bricks, games, computers, dolls/action figures and books/magazines [Steenhold, 1999]. These children are also called the PC or net generation [Kupperschmidt, 2001] [Lievrouw and Livingstone, 2002]. This has become a reality because the access to computers has become easier.
In USA, it was reported in 1998 that 51% of the American households had access to a computer. [Bureau, 2000]. This number was roughly 85 % in 2008 for the households in Denmark [Danmarks statistik, 2008].

3.2 Pedagogical considerations

In the field of computer-based learning there have been to approaches; the teacher-centred and the student-centred approach.
The teacher-centred approach, where the educational view of the theory of behaviourism, states that human learn through stimulus and response linkage [Orton, 2004]
[McKeough, 1992]. The claim is that it is the observable change in behaviour that indicates whether or not the learner had gained knowledge [Ally, 2004]. This approach has in the last couple of years been diminished.

The dominant approach nowadays is the student-centred approach. The theories in this approach provide a method of learning, which allows the learner to become an active learner [Smith, 1996] [McKeough, 1992].
There are different theories, which fall under the student-centred approach, these are: the theory of constructivism, active learning, discovery learning, knowledge building and the theory of constructionism.
The theory of constructivism has recently been most commonly used. The theorist in this field claims that learners interpret information and the world according to their personal reality, in other words they learn by observation, processing and interpretation after which they personalize the information into personal knowledge. [Ally, 2004]

3.3 Conclusion of the literature review

A literature review has been done in order to find out if computer-based learning with a game aspect is the right approach for children. The literature review is placed in appendix chapter B

It was not possible to find any evidence, which indicated that game-based learning was superior to conventional learning.
However the literature review strongly indicated that children expressed a higher level of enjoyment, when they used the computerized approach in relation to learning. Therefore it can be concluded that children would be more motivated when using a computer in a learning process.

And in effective learning, motivation is seen as a key aspect. However, motivation needs to be sustained through feedback, responses, reflection and active involvement in order to designed learning to take place. [Garris et al., 2002]

Because children are used to computers and find it enjoyable to use in relation to learning, this media will be used in this study to make preventive precautions against Type 2 diabetes.

3.4 Summary

It is believed, that the knowledge about a healthy lifestyle, and how an unhealthy lifestyle can put one in risk of getting Type 2 diabetes, should be communicated to children between 7 and 12 years. The areas of interest are listed:

- *Knowledge about Type 2 diabetes.*
- *Knowledge about diet.*
- *Knowledge about exercise.*

Currently there are no conventional learning materials about Type 2 diabetes and lifestyle written in child-friendly way.

Chapter 4

Problem statement

Type 2 diabetes is emerging among children all around the world. It is estimated that Type 2 diabetes represents 8-45% of pediatric patients with diabetes currently diagnosed in USA. However, the incidence of Type 2 diabetes among children is believed to be rising.

The children in risk of Type 2 diabetes are generally overweight, have a strong family history of Type 2 diabetes and often have signs of insulin resistance. The ethnicity plays a vital role as a risk factor for causing Type 2 diabetes, where non-Caucasian are at high risk for Type 2 diabetes.

Studies suggest a high prevalence of micro vascular and macro vascular complications among adolescents who developed Type 2 diabetes during childhood. Type 2 diabetes in children has recently been recognized as a potential public health problem.

As obesity is currently on the increase in several industrialized or industrializing countries, a similar increase in Type 2 diabetes in children may soon emerge in Denmark, and this will require preventative measures.

The preventive precautions have to influence the non modifiable Type 2 diabetes risk factors; Diet and exercise. It is believed, that the knowledge about a healthy lifestyle, and how an unhealthy lifestyle can put one in risk of getting Type 2 diabetes, should be communicated to children between 7 and 12 years. The areas of interest are listed:

- Knowledge about Type 2 diabetes.
- Knowledge about diet.
- Knowledge about exercise.

Currently there are no conventional learning materials about Type 2 diabetes and lifestyle written in child-friendly way. This leads to the problem statement of this study:

How is it possible to design a system for lifestyle intervention in children between 7 and 12 years at risk of developing Type 2 diabetes? And how can this program intervene with the current lifestyle of the target group?

In order to solve this problem statement a methodology has been used to structure the system development, this methodology is placed in appendix chapter A.

Part II

System development

Chapter 5

Requirements

This chapter deals with the requirements of the system, PreDiabetes2Care (PreD2Care). The structure of this chapter is organized so the system description is presented at first. Hereafter the use case diagram is depicted and is used as a basis to find the functional requirements. The non functional requirements are hereafter presented.

5.1 System description

This is a system thought as a pedagogical tool for children aged 7 to 12 years. The system is expected to present interfaces about Type 2 diabetes and lifestyle. The interfaces will include topics such as diabetes, insulin, inheritance, healthy eating and exercise. Additionally an option should be incorporated, that makes it possible to evaluate the user's performance during the program execution.

5.2 Functional requirements

The functional requirements are requirements describing, what the system should do.

Use case diagram

A use case diagram of the system is used to define the functional requirements. The use case diagram is used to identify the primary elements and processes that form the system. The primary elements are termed as 'actors' and the processes are called 'use cases'. The use case diagram shows which actors interact with each use case. [Eriksson et al., 2004]

The system's use case diagram is depicted in figure 5.1. A total of 5 use cases have been identified. One of these use cases will in this section be specified in details in a individual use case specification. In the end of this specification, the functional requirement will be stated. The remaining use cases specifications is placed in appendix in section C.

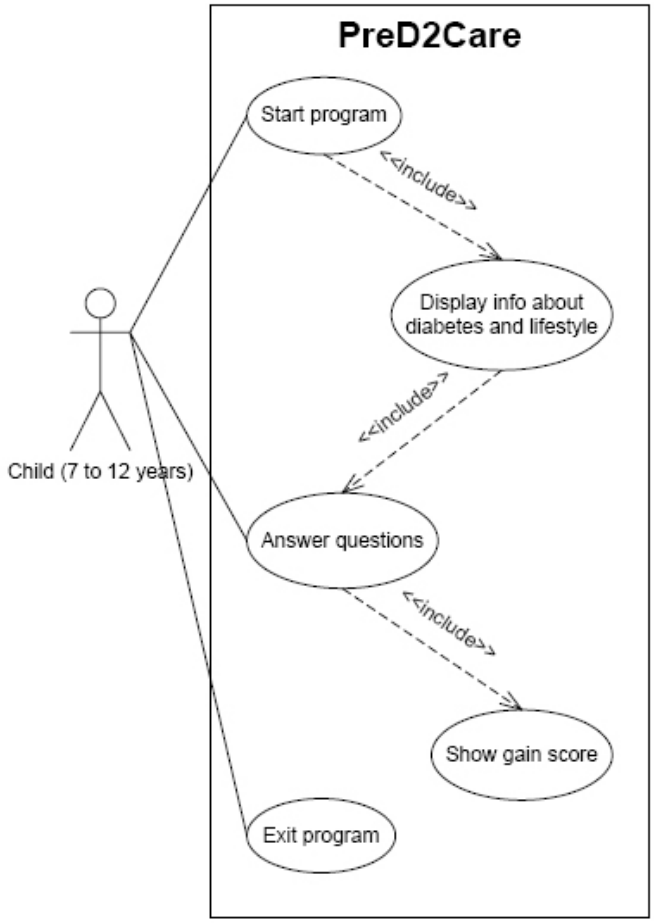

Figure 5.1: *Illustration showing the use cases of the system.*

Use case specification

Start program

Main flow of events
This use case is initiated, when the user in the main menu chooses to start the program. The system should afterwards show the content (i.e. information about diabetes and lifestyle) of the program. In order for this event to happen the use case 'Display info about diabetes and lifestyle' is included.

Exceptional flow of events
The user can exit the program at any time by clicking on the cross located in the uppermost right at the interface.

Functional requirements
The system should display information about diabetes and lifestyle.

The system should allow the user at any time to exit the program.

5.3 Non functional requirements

Non functional requirements describe not what the system will do, but how the system will do it. The topics here are e.g. performance requirements and system properties.
Non Functional Requirements are furthermore difficult to test; therefore, they are usually evaluated subjectively. [Chung et al., 1999]

Performance requirements

A performance requirement is a statement that describes how well a function should be executed. It can also describe the conditions under which the function is to be performed. Generally performance requirements are couched in terms of degree, rate, quantity, quality etc. [Lauesen, 2002] [Nixon, 2000]

The system should run on a 598 MHz and 512 MB machine. Furthermore the system is intended to be a stand-alone product and should not depend on the availability of other software. It should run on Windows based platform.

Usability requirements

The usability requirements specify how easy the system must be to use. Usability specify only how the system's functionality is to be perceived by the user, for instance how easy it must be to learn and how efficient it must be for carrying out user tasks. In other words usability requirements include a range of system aspects related to effectiveness, efficiency, learnability and memorability. [Juristo et al., 2007] [Lauesen and Younessi, 1998] [Cysneiros and Kushniruk, 2003]

The system is aimed toward children who are in the age group between 7 and 12 years. The system should therefore be child-friendly and 'quick to learn'. The system is also expected to be executed problem-free on a computer.
The purpose of the system is to learn children about diabetes and lifestyle; therefore it is expected from the system to affect the children's memory.

5.4 Specification requirements

The requirements originated from both the functional and non functional requirements are listed in this section.

Functional requirements

The system should:

1. display information about diabetes and lifestyle.

2. allow the user at any time to exit the program.

3. allow the user to be evaluated.
4. provide an option to evaluate, whether the user has learned anything in relation to diabetes and lifestyle.
5. make it possible to show the user how good their performance has been under the evaluation of the system.

Non functional requirements

The system should:

1. run on a 598 MHz and 512 MB computer.
2. not depend on the availability of other software.
3. run on Windows based platform.
4. be child-friendly and 'quick to learn'.
5. execute without problems on a computer.
6. effect the user's ability to remember information about diabetes and lifestyle.

Chapter 6

Analysis

The subject of interest in this chapter is firstly the platform in which the system has to be executed. Hereafter the system's use cases are being specified in details and presented as activity diagrams. After this analysis classes is found and used as basic for the design of the system. At last in this chapter the structure of the system is presented.

6.1 Platform

As it is stated in chapter 5 the system is thought as stand-alone. This means that the system is not depending on the presence of other software.
For the system it should be indifferent, whether the computer the system is running on uses the operating system platform provided from e.g. Windows or Linux.
In order to realize this, the system is programmed in Java. This object-oriented programming language makes it possible to write on one platform and run on many platforms. The source code is compiled into a virtual machine code. This quality of Java makes the Java platform independent. A system coded in Java is enabling the system to be placed on a web site or executed on the client side on a computer without recompiling. [Sabharwal, 1998] [Nordfalk, 2007]

6.2 Use cases

The use case discovered for the system is specified in details in so-called activity diagrams. Activity diagrams illustrate the scenario which will happen after the use case is initiated. Activity diagrams are used to generate an overview of the actions done by the actor and the system. [Eriksson et al., 2004]

In this chapter the activity diagram for the use case 'Start program' is shown in figure 6.1. The remaining activity diagrams can be found in section C.

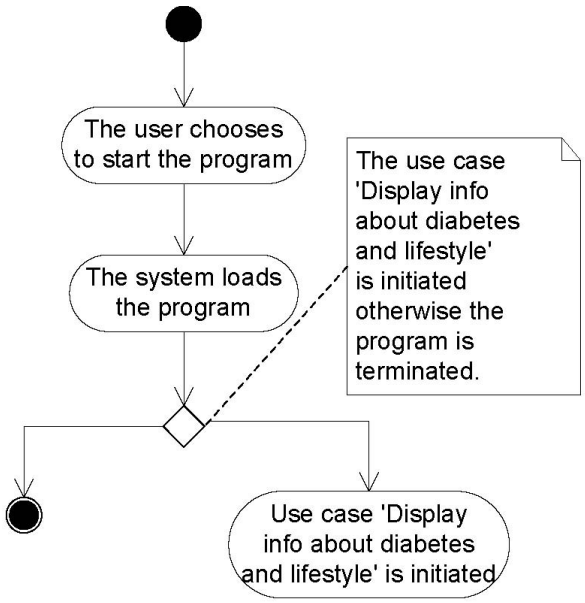

Figure 6.1: *Illustration showing the activity diagram based on use case 'Start program'.*

The activity 'Start program' begins when the child chooses to start the program. This action is triggering the system to load the program. Hereafter the use case 'Display info about diabetes and lifestyle' is initiated. The child can anytime in the program choose to exit the program.

6.3 Classes

The next step is to express the behaviour of the use case in to classes. This is done over two rounds. First candidate classes are found for the system. In the second round some of the candidate classes are transformed into the analysis classes, which will form a basis for the further design of the system.

In the following an example for the discovering of candidate classes is presented. The use case used for this is 'Start program'.

Candidate classes

The candidate classes for the use case 'Start program' is underlined in the following italic typed use case specification for the use case 'Start program'.

The activity 'Start program' begins when the child chooses to start the program. This action is triggering the system to load the program. Hereafter the use case 'Display info about diabetes and lifestyle' is initiated. The child can anytime in the program choose to exit the program.

The candidate classes is nouns or noun phrases; that is identifying the words or phrases

that denotes things [Stevens and Pooley, 2006] [Hunt, 2003]. Figure 6.2 presents all the candidate classes for the system.

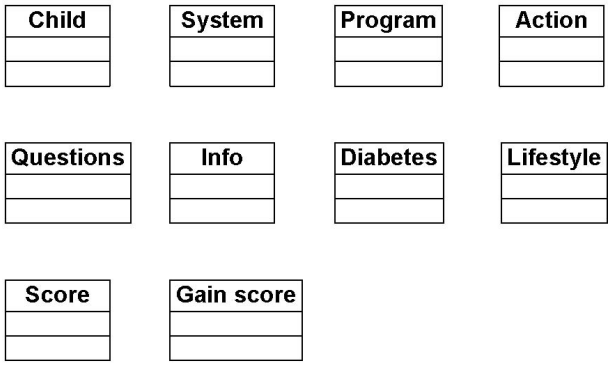

Figure 6.2: *Illustration showing all the system's candidate classes.*

Analysis classes

The candidate classes are now considered in relation to some questions. From this procedure it is possible indentify the candidate classes, which can transformed to analysis classes. The relavent questions are:

- Is it located in the system? If not, is it an actor or the system?
- Does it have an identifiable behaviour in relation to the problem domain?
- Does it have an identifiable structure, i.e. in relation to the data for which the system has to include or handle?
- Does it have a connection to any of the other candidate classes?

Figure 6.3 shows the analysis classes of the system.

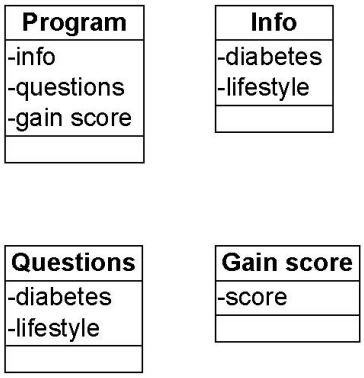

Figure 6.3: *Illustration showing the analysis classes of the system. Some of the candidate classes are appearing as attributes for some of the analysis classes.*

From figure 6.3 it is seen that some of the candidate classes appears as attributes.

6.4 System structure

The system structure is based on the use cases and analysis classes of the system. It is therefore structured in a way that provides the user with two main options. One option is to start the program and the other is to exit the program. When the user clicks the Start button, the program begins. This is illustrated in figure 6.4.

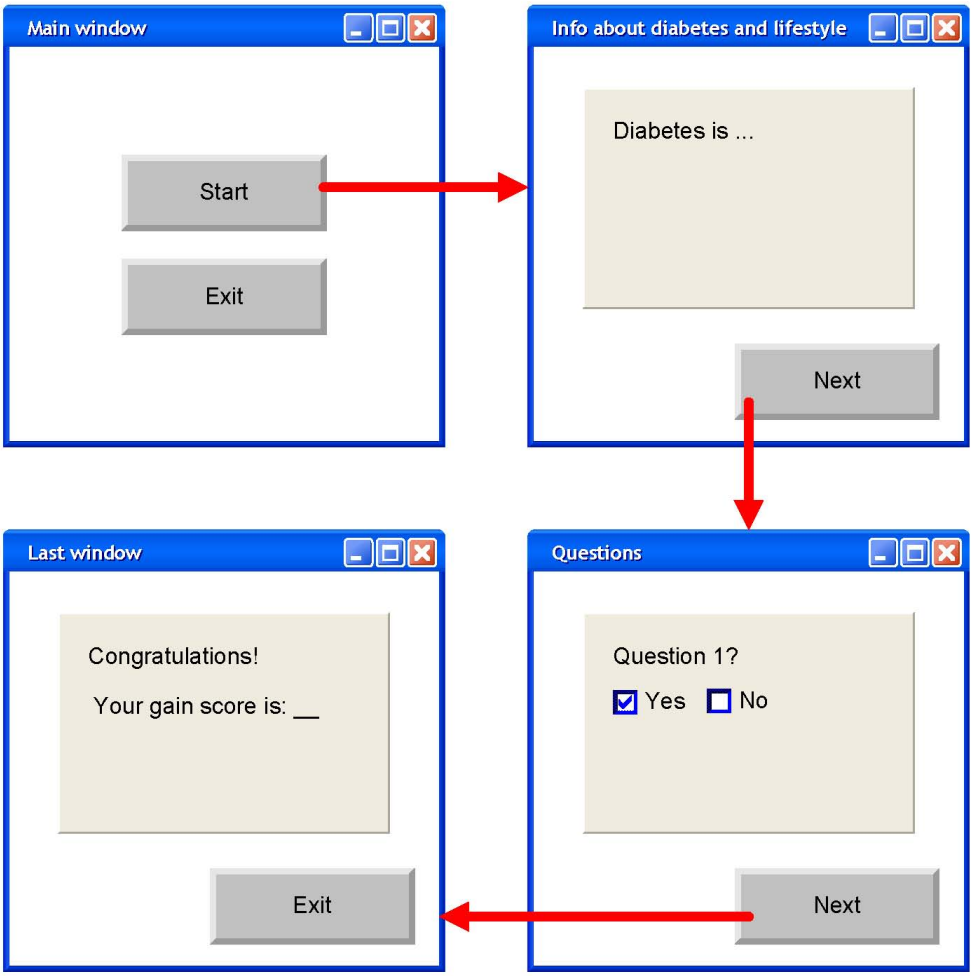

Figure 6.4: *Figure illustrating the structure of the system. The user is presented with two option, Start and Exit. If the user decides to 'Start' the program, the user is provided with knowledge about diabetes and lifestyle. Hereafter the user is given the option to answer some questions. The purpose with these questions is to evaluate the user's level of knowledge obtainment. The program's last interface presents the user a number for the user's level of knowledge obtainment regarding the topic diabetes and lifestyle.*

Chapter 7

Design and implementation

In this chapter the design and implementation issues are presented. Firstly design issues regarding the components of the user interface are treated. Hereafter the implementation version of the interfaces is presented for the reader.

7.1 Graphical User Interface

Graphical user interfaces (GUI) is defined on three abstraction levels; technical, conceptual and organisational.

Technical level

The technical level is the lowest level of abstraction. Here the interface is the part of the system, which determines how the user and the system communicate. The area of interest are the look of the buttons on the screen, the colours used, how the system reacts to user actions etc. [Kuutti and Bannon, 1993]

User-friendliness

The concept 'user-friendliness' in this level refers mostly to the cognitive and ergonomic features of the layout structure of an interface. [van Loo, 2001]

Buttons

The buttons is decided to be rectangular and edged. The reason for this design is that children in Denmark play quite a lot with LEGO bricks, which is formed with a rectangular and edged form. The LEGO Group is writing on its website, that the world's children spend 5 billion hours a year playing with LEGO bricks [Lego-Group, 2009].

Furthermore it is believed that the size of the buttons should be made large, so children which are unaccustomed with computer can use the buttons with success.

Line length

Researchers have been recommended that shorter line lengths should be used instead of

full-screen lengths. The basic for this recommendation is that longer line lengths require greater lateral eye movements, which makes it more likely to lose one's place within the text. [Horton, 1989] [Mills and Weldon, 1987]
Longer line lengths are thought to be more tiring to read [Horton, 1989] [Huey, 1968]. People with poor reading ability performed better when the line length was approximately seven words. This suggests that young readers who have not mastered reading may benefit the most from narrower line lengths. [Gregory and Poulton, 1970]
A experimental study of children aged 9 to 12 years supports that narrow line length was most preferred by children [Bernard et al., 2002].

The target group for this study is children aged 7 to 12 years. These are categorized as people with poor reading abilities. Therefore it is decided to make use of approximately seven words per line.

Font

In addition to the above-mentioned line lengths, it is decided that the font size 23 would be appropriate. This is because researchers have emphasized that children between 6 and 12 years prefer simple and large fonts. [Nielsen, 2002] [Bernard et al., 2001]. Additionally the font Times New Roman has been chosen, because this font is used frequently on the internet and in books.

Content

The last issue here is how the content of the interfaces should be presented for the children. Nielsen (2002) underlines the importance of age appropriate content. Therefore the Danish diabetes association is used as inspiration in order to solve this problem. This association has published a booklet concerning diabetes Type 1 for children between 9 and 13 years. [Diabetesforeningen, 2003]

Colours

The background colour of the screen is chosen to be grey. This colour is a neutral colour. Studies show that this colour increases the psychological response from the colours used, when the background colour was grey. [Peterson, 2007]

Furthermore the colour blue is used on the buttons. This is done on the basis of a study, which establishes that blue is the overall favourite for both genders [Warner, 2007].

Conceptual level

The second abstraction level or the conceptual level is where the interface is the part of the system, which must understood and mastered in order to utilise the system for the desirable purpose. The main objective here is to support the operations of the user. An user task could be reading about diabetes. [Kuutti and Bannon, 1993]

User-friendliness

'User-friendliness' refers mostly in this level to the ease of use; how many actions the user has to perform to get something done, how easy it is for the user to find a specific command. [van Loo, 2001]

Ease of use

The term 'ease of use' is often a mixture of 'ease of access' (How fast can I get there?) with 'ease of comprehension' (How well do I understand where I've arrived?). 'Ease of use' is not always the primary criterion for designers. But it would be preferable if 'ease of use' was more valued, so the needs of the novice user were satisfied. [Marcus and van Dam, 1991]

In this project 'ease of use' is set as a main criterion. In practice this is carried out by putting big blue coloured buttons, which the user is thought to click on in order to move between the interfaces.

Organisational level

The highest abstraction level is the organisational level. On this level the interface is thought as the relation between the system and use context. The interface emerges when the system is used or in other words the interface is the way the user tasks are supported by the system. The interesting issue here is whether the interface offers the user the possibility to perform the user tasks in a straight forwarded way. [Kuutti and Bannon, 1993]

User-friendliness

Here 'user-friendliness' refers to questions regarding how well the system supports the work of the user in its actual context of use. [van Loo, 2001]

User satisfaction

It is of high importance that the user is satisfied using the system. This is based on the fact that if the user is not satisfied by what the system is offering then the consequence would in be that the user doesn't want to use the system. That is highly undesirable.
The literature search done in the problem domain of the project have indicted that children prefer to use computer in learning rather than the conventional way of learning, where the teacher lecture the class about the subject (see chapter B)

It is therefore believed that the user would be satisfied, if the system provides the child with the information about diabetes and lifestyle on a subjective and illustrative way.

7.2 System structure

All the above-mentioned design issues are implemented in the system, PreD2Care. The system is coded using Java (Netbeans IDE 6.5).
The design of the pedagogical tool PreD2Care is based on the following structure.

1. Information interfaces concluding with a reminder interface (level 0-4: diabetes, insulin, inheritance, diet and exercise).

2. Second reminder interfaces (level 5).

Information interfaces concluding with a reminder interface

These interfaces treat the topic of Type 2 diabetes and lifestyle. One issue regarding this topic is information about where insulin is produced and that reduced production of insulin will result in diabetes (see figure 7.1).
After this information has been presented for the user, a reminder interface with questions regarding the completed issue will appear. The purpose of the reminder interfaces is to unconsciously remind the user of the information, the user has been presented (see figure 7.2).
The answers of the questions indicate how much the user has gained in matter of short-term-memory knowledge.

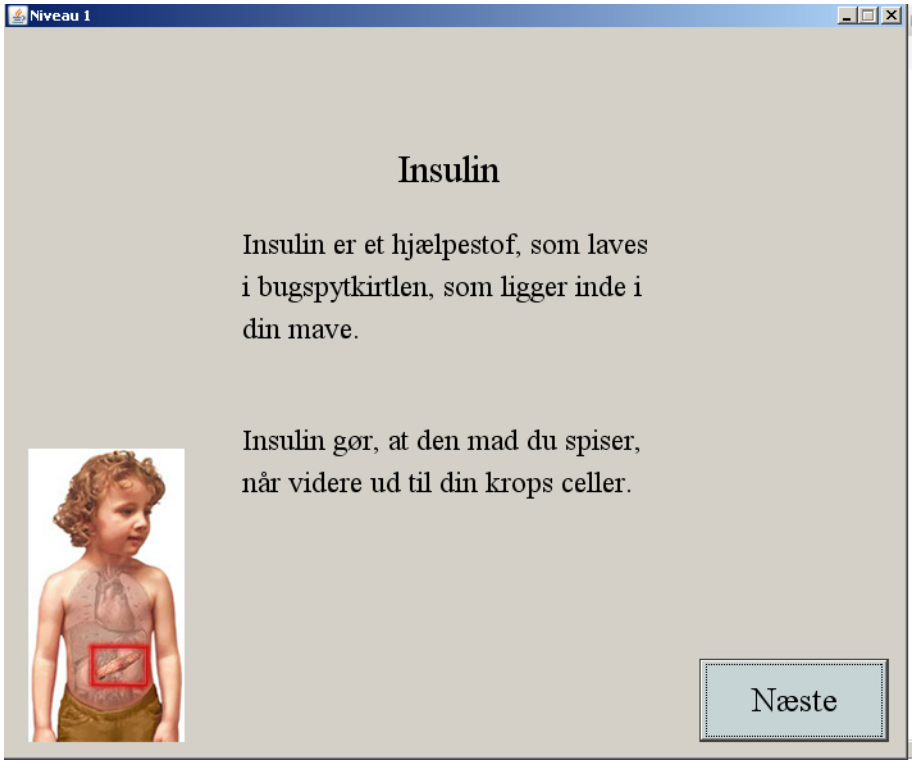

Figure 7.1: *Screenshot of the program's information interface.*

Figure 7.2: *Screenshot of the program's first information interface about insulin.*

Second reminder interfaces

These interfaces are the last attempt to get the user to think about the information the pedagogical tool has been presenting for the user.
The answers of the questions indicate how much the user has gained in matter of long-term-memory knowledge.

In the end of the program, the user is given a gain score (see figure 7.3). This number is based on the answers the user has given under the first reminder interface (5 point to every correct answer) and in the second reminder interfaces (10 point to every correct answer). The maximum gain score is 100.

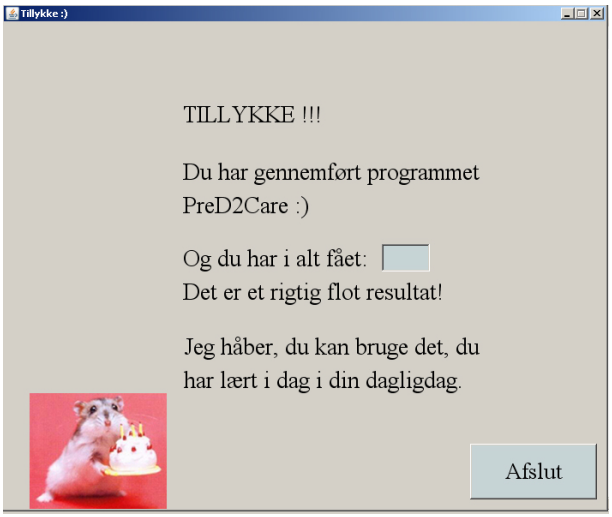

Figure 7.3: *Screenshot of the program's insulin reminder interface.*

The rest of the user interfaces is placed in appendix chapter D. The overall structure of the system is illustrated in figure 7.4.

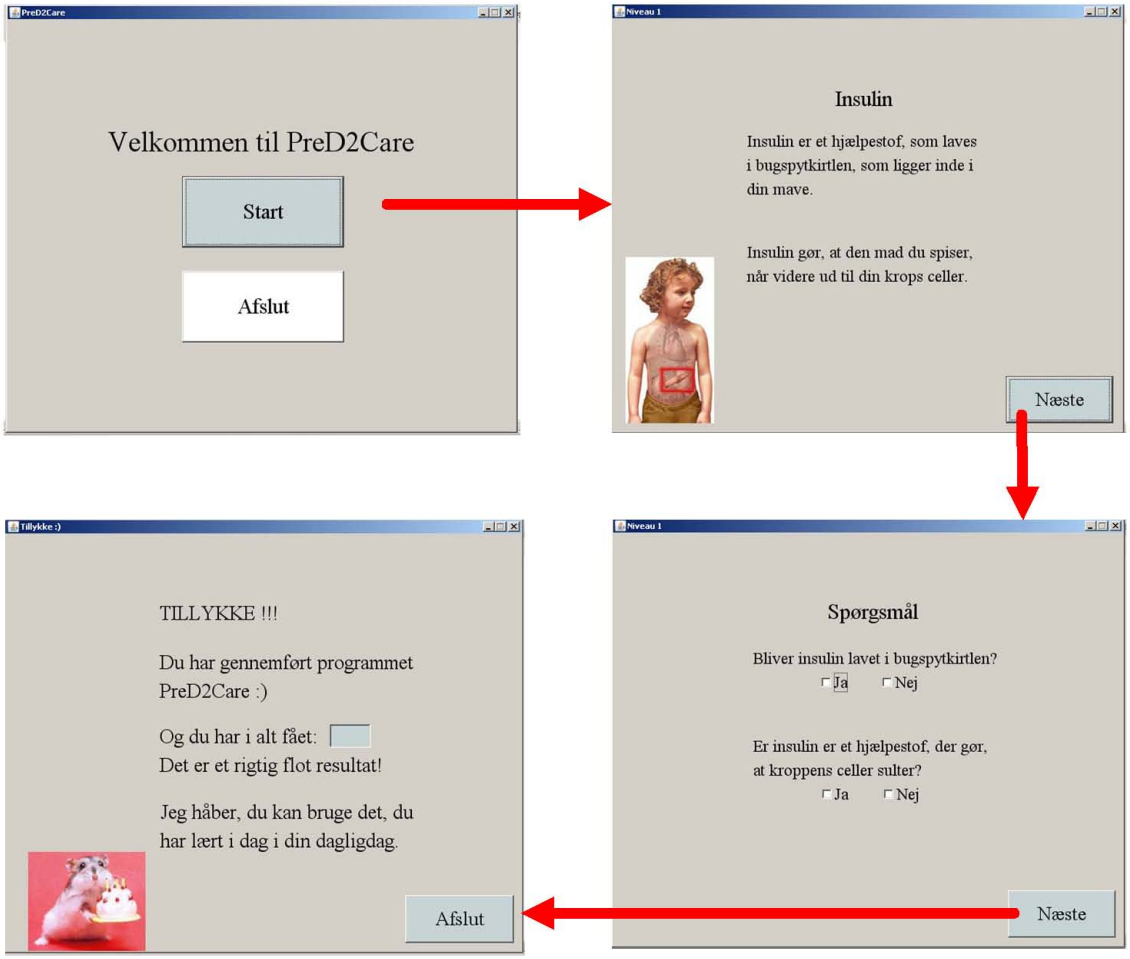

Figure 7.4: *Illustration showing the structure of the system.*

Chapter 8

Test

This chapter presents all the ways the system is tested. These tests are tests of specific components to the overall test of the system, where the functionality of the system is tested.

8.1 Strategy

There are many ways to test a software system. There are tests, where the focus is laid on the components of the system. Other tests are control tests, where the overall functionality of the system is tested. Furthermore tests securing the requirements are available; these tests are done by the end user of the system. [Black, 2004]

The test strategy, which is used in this project, is shown in figure 8.1.

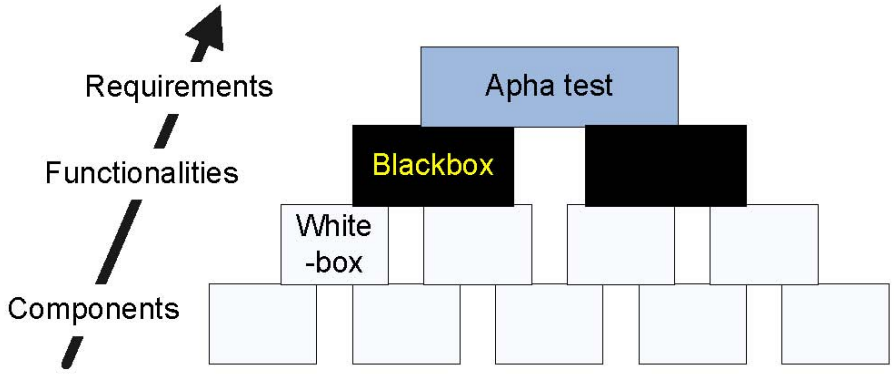

Figure 8.1: *Illustration showing the tests included in the test strategy. Additionally the order for the tests is also shown symbolised with an arrow. The texts written along the line are those elements, which are being tested.*

Figure 8.1 shows that the system is tested in three levels; the components, functionality and requirements. The tests of interest are the white box test, black box test and alpha test.

White box test

A white box test is generally tested by the system developer. This is mainly because the white box test requires that the test participant is familiar with the components of the system. Furthermore the individual functionalities between the components are also being tested here. This test is focused on the internal relationships of the software. [Black, 2004]

In practice it is the classes of the program, which is tested under this test. The white box test is a test, which is done continuously through the system development.

The white box is theoretically a test which should make the system code flawless. In practice this is not achieved mainly because the white box test is a extensive and time consuming. This test is therefore normally done in limited areas of the system, which are commonly causing problems. [Pressman, 2005]

Black box test

As in the white box test the test participant of this test is the system developer. The developer is familiar with the overall functionality of the system. The functional requirements are tested for the first time during the black box test.
The test participant is testing, whether the system meets the requirements and simultaneously identifying the errors related to these requirements. The test participant is expected to find the flaws in the user interface, the effectiveness of the system, initialisation and termination of the system. [Black, 2004] [Pressman, 2005]

Alpha test

The alpha test is done by the end user of the system, where the functionalities of the system are tested. The system developer is recording the problems and errors the user is making. An alpha test is usually causing alterations to the system. [Pressman, 2005]

8.2 Test planning

The white box and black box tests are tested through the system development and they are therefore considered as a part of the process of coding.

The alpha test is an usability test, which has organised as cases. The basis for this test is heuristic evaluation. Because the target group is specific, realistic case scenarios has been made for the test participant to solve. [Nielsen, 2009]

The case structure of heuristic evaluation secures that the system is testing the GUI's three levels of abstraction; the technical, conceptual and organisational level. Furthermore the test participant is going through all the parts of the system and thereby contributing to the evaluation whether the requirements for the system are fulfilled.

The alpha test is including the following cases.

- **Case 1**: You have to start the program.

- **Case 2**: You have to exit the program.
- **Case 3**: You have to go through the program and answer the questions.
  This case was done twice, the first test was conducted hence the test subjects did go through the program's user interface by reading on their own accord. In the second test the reading was done by the experimenter.
- **Case 4**: You have to start the program and read the first interface about insulin and afterwards exit the program.

8.3 Results

Alpha test

The data available to evaluate the system is gathered in 2009 from children in Denmark. All the children are non-diabetic. Data contains information about the scores achieved from the first and second test. The inclusion criteria for test participants in this study are that the participant should be between the age 7 to 12 years and non-diabetic. Four test participants were selected for this project (see table 8.2).

Test participant	Age	Sex	BMI	Diabetes
1	8	Female	14.9	No
2	9	Female	16.6	No
3	10	Male	13.6	No
4	12	Male	17.3	No

Figure 8.2: *Illustration showing the description of test paticipants.*

Case 1, 2 and 4 is completed correctly by the test participants. The test results i.e. gain scores from the first and second test of case 3 are examined in this section. All the test results are placed in appendix chapter E.

Case 3: You have to go through the program and answer the questions.

The first test is conducted hence the test subjects goes through the system's user interface by reading on their own accord. In the second test the reading is done by the experimenter. The results from these tests are shown in table 8.3

Test participant	Test 1		Test 2	
	Gain score (max. 100)	Test length [min]	Gain score (max. 100)	Test length [min]
1	50	16	75	10
2	65	12	75	9
3	90	7	85	6
4	75	6	90	6

Figure 8.3: *Illustration showing the test particapants' gain scores and test lengths.*

Gain scores is used as evidence for the obtainment of knowledge. The second test is conducted to determine, whether there is a need for implementing audio in the system. For this purpose an additional factor 'the length of the test' is also collected.

Table 8.4 presents the average gain scores and test lengths of test 1 and 2 for all test participants. Furthermore average values from test participants 1+2 (aged 8 and 9 years) and test participants 3+4 (aged 10 and 12 years) are shown.

Test participant	Test 1		Test 2	
	Average gain score	Average test length [min]	Average gain score	Average test length [min]
All	70	10.25	81.25	7.75
1+2	57.5	14	75	9.5
3+4	82.5	6.5	87.5	6

Figure 8.4: *Illustration shows the average gain scores and test lengths.*

A post-test questionnaire was also completed. This questionnaire was used to evaluate the pedagogical toll's level of difficulty and to determine if this level is appropriate for the target group.

The test participants were all expressing enjoyment of the idea of using a computer program as an alternative to conventional learning about the topic diabetes.
The collected data indicates that the level of difficulty is higher than acceptable. It was decided together with the test participants that the use of medical terms should be limited in the next version of the system.

The majority of the test participants indicated that some of the pictures used didn't support the text on the user interfaces.

Chapter 9

The next version of the system

In this chapter the alterations, which have been done to the first version of the system, is explained. Firstly the necessary changes to the buttons have been presented. Hereafter modifications regarding the text and pictures are stated.

9.1 Graphical User Interface

Buttons

The test showed that the button 'Forrige' was not used by the majority of the test participants. However, one of the test participants tried the button and was surprised of the outcome. The test participant didn't use the button further.

On the basis of these observations, which showed the redundancy of the button, it was decided to delete the button 'Forrige'.

Text

Words

The text seemed to be difficult for especially the youngest test participants. The basis for this statement was the recorded test length and gain score.
The youngest participants were those who got the highest values for the test length under the first test (12 and 16 min.) and the lowest gain scores (50 and 65 points).
These results improved under the second test, where the experimenter read the text on the interfaces aloud for the test participants. Hereafter the youngest participants improved both their test lengths (9 and 10 min.) and gain scores (both got 75 points).
Additionally both of these participants answered that the text was difficult under the post-test questionnaire.

Furthermore the participants were asked about, which words they found most difficult. Here, the words Type 2 diabetes, insulin, and pancreas were the words all the participants felt were most difficult. A listing of all the difficult words can be found in the following.

1. Type 2 diabetes.

2. Insulin.
3. Pancreas.
4. Environment.
5. McDonald's.
6. Risk.
7. Light products.
8. Cells.
9. Race.
10. PreD2Care.

The list placed above is showing the top 10 of the difficult words. The three first placed words were found difficult by all the test participants.

On the basis of these results, the most of the words were changed. These changes were accordingly to the suggestions given by the test participants.

Questions

Another issue regarding the text on the interface was the formulation of the questions aked under the reminder interfaces. The results indicated that there were three questions, for which many of the participants answered wrongly. These questions were as follows:

- Laver kroppen for meget insulin hos personer med type 2 diabetes?
- Er insulin er et hjælpestof, der gør, at kroppens celler sulter?
- Er normal sodavand bedre for kroppen end light sodavand?

These questions were altered to the following:

- Laver kroppen for meget insulin hos personer med sukkersyge?
- Får man sukkersyge, hvis ens krop ikke laver nok insulin?
- Er normal sodavand bedre for kroppen end sodavand uden sukker?

Pictures

All the test participants expressed that the use of pictures was a good ides. But they all thought that a link between the texts and pictures were missing.

This knowledge was used to make an attempt to link the text and the pictures. This was decided to be done by using visual links such as arrows pointing from the text to the picture. The user of the system would hereby feel that the pictures were placed on the interface for a reason, and this was to support the text.

9.2 System structure

All the above-mentioned alterations have been implemented in the system, PreD2Care.

The second version of the system's first information interface about insulin is presented in figure 9.1. It is here observable that medical terms have been reduced to a minimum. Furthermore there is inserted a arrow which points to the pancreas allowing the user to relate the text to the picture.

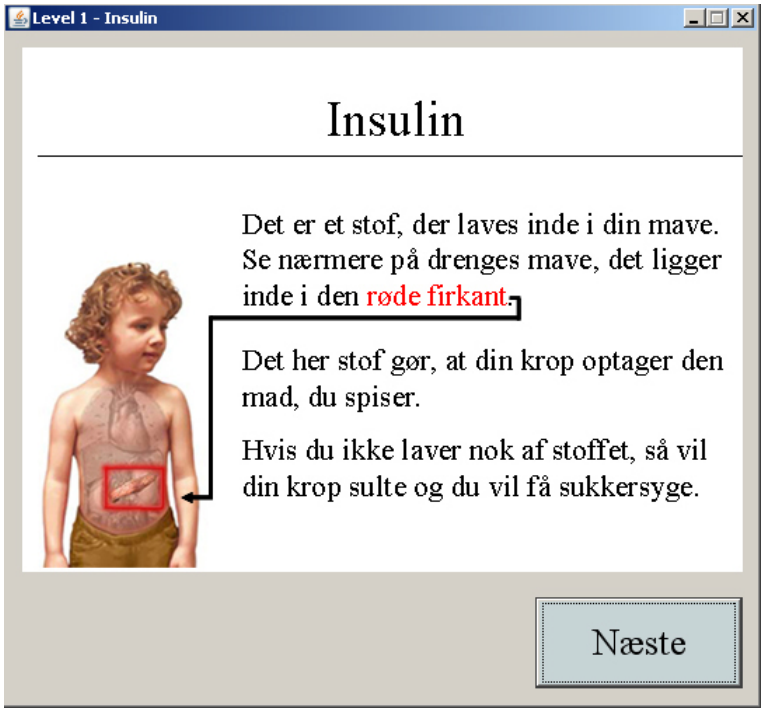

Figure 9.1: *New version of the program's first information interface about insulin.*

The test results have indicated that three of the questions in the first version were unintelligible for the test participants. The texts from these questions were therefore in the new version modified. An example of this modification is presented in figure 9.2, look at the second question in the interface.

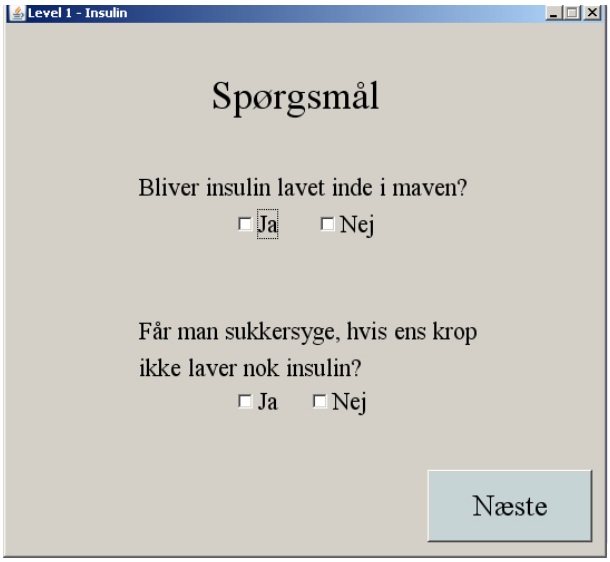

Figure 9.2: *New version of the program's insulin reminder interface.*

The last interface is also altered in order to resemble the other interfaces (see figure 9.3).

Figure 9.3: *New version of the program's last interface.*

The rest of the changed user interfaces is placed in appendix chapter F. The overall structure of the new version of the system is illustrated in figure 9.4.

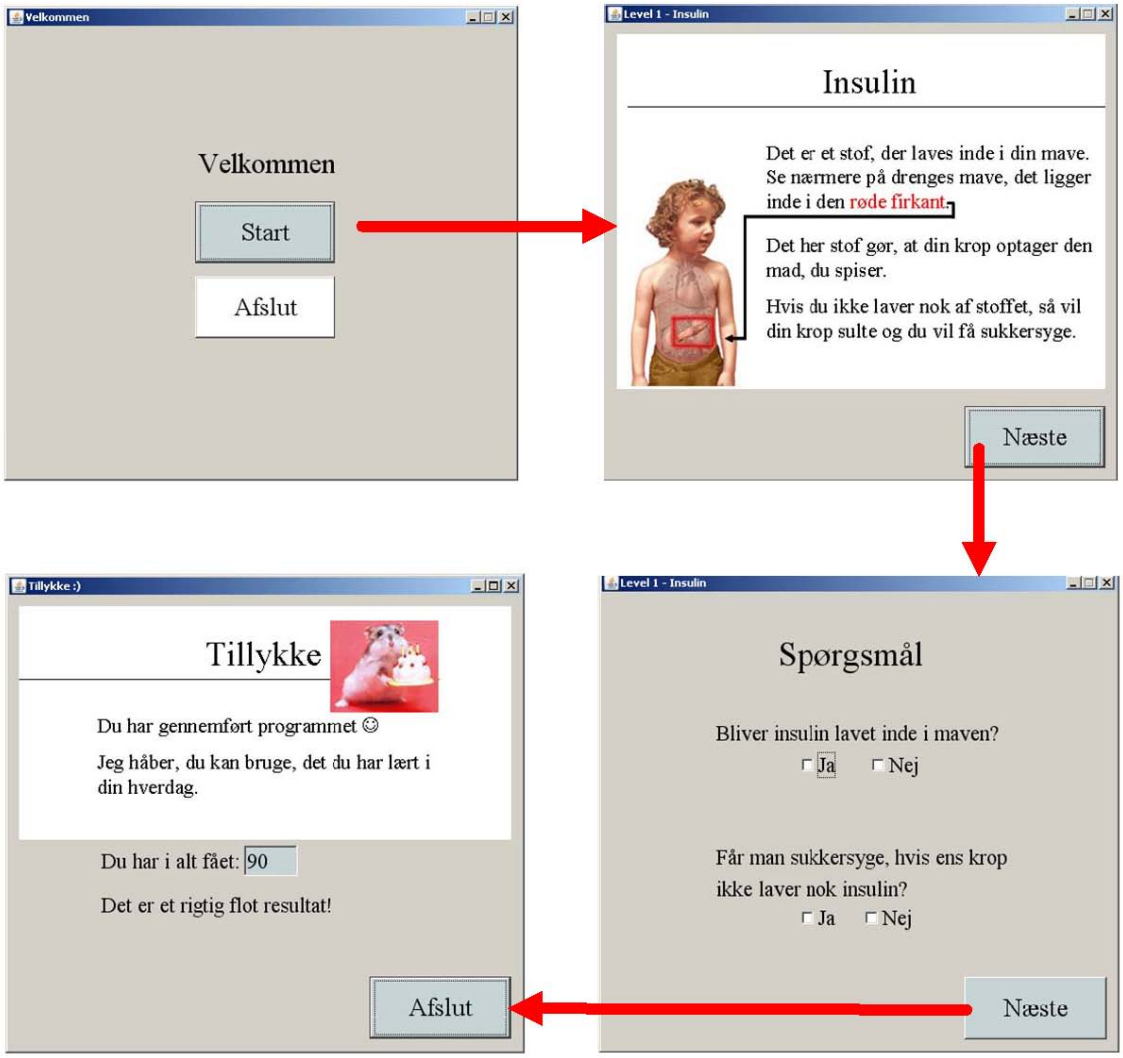

Figure 9.4: *Illustration showing the structure of the new version of the system.*

Part III

Conclusions

Chapter 10

Discussion

This chapter is presenting issues regarding the design of the system, the test and lastly the preventive effects are stated.

10.1 System

Two entries

The current system is made as one-size-fits-all system for children aged from 7 to 12 years. The test results have shown that this one approach is not sufficient enough to cover this age group of children.

The test results indicate strongly that the program's level of difficulty is a little high for the children aged 8 to 9 years and a little low for the children aged 10 and 12 years.

From these results it can be concluded that a one-size-fits-all program can not be used in the age group between 7 to 12 years. It is necessary to implement two entries to the program. So children aged 7 to 9 years will be introduced for the program in a lower level of difficulty than the children aged 10 to 12 years.

The possibility to include audio assistance for the youngest participants should be considered. This conclusion is based on the results, where the youngest children (test subject 1 and 2) obtained a higher gain score in the second test. Test subject's 1 gain score under the second test was 33.3% higher compared to the first test. For test subject 2 this number was 13.3%.

Alternative route

In the current version of the system, the user is guided through the main interface of the system to the last interface. There isn't presented an alternative to this path.
This course of action is acceptable for a novice user to achieve knowledge about diabetes and lifestyle. However the system can not be used as a sort of encyclopaedia, where the user could acquire knowledge within a specific field of diabetes or lifestyle. It will be a useful for the system, if this feature was implemented in the system.

This feature can be incoperated in the current version of the system in the way depicted in figure 10.1.

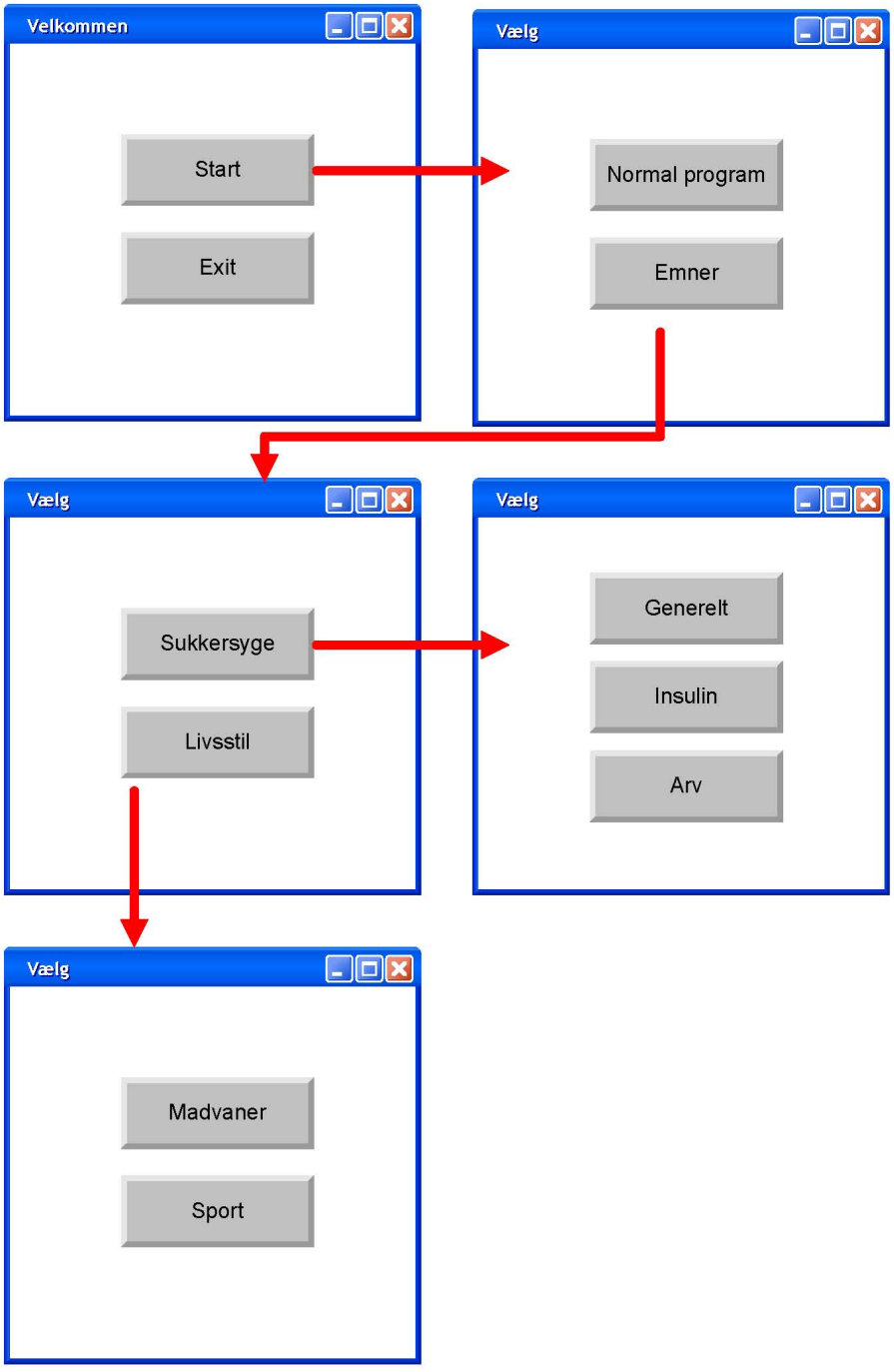

Figure 10.1: *Illustration showing a potential solution for how to include a encyclopedia function to the system.*

In order to secure the most optimal utilisation of this, it is necessary to make some changes in the existing interfaces about 'Diet' and 'Exercise'. The information interfaces should be

made general, so these topics make sense for by themselves and not in relation to diabetes.

If this is successfully implemented, then the system could be used as a preventive tool not only pointed at Type 2 diabetes but also other diseases, where the topics diet and exercise play an important role in the prevention process.

High score list

The male test participants expressed that the existence of a gain score were motivating. They could use this gain score to compare it will others, which have completed the program.

A high score list would create a perception of common experience in the users. A high score list would allow the users to compare their gain score even if the users were not completing the program at the same time. The high score list should therefore include the forename and gain score of the users, which have completed the program.

The high score list can be seen as a element of competition. Competition is a human tendency, which consists of a desire to excel, an impulse to do better than our rivals [Greenberg, 1932].
And it is commonly knowledge that competition is generally good for children. And it is believed that children are instinctively competitive and feel good about competing. Furthermore competition is thought to create conditions in which children will do their best.

Competitions can furthermore offer ways to gain insights about one's capacity to develop intellectual skills. When rewards are minimized, competitions can be fun. [Lopes, 1994]

10.2 Test

Heuristic evaluation

Usability requirements (non functional requirements) can be difficult to test in practice. There are some ways to solve this problem and one of these ways is through heuristic evaluation, which also is the method used in this study. Heuristic evaluation is a method to fault-detect software, where the test is performed with the assistance of the end user. The advantage of heuristic evaluation is that a small amount of test participants would discover the majority of the errors of the system. Studies have shown that the highest effectiveness in the finding of errors can be achieved with the use of three to five test participants (see figure 10.2. [Nielsen, 2009]

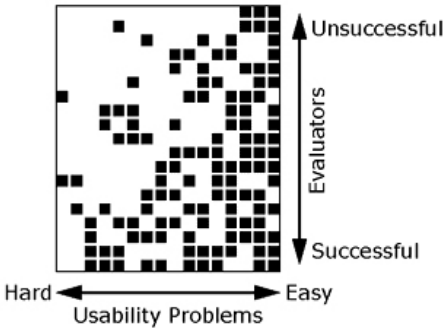

Figure 10.2: *Illustration showing which evaluators found which usability problems in a heuristic evaluation of a banking system. Each row represents one of the 19 evaluators and each column represents one of the 16 usability problems. The rows have been sorted in such a way that the most successful evaluators are at the bottom and the least successful are at the top. The columns have been sorted in such a way that the usability problems that are the easiest to find are to the right. [Nielsen, 2009]*

Test evaluation

There were defined some benchmark setting for the test in order to evaluate, the results from the test. The benchmark settings are defined to be the 'hard numbers' for the performance. The benchmark settings were as follows:

- The end user has to finish the program within 15 minutes.
- The participant has to obtain a minimum score of: 60 point of 100 point.

The first condition was defined on the basis of prior knowledge that children in this age group have short attention spans, i.e. they could maximum concentrate 15-20 minutes at a time. [Johnson, 1993].

Accept test

The majority of the errors the test participants found has been changed in the new version of the system. Theses changes have been done according to the results and observations done during the test of the system.

Even through this is the case, it is not synonymous with that the new version of the system is the perfect or fitting solution seen from the target group. An accept test should be carried out in order to verify the new version and to find flaws in the system.

10.3 Preventive effect

If children's present lifestyle were changed, then the future would be more attractive for the individual, health care and society. This will not only reduce the cost diabetes hold on the health care.

Other obesity relating diseases would also be reduced. These diseases are: hypertension,

cardiovascular diseases, stroke, increased risk for cancer and especially for women obesity cause reduced fertility, complicated pregnancies and childbirths. [Larsen et al., 2006] [Must et al., 1999] [Norman and Clark, 1998]

At last it is of importance to mention that if the habit of a healthy lifestyle is successful incorporated in young children, then there is a high possibility that these habits would accompany these individuals in their adult life.

Chapter 11

Conclusion

Type 2 diabetes has recently been observed in children and adolescents in both developed and developing countries. Researchers has stated that 8-45% of new-onset pediatric diabetes cases in USA and UK may be of Type 2 diabetes [Copeland et al., 2005] [Fagot-Campagna et al., 2000] [Gahagan and Silverstein, 2003] [Kaufmann, 2002] [Permutt et al., 2005] [Rosenbloom et al., 1999] [Zeitler, 2007]. Furthermore researchers have predicted that the prevalence of Type 2 diabetes in American children is expected to exceed that of Type 1 within 10 years [Gahagan and Silverstein, 2003].

In Denmark <1% of children and adolescents are diagnosed with Type 2 diabetes [Poulsen and Jacobsen, 2005]. But it is believed to be a major health issue in the future in Denmark. Therefore it is of crucial importance to take precautions in order to prevent the outbreak of Type 2 diabetes in children and adolescents.
It is believed that knowledge about the issues Type 2 diabetes and lifestyle is the first step towards lifestyle changing behaviour and finally improved health. This knowledge is therefore needed to be presented for the children in an understandable way.

The basic needs were the desire to reach and educate children about Type 2 diabetes and how they can make preventive precautions by changing their lifestyle.
In this study the performance of a pedagogical tool about Type 2 diabetes and lifestyle has been evaluated.

The performance of the program was evaluated using four test participants and therefore the obtained results can't be generalized to all children, but rather express a tendency. But experience has shown that four users will expose 70% of the usability problems, when using heuristic evaluation [Nielsen and Mack, 1994]. This experience-based evidence indicates that the results from this study can be generalized for children aged from 7 to 12 years.

This study indicates that a pedagogical computer tool can cause lifestyle intervention in children between 7 and 12 years. This, because it is believed that knowledge about the issues in Type 2 diabetes and lifestyle is the first step towards lifestyle changing behaviour and finally improved health.
This conclusion is based on the circumstance that the following benchmark settings for this study have been fulfilled by the majority of the test participants:

- The end user has to finish the program within 15 minutes.
- The participant has to obtain a minimum score of: 60 point of 100 point.

An exception was the result from test participant 1's first test. But this test result is believed as a result of the test participant's inferior reading skills. This has been proved under the second, where the test participant achieved a higher gain score.

Furthermore the observations made during the test of the pedagogical tool support that children are more willingly and enthusiastically to use computer tools in relation to learning health issues during leisure time compared with conventional learning, which originate from books.

Chapter 12

Future aspects

12.1 Online delivering

The pedagogical tool could also be delivered online. The use of internet has worldwide risen in the last couple of years, where it in the period 1994 to 2000 has risen from 3 to 377 million users [Gardner and Oswald, 2001].

In 2000, 25% of the all homes in UK were connected to the internet
[Tuffrey and Finlay, 2002]. And the percentage of Americans going online rose from 66.9 to 72.3 in 2001 [Sexton et al., 2002].

This increase has not only happened in the developing countries. Recent studies have indicated that the demographics of the internet use is shifting, the typical user is changing from being a white man with a socioeconomic status. The internet moves towards becoming a commercial medium. [Hoffman et al., 1996]

Furthermore research has shown, that 40-68% of the internet searches in USA were to find health information, this tendency is also reported among children and adolescents [Tuffrey and Finlay, 2002]. The internet enables the user to explore topics in a confidential and anonymous way [Bleakley et al., 2004].

Furthermore the use of internet as a delivery source would allow the program to be updated with new features and the user would thereby continue to be motivated to use the tool.

12.2 Language

The language used in the system is Danish. If the system has to been available for the majority of children in the world, it has to be available in other languages.

For a start, a module of the system could be written in English. This is because, English is a global language, where about a quarter of the world's population is already fluent or competent in English, and this number is still growing. In the early 2000s, it was around 1.5 billion people, who spoke English [Crystal, 2003].
Other major languages are French, German, Spanish, Chinese, and Hindi [Maurais, 2003].

12.3 Technological future

As the technology becomes more powerful, it will be possible to design a health education tool that assesses individual preferences, abilities and learning styles. Furthermore the tool would make it possible to tailor the content and format (e.g. ± audio) to suit the need of the individual.

This is mainly, because a pedagogical tool with a variety of content and challenges would have a better chance of maintaining interest of user than one that is one-size-fits-all.

12.4 Other preventive approaches

The efficacy of traditional lifestyle approaches has not yet been demonstrated in children.

Recent investigations suggest that pharmacological agents can be used as a complement to traditional lifestyle interventions and reduce the risk of Type 2 diabetes.
Metformin limits weight gain and reduces fasting glucose, insulin, and lipid levels in obese, insulin-resistant adolescents. Metformin is well tolerated in the majority of children and adolescents with Type 2 diabetes and insulin resistance. The long-term safety and efficacy of pharmacological agents in children at risk for Type 2 diabetes are unknown. [Freemark, 2003]

Another alternative is a surgical solution, where Deep Brain Stimulation (DBS) is used.
The natural energy homeostasis system has a tendency towards an energy equilibrium, which effectively controls body weight. However, psychological, pathological, and social factors can force the energy equation out of balance.
A region in the brain, which controls the homeostasis system, could be used as a target for the development of a new clinical application in which DBS could be used to treat obesity. [Covalin et al., 2005]

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[Yoon et al., 2006] Yoon, K.-H., Lee, J.-H., Kim, J.-W., Choo, J. H., Choi, Y.-H., Ko, S.-H., Zimmet, P., and Son, H.-Y. (2006). Epidemic obesity and type 2 diabetes in asia. *Lancet*, 368:1681–88.

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Part IV

Appendix

Appendix A

Methodology

The master thesis is structured using Unified Process (UP). This is a software development process framework, which based on an iterative and incremental process.
[Eriksson et al., 2004]

Furthermore Unified Modelling Language 2 (UML2) has been used for the documentation of the system development process. This is a visual modelling language, which is a standardised system development tool. UML2 is in general speaking considered as the 'state of the art'. [Eriksson et al., 2004] [Engels and Groenewegen, 2009]

Structure of the thesis

The thesis has been structured using the disciplines of UP, which are illustrated in figure A.1. The UP disciplines are requirement, analysis, design, implementation and test.

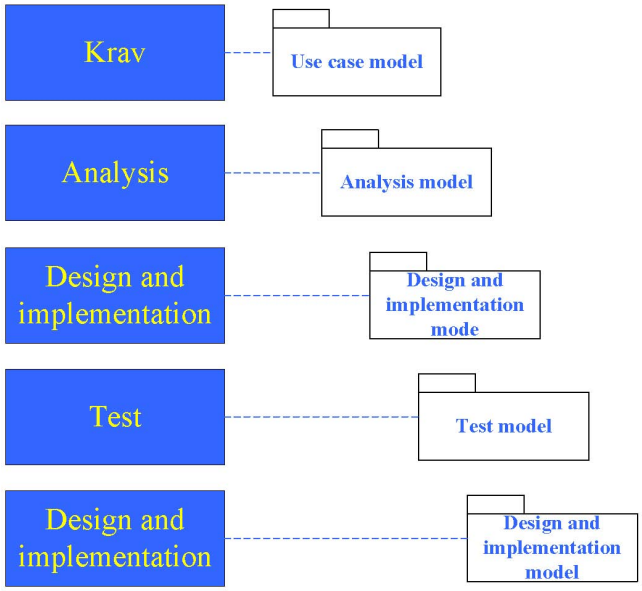

Figure A.1: *Illustration showing the UP-disciplines and the chosen models.*

In every of the shown disciplines, there have been used some specific models. These models offer opportunities to choose specific types of UML2 diagrams under the development process.

- Use case model: use case diagrams, use case specification and specification requirement.
- Analysis model: activity diagram, analysis classes and system structure.
- Design and implementation model: GUI-design.
- Test model: white box-, black box- and alpha test.

Appendix B

Literature review

The literature review done in this study is presented here in this chapter. The topic for literature review was computer-based learning and children.

Literature was sourced from keyword searches of electronic databases, key journals in the field and a general search of the internet. Selected criteria include papers with relevance to children and computer-based learning with a game aspect. The criteria were used to identify relevant literature for inclusion in the thesis.

Computer-based learning and children

Healy and Connolly (2007) conducted an experimental study, where the aim was to compare game-based learning with traditional learning among 30 children aged 9- to 10-years. The results supports that game-based learning can benefit the learning experience and improve the academic performance of the child. [Healy and Connolly, 2007]

In another study, where 133 participants was enrolled in a study, where socio-cultural theory united with augmented reality (AR) were tested among 9- to 10 year children, it was found that the children used AR were less engaged than the control group. This study provides evidence that games themselves not always are motivating. [Kerawalla et al., 2006]

Virvou and colleagues (2005) carried out a trial, where a tutoring system with and without a game interface were studied. The test subjects were fourth graders, approximately 9 years old children. Here the results showed the learners, who used the game interface, were those, who achieved the highest improvement. The authors suggest that the success of the game can be attributed to the support (e.g. advise), which were added in the game. But this study revealed that the same support weren't effective, when using without the game interface. [Virvou et al., 2005]

Serrano and Anderson (2004) tried in at study to teach bilingual children in the fifth grade (10 years) about the food pyramid and better eating habits. The results indicate that the children gained better knowledge about the food pyramid and nutrition. The only flaw in this study was that the control group had no instruction. Therefore this study only show, that game-based learning is better than nothing. [Serrano and Anderson, 2004]

Another study where the same mistake was done, it was in a study by Brown and co-workers (1997). The purpose here was to assess the effectiveness of a video game to teach young diabetic patient aged 8 to 16 years about diabetes. The results show that the experiment group displayed a better understanding for diabetes self-management and by that improved self-management behaviours and increased communication to the parents about the disease. However in this study the control group was not given diabetes-related instructions. [Brown et al., 1994]

Rowe (2001) compared two card games, which should help 9- to 13-years students in area of mathematics. The results of the study illustrated that one of the card games was found to improve the learner's performance. [Rowe, 2001]

In a experimental test done by Thompson (2003), where the effects of playing chess on scholastic performance were investigated among 508 students from grades 6 to 12 (11 to 18 years), game-based learning had no effect. [Thompson, 2003]

Koran and McLaughlin (1990) compared the effectiveness of a drill and practice game for teaching basic multiplications. This were tested among 28 students in the fifth grade (10 years) and the results showed that the conventional teaching and the teaching game both were equally effective, however the students preferred the game.
[Koran and McLaughlin, 1990]

Rosas and colleagues (2003) studied the effects of the introduction of game-based learning into a classroom, especially on learning, motivation and classroom dynamics. This study was conducted using 1274 first- and second-grade students (6- and 7 years). The results showed no difference in the performance between the test and control group. [Rosas et al., 2003]

In another study the main objective was to determine the effects of control, challenge and complexity on learner involvement. The effects were studied using a sample of 300 children in the age 5 years and 9 months to 12 years and 3 months, where the mean age was 8 years and 11 months. The results showed that learner involvement increased, when the player had more control of the game. Further the results showed that complexity united with challenge increased the learner involvement. [Wishart, 1990]

Appendix C

Diagrams

Use case specifications

Display info about diabetes and lifestyle

Main flow of events
This use case starts, when the user initiate the use case 'Start program'. This initiation should show the content (i.e. information about diabetes and lifestyle) of the program. It is stated in the system description that the user should be evaluated when using the system. Therefore there is «include» relationship between this use case and the use case 'Answer questions'.

Exceptional flow of events
The user can exit the program at any time by clicking on the cross located in the uppermost right at the interface.

Functional requirements
The system should display information about diabetes and lifestyle.

The system should allow the user to be evaluated.

The system should allow the user at any time to exit the program.

Answer questions

Main flow of events
This use case begins after the use case 'Display info about diabetes and lifestyle'. This because the use case 'Answer questions' is included in the use case 'Display info about diabetes and lifestyle'.
Under this use case it should be possible for the user to answer question, which can be used to evaluate, whether the user has learned anything in relation to diabetes and lifestyle.

Exceptional flow of events
The user can exit the program at any time by clicking on the cross located in the uppermost right at the interface.

Functional requirements
The system should provide an option to evaluate, whether the user has learned anything in relation to diabetes and lifestyle.

The system should allow the user at any time to exit the program.

Show gain score

Main flow of events
This use case starts after the use case 'Answer questions'. This because the use case 'Show gain score' is included in the use case 'Answer questions'.
Under this use case it should be possible to show the user how good the user has performed under the system's incorporated evaluation. This score can be used to determine, whether the user has learned anything regard diabetes and lifestyle.

Exceptional flow of events
The user can exit the program at any time by clicking on the cross located in the uppermost right at the interface.

Functional requirements
The system should make it possible to show the user how good their performance has been under the evaluation of the system.

The system should allow the user at any time to exit the program.

Exit program

Main flow of events
This use case is initiated, when the user in the main menu chooses to exit the program. Furthermore the user can exit the program at any time by clicking on the cross located in the uppermost right at the interface.

Functional requirements
The system should allow the user at any time to exit the program.

Activity diagrams

Display info about diabetes and lifestyle

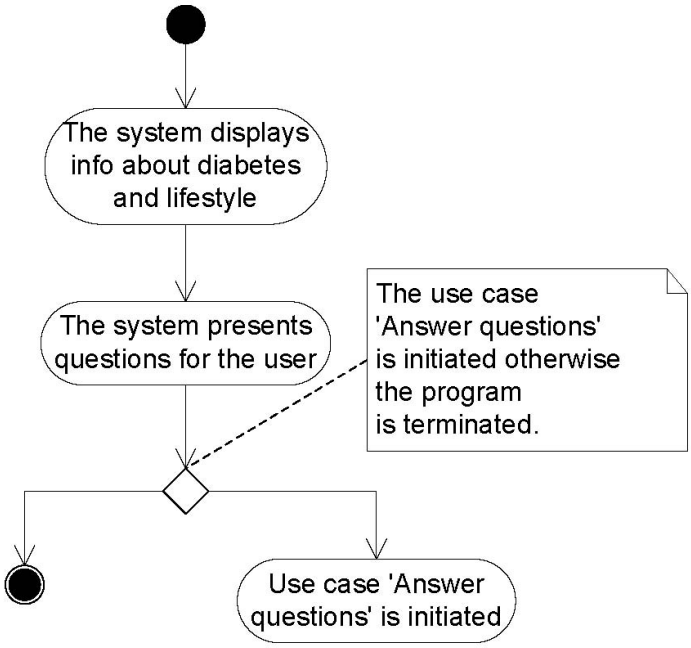

Figure C.1: *Illustration showing the activity diagram based on use case 'Display info about diabetes and lifestyle'.*

The activity 'Display info about diabetes and lifestyle' is started when the child wants to display the program. This action causes the system to display info about diabetes and lifestyle. The child is furthermore presented for questions by the system. Hereafter the use case 'Answer questions' is initiated. The child can anytime in the program choose to exit the program.

Answer questions

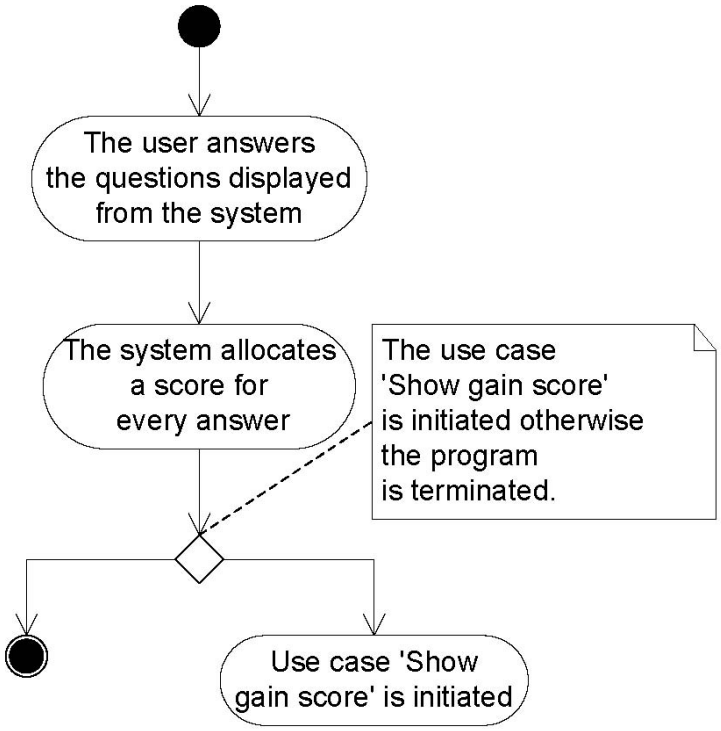

Figure C.2: *Illustration showing the activity diagram based on use case 'Answer questions'.*

The activity 'Answer questions' is active when the system presents the child for questions. These questions are expected to be answered from the child. The system allocates a score for the questions the child has answered. Hereafter the use case 'Show gain score' is initiated. The child can anytime in the program choose to exit the program.

Show gain score

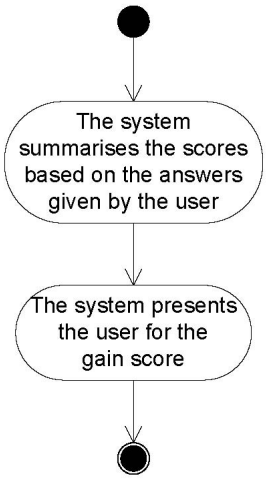

Figure C.3: *Illustration showing the activity diagram based on use case 'Show gain score'.*

The activity 'Show gain score' begins when the system has summarised the scores for the child. The system presents the child for the gain score. The child can anytime in the program choose to exit the program.

Exit program

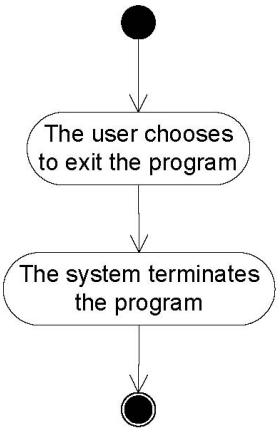

Figure C.4: *Illustration showing the activity diagram based on use case 'Exit program'.*

The activity 'Exit program' begins when the child chooses to exit the program. This action triggers the system to terminate the program. The child can anytime in the program choose to exit the program.

Appendix D

Screenshots - version 1

All the GUIs for PreD2Care is presented in this chapter. The interfaces would appear in the same order as they would do in the program. These versions of the GUIs are those that have been usability tested.

Introduction interfaces

Figure D.1: *Interface 1.*

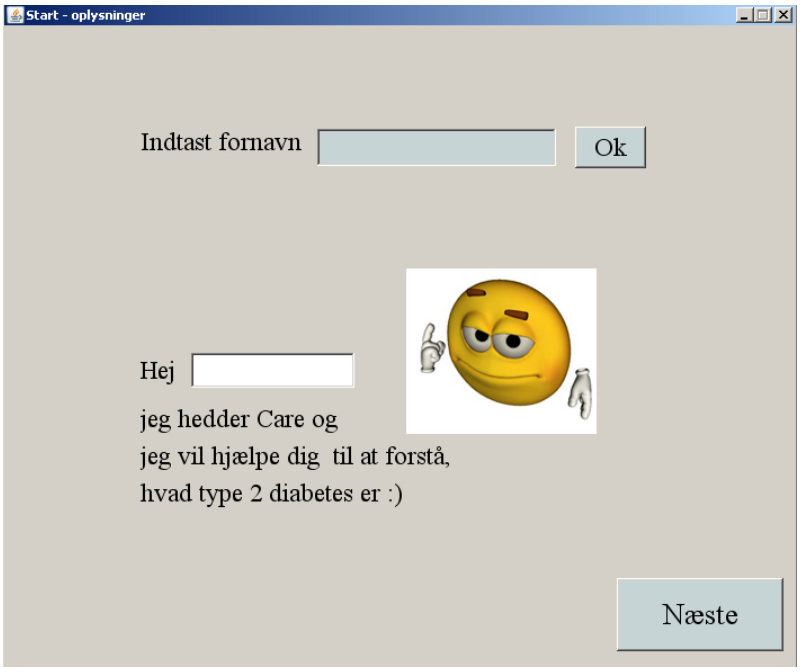

Figure D.2: *Interface 2.*

Interfaces about diabetes

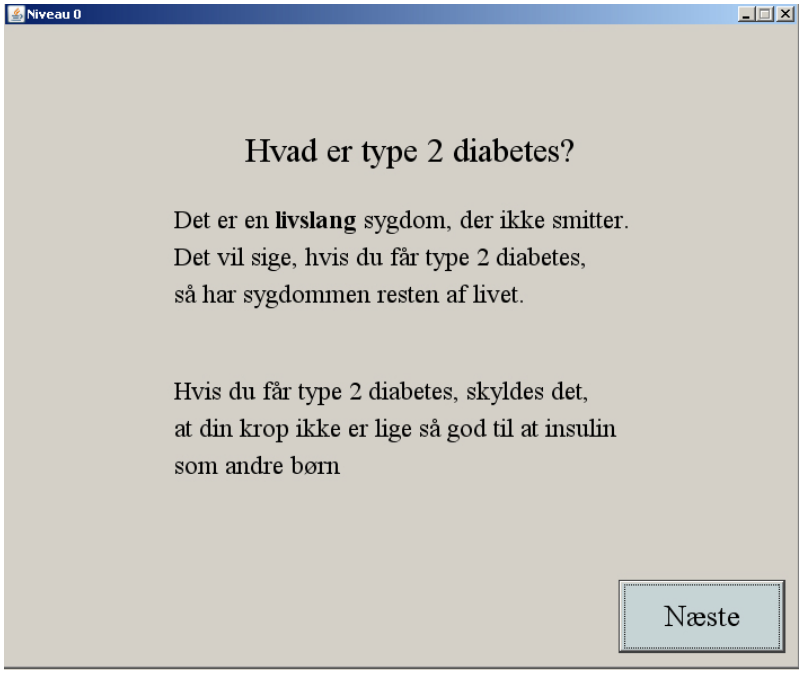

Figure D.3: *Interface 3.*

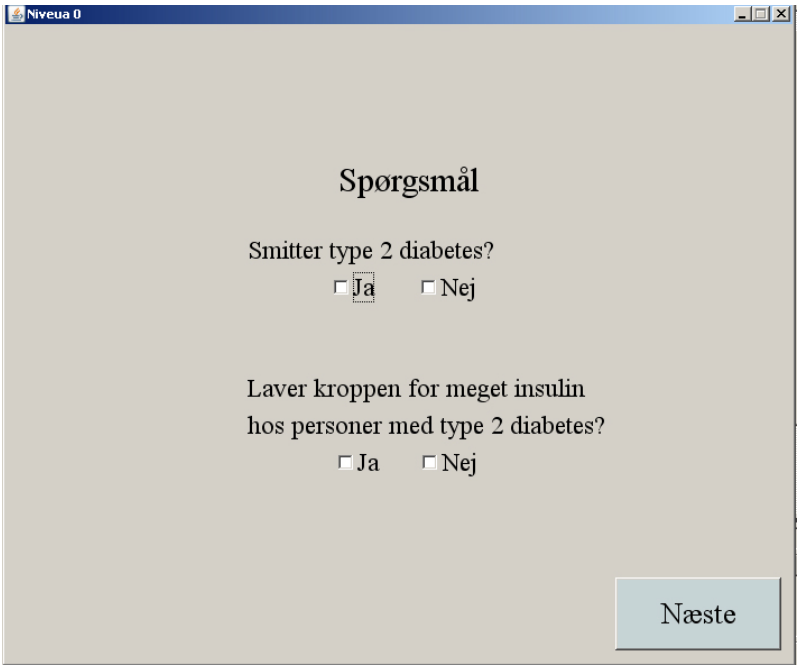

Figure D.4: *Interface 4.*

Interfaces about insulin

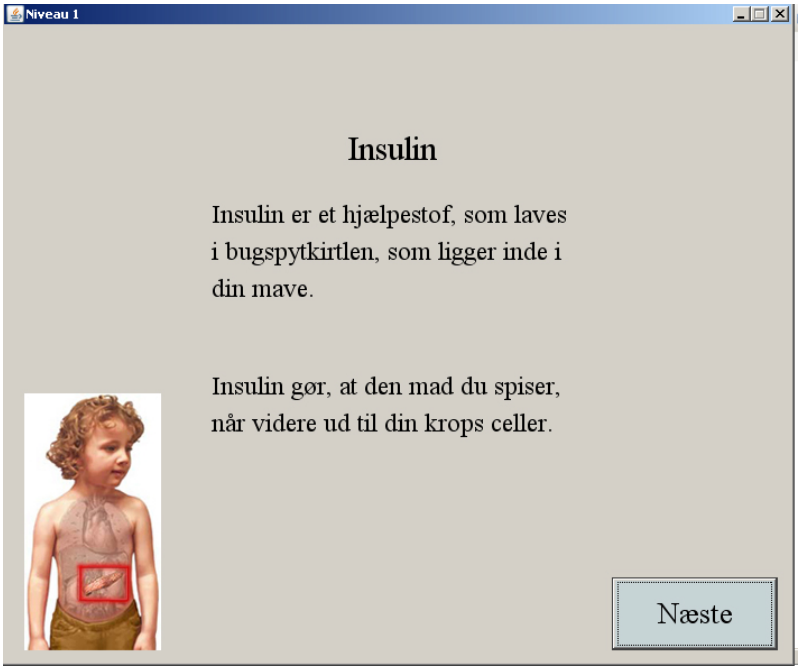

Figure D.5: *Interface 5.*

Figure D.6: *Interface 6.*

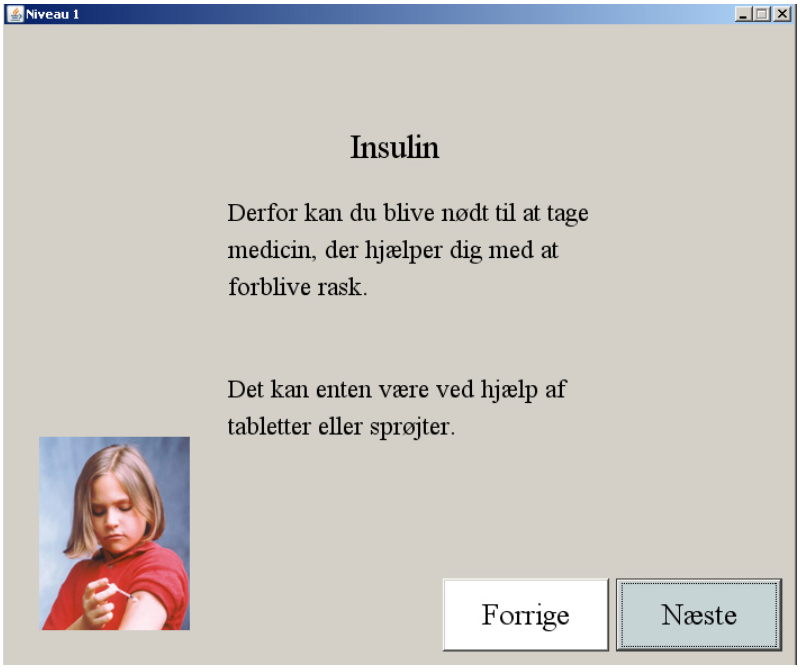

Figure D.7: *Interface 7.*

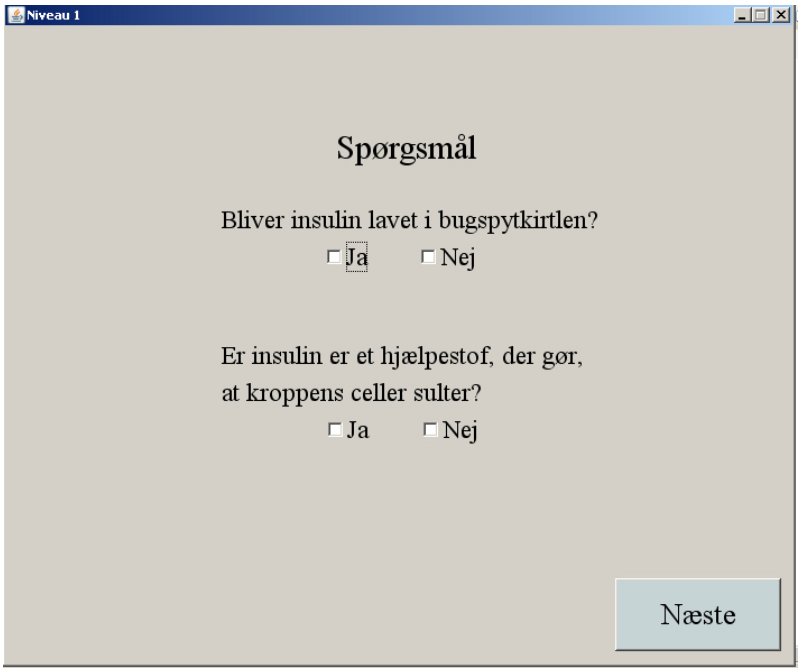

Figure D.8: *Interface 8.*

Interfaces about inheritance

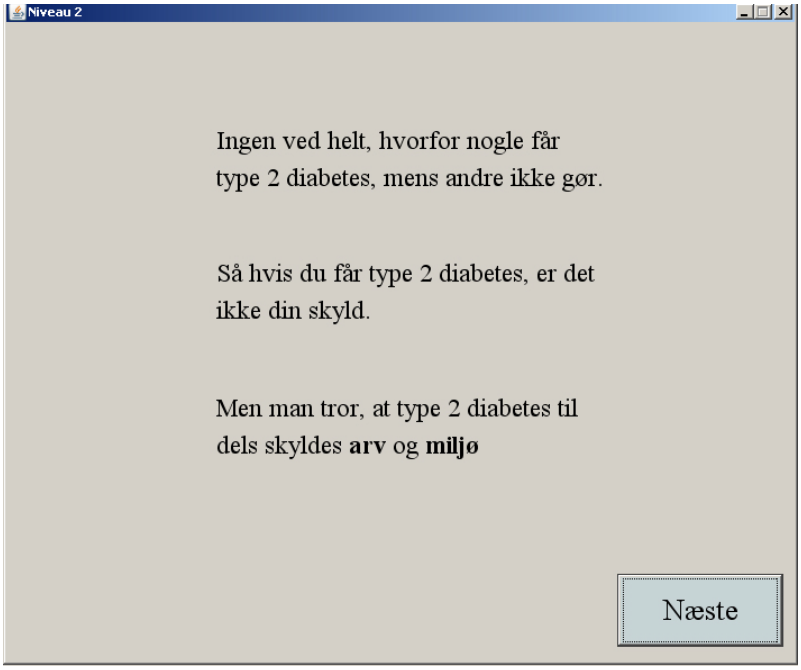

Figure D.9: *Interface 9.*

Figure D.10: *Interface 10.*

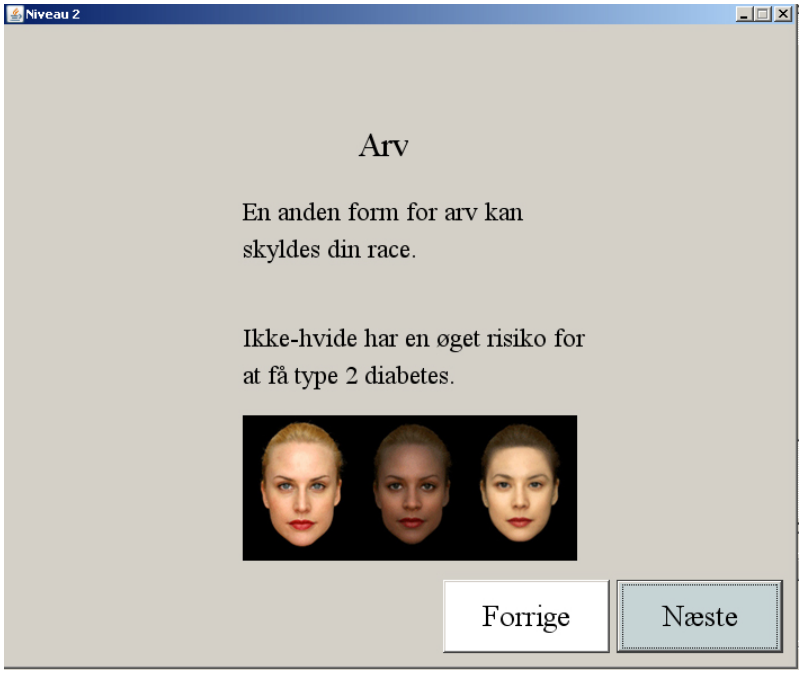

Figure D.11: *Interface 11.*

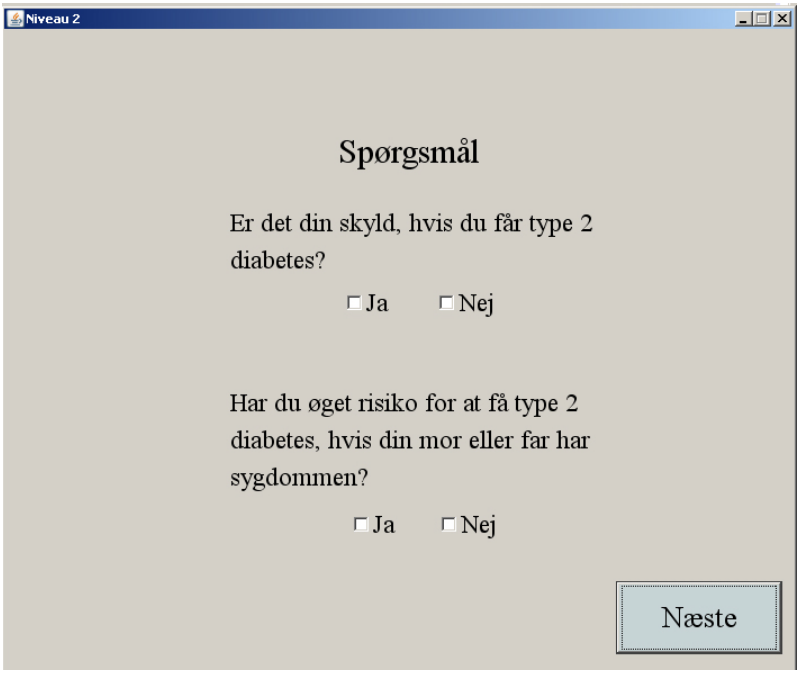

Figure D.12: *Interface 12.*

Interfaces about diet

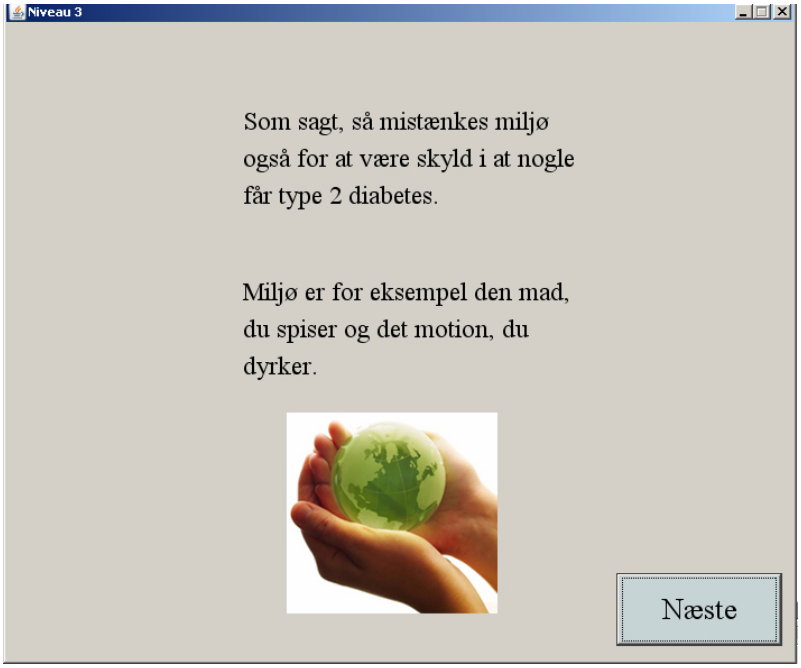

Figure D.13: *Interface 13.*

Figure D.14: *Interface 14.*

Figure D.15: *Interface 15.*

Figure D.16: *Interface 16.*

Figure D.17: *Interface 17.*

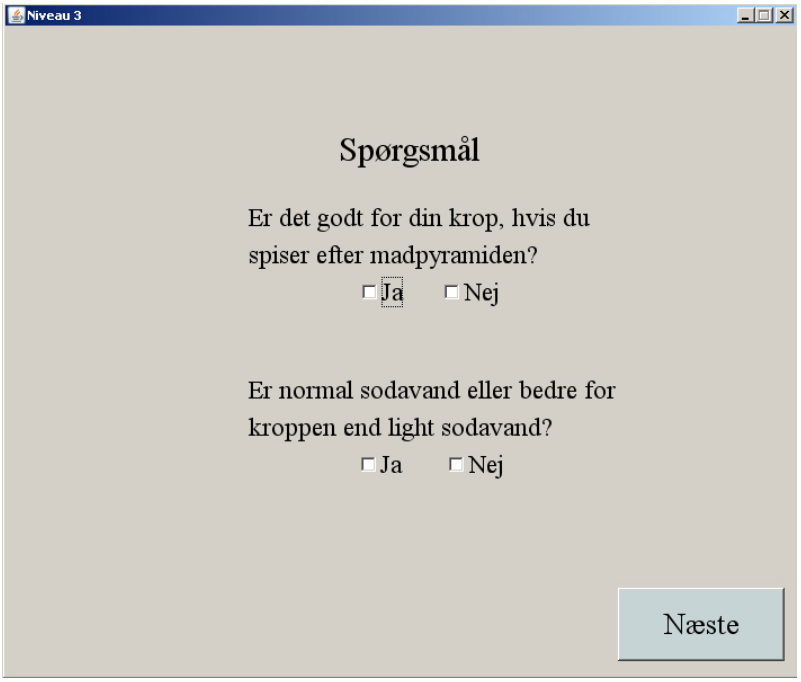

Figure D.18: *Interface 18.*

Interfaces about exercise

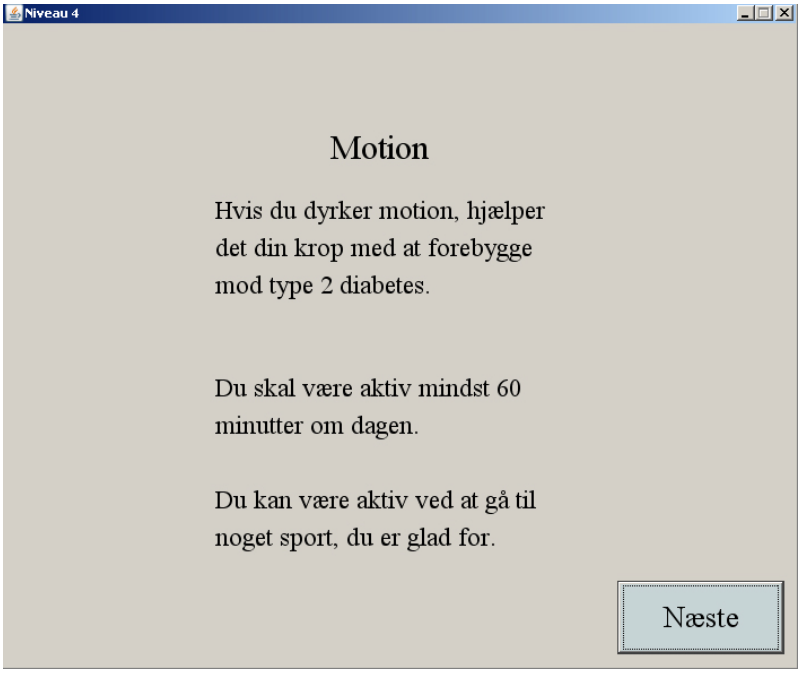

Figure D.19: *Interface 19.*

Figure D.20: *Interface 20.*

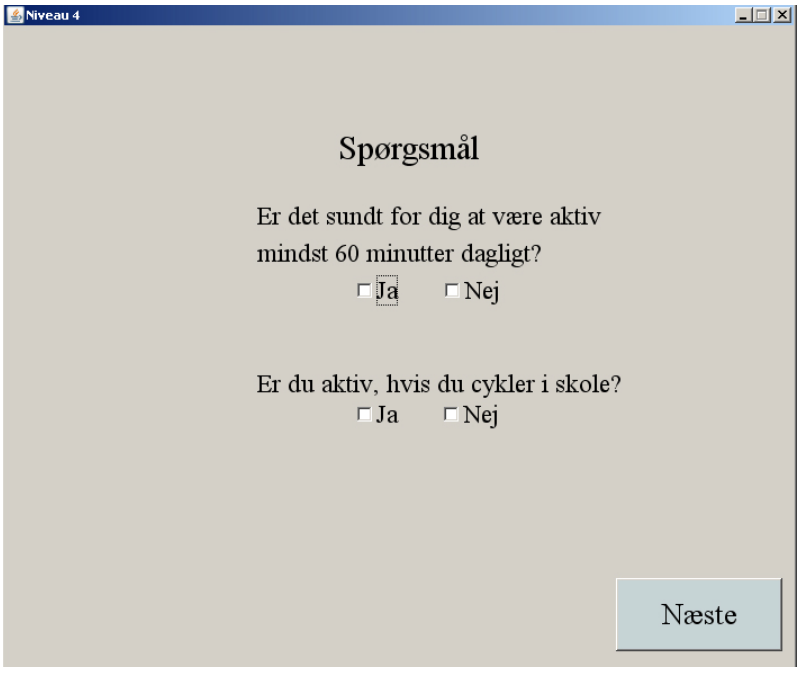

Figure D.21: *Interface 21.*

Second reminder interfaces

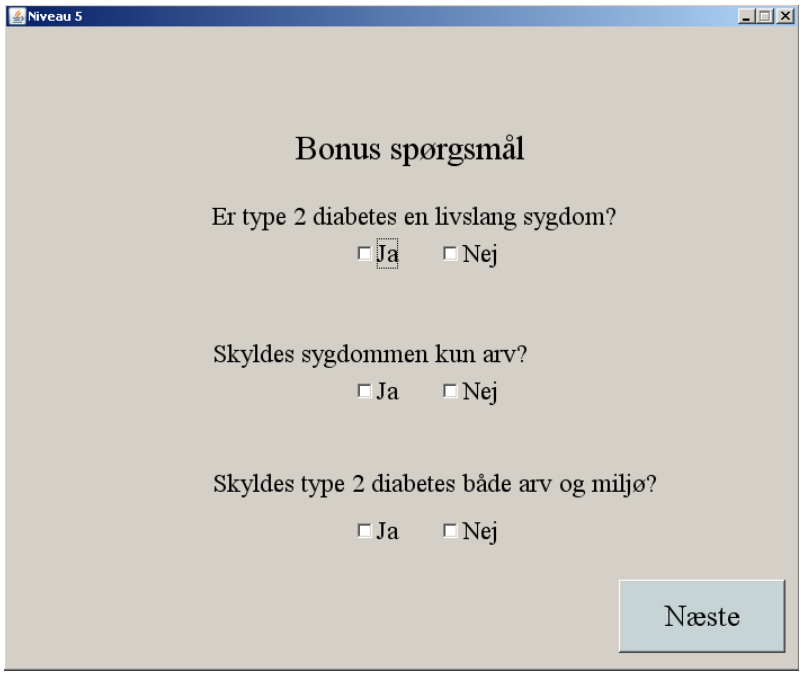

Figure D.22: *Interface 22.*

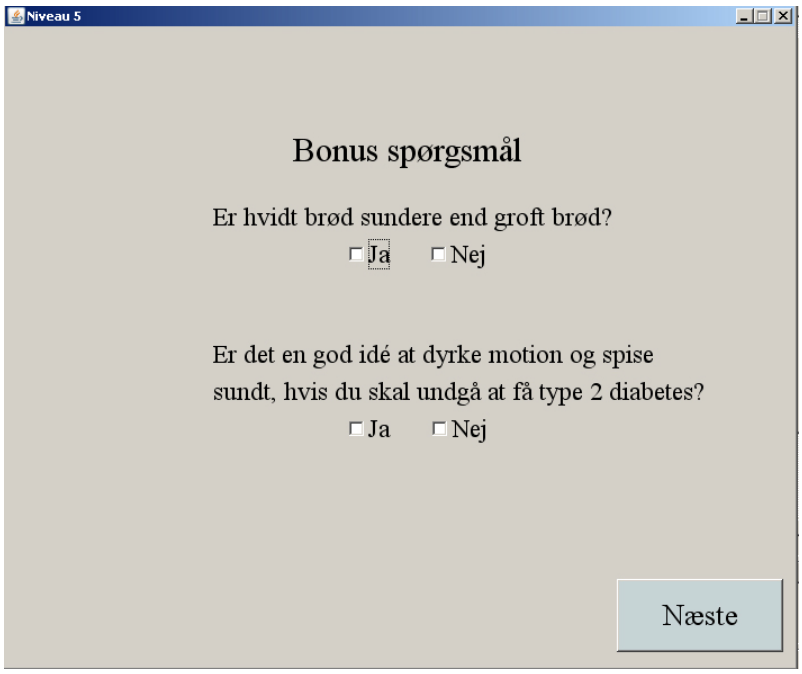

Figure D.23: *Interface 23.*

Last interface

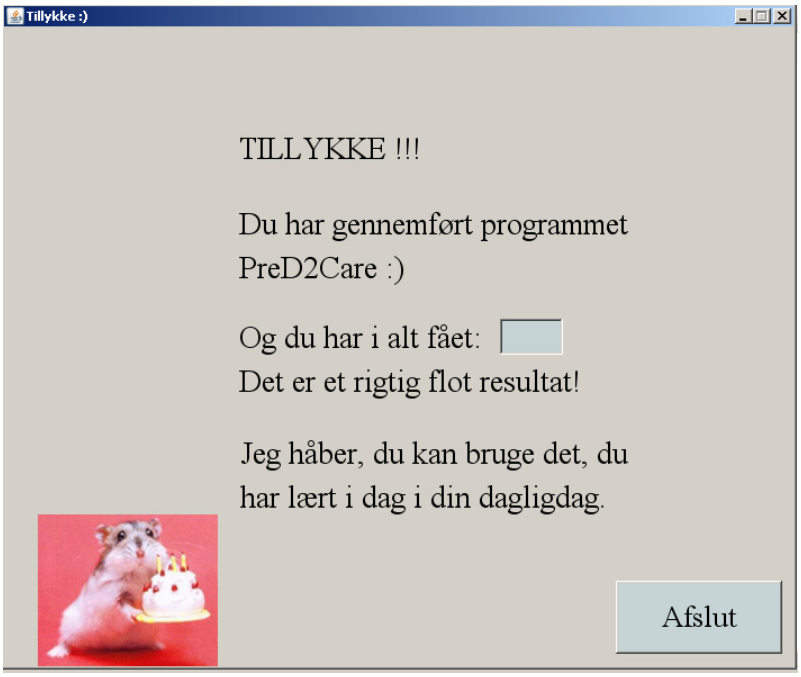

Figure D.24: *Interface 24.*

Appendix E

Test results

Case 1, 2 and 4 is completed correctly by all the test participants. Test results for case 3 would be presented in this chapter.

Test participant 1

Background (Pre-test) Questionnaire

This is used to confirm and elaborate info from the screening prior to the test and to collect demographics.

- Hvad hedder du?
  xxxxxxx.
- Hvor gammel er du?
  8 år.
- Hvad er dit køn?
  Pige.
- Hvor høj er du?
  1,35 m.
- Hvor meget vejer du?
  26 kg.
- Body Mass Index (BMI) = 14,9.
- Har du type 2 diabetes?
  Nej.
- Har din mor eller far type 2 diabetes?
  Ja, min far.
- Har du før hørt omkring type 2 diabetes?
  Ja, lidt.
  - Hvis ja, hvor?
    Fra min klasselærer.

- Spiser du grøntsager og frugt?
  Ja, mest frugt.
  - Hvis ja, og en skala fra 1 til 10 bliver brugt, hvor 1 er meget lidt og 10 er rigtig meget. Hvor ligger du i forhold til grøntsager og frugt?
    Skala = 5.
- Går du til noget sport?
  Nej, ikke lige i øjeblikket. Jeg går til Skjern Garden. Men ellers har jeg tidligere gået til håndbold og svømning.
  Men jeg leger med mine kammerater i skolens frikvartere.
- Cykler du i skole?
  Nogle gange, men jeg bliver for det meste kørt i skole.
- Har du en computer derhjemme?
  Ja.
- Hvad med intetnet?
  Ja.

Results

First test

The end user read the text.

- The end user finished the program in 16 minutes.
- The participant obtained a score of: 50 point of 100 point. The answers were as follow:
  - Normal questions
    ja, nej, nej, ja, nej, nej, nej, ja, ja og ja. (5 point for each of the right answers.)
  - Bonus questions
    nej, ja, ja, nej og ja. (10 point for each of the right answers.)

The Benchmark settings for the test were not met.

Second test

I read the text for the participant.

- The end user finished the program in 10 minutes.
- The participant obtained a score of: 75 point of 100 point. The answers were as follow:
  - Normal questions
    ja, nej, ja, nej, nej, ja, nej, ja, ja og ja.
  - Bonus questions
    ja, nej, ja, ja og ja.

The Benchmark settings for the test were met.

Post-test Questionnaire

This questionnaire is used to acquire preference information from the end users. The focus is on opinions and feelings.

- Var teksten svær at læse?
  Ja.
  - Hvilke ord var mest besværlige?
    (We went through the program again. The suggestion from the end user for renaming is written after the arrow.)
    Type 2 diabetes → **sukkersyge**; insulin; livslang; hjælpestof → **stof**; bugspytkirtel; celler; race; arv; miljø → **din måde at leve på**; øget → **højere**; risiko → **chance**; mistænkes → **tror man**; motion → **sport**; næring → **vitaminer**; groft brød → **rugbrød**; McDonalds → ***her kunne symbolet for McDonalds anvendes***; gengæld → **i stedet for**; light → **cola zero**; dyrker sport → **går til sport**; gøre følgende → ***dette måtte godt slettes***; PreD2Care → ***dette måtte godt slettes***; dagligdag → **hverdag**.
  - Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
    Skala = 6.

- Forstår du hvad type 2 diabetes er?
  Ja.
  - Hvis ja, beskriv med egne ord, hvad det er.
    Det er, når man ikke kan tåle sukker. Og hvis man spiser meget sukker og fedt, så kan man få sukkersyge.

- Var spørgsmålene svære? Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
  Ja. Skala = 5.

- Hvad synes du om, at du får point for dine svar i programmet?
  Jeg er glad for det.

- Synes du de billeder, der er brugt i programmet, er billeder, der hjælper dig til at forstå programmets tekst?
  Nogle af billederne hjalp mig.
  (We went through the program again.)
  Smiley-billede: følte det som om, det var smileyen, der sagde teksten.
  Bugspytkirtel-billede: var glad for den røde firkant, der viste, hvor bugspytkirtlen lå.
  Insulinshot-billede: viste, pigen tog en sprøjte mod sin sukkersyge.
  Familie-billede: tænker på en familie, men ville gerne have et mere realistisk billede.
  Race-billede: ok, men manglede tekst til billedet, såsom hvid & ikke-hvid.
  Miljø-billede: den var ikke god.
  Madpyramide-billede: den var ok, men ville gerne have tekst til billedet.
  Gymnastik-pige-billede: ville foretrække flere billeder, der hver viste de situationer, der stod i teksten.

Mus-billede: var rigtig glad for at det var et dyr, der var blevet brugt. Min egen favorit ville have været en hund i stedet for en mus.

- Hvad synes du om de farver, der er valgt?
  Ok
  - Hvis din mening ikke er så god, hvilke farver burde der være valgt?
    Der i starten, kunne man god have skiftet om på farverne. Så ´Start´ var hvid og ´Afslut´ var farvet.
    Følte at den farvet knap var blevet brugt, og derfor skulle den knap, der skulle bruges være hvid.
    Favorit-farver: rød, hvid og gul.
- Hvad synes du til at blive undervist omkring et emne ved brug af et computerprogram?
  Jeg synes, det er sjovere at bruge en computer til undervisning. Jeg spiller også nogle matematik-spil på nettet.
- Efter at have prøvet programmet, hvad føler du omkring din egen livsstil? Dvs. dine følelser omkring, du spiser rigtig, dyrker nok motion osv.
  Jeg synes, min måde at spise og være aktiv er ok.

My observations

The test participant was seeking my approval for her choices under the test.
Furthermore the use of 'enter' was automatic under the task 'Write your name'. But when the program didn't respond to this, the end user resolve the problem by using the 'Ok'-button.
After the session, the test participant asked if it was possible for her to try the program by herself. This was of course granted. Hereafter I could observe that the participant went to the kitchen after a rye bread.

Test participant 2

Background (Pre-test) Questionnaire

This is used to confirm and elaborate info from the screening prior to the test and to collect demographics.

- Hvad hedder du?
  xxxxxx.
- Hvor gammel er du?
  9 år.
- Hvad er dit køn?
  Pige.
- Hvor høj er du?
  1,38 m.

- Hvor meget vejer du?
  30 kg.
- BMI = 16,6.
- Har du type 2 diabetes?
  Nej.
- Har din mor eller far type 2 diabetes?
  Nej.
- Har du før hørt omkring type 2 diabetes?
  Nej.
- Spiser du grøntsager og frugt?
  Ja.
  - Hvis ja, og en skala fra 1 til 10 bliver brugt, hvor 1 er meget lidt og 10 er rigtig meget. Hvor ligger du i forhold til grøntsager og frugt?
    Skala = 7.
- Går du til noget sport?
  Nej. Jeg har gået til håndbold.
- Cykler du i skole?
  Ja.
- Har du en computer derhjemme?
  Ja.
- Hvad med intetnet?
  Ja.

Results

First test

The end user read the text.

- The end user finished the program in 12 minutes.
- The participant obtained a score of: 65 point of 100 point. The answers were as follow:
  - Normal questions
    nej, ja, ja, ja, ja, nej, ja, ja, ja og ja. (5 point for each of the right answers.)
  - Bonus questions
    ja, ja, ja, nej og ja. (10 point for each of the right answers.)

The Benchmark settings for the test were met.

Second test

I read the text for the participant.

- The end user finished the program in 9 minutes.
- The participant obtained a score of: 75 point of 100 point. The answers were as follow:
  - Normal questions
    nej, ja, ja, ja, nej, ja, nej, ja, ja og ja.
  - Bonus questions
    ja, nej, ja, nej og ja.

The Benchmark settings for the test were met.

Post-test Questionnaire

This questionnaire is used to acquire preference information from the end users. The focus is on opinions and feelings.

- Var teksten svær at læse?
  Ja.
  - Hvilke ord var mest besværlige?
    (We went through the program again. The suggestion from the end user for renaming is written after the arrow.)
    Type 2 diabetes → **sukkersyge**; insulin; hjælpestof; bugspytkirtel; celler; miljø → **din måde at leve på**; risiko; groft brød → **rugbrød**; light → **cola zero**; PreD2Care.
  - Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
    Skala = 5.
- Forstår du hvad type 2 diabetes er?
  Ja.
  - Hvis ja, beskriv med egne ord, hvad det er.
    Det er, når en person bliver syg og bagefter ikke må spise sukker.
- Var spørgsmålene svære? Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
  Ja. Skala = 5.
- Hvad synes du om, at du får point for dine svar i programmet?
  Det synes, jeg er godt.
- Synes du de billeder, der er brugt i programmet, er billeder, der hjælper dig til at forstå programmets tekst?
  Ja.
  (We went through the program again.)

Smiley-billede: smileyen snakker.
Bugspytkirtel-billede: bugspytkirtlen er tegnet på drengen. Det var rigtig godt. For jeg viste ikke, hvor det lå før.
Insulinshot-billede: det var godt.
Familie-billede: et familebillede.
Race-billede: jeg kunne ikke helt finde mig selv..
Miljø-billede: Jeg ved ikke helt.
Madpyramide-billede: den er god.
Gymnastik-pige-billede: okay.
Mus-billede: et sødt billede

- Hvad synes du om de farver, der er valgt?
  De er fine.
  - Hvis din mening ikke er så god, hvilke farver burde der være valgt?
    Det ville være rarere med rød også.
- Hvad synes du til at blive undervist omkring et emne ved brug af et computerprogram?
  Det synes jeg er godt. Jeg kan godt lide at bruge computeren.
- Efter at have prøvet programmet, hvad føler du omkring din egen livsstil? Dvs. dine følelser omkring, du spiser rigtig, dyrker nok motion osv.
  Jeg synes måske, jeg skulle være lidt mere aktiv end nu.

My observations

The test participant was seeking my approval for her choices under the test.
Furthermore the test participant expressed several times, that it was good to learn using a computer.

Test participant 3

Background (Pre-test) Questionnaire

This is used to confirm and elaborate info from the screening prior to the test and to collect demographics.

- Hvad hedder du?
  xxxxxx.
- Hvor gammel er du?
  10 år.
- Hvad er dit køn?
  Dreng.
- Hvor høj er du?
  1,25 m.

- Hvor meget vejer du?
  21 kg.
- BMI = 13,6.
- Har du type 2 diabetes?
  Nej.
- Har din mor eller far type 2 diabetes?
  Ja, min far.
- Har du før hørt omkring type 2 diabetes?
  Nej.
- Spiser du grøntsager og frugt?
  Ja.
  - Hvis ja, og en skala fra 1 til 10 bliver brugt, hvor 1 er meget lidt og 10 er rigtig meget. Hvor ligger du i forhold til grøntsager og frugt?
    Skala = 5-6.
- Går du til noget sport?
  Ja.
  - Hvis ja, hvilken eller hvilke?
    Jeg går til fodbold og taekwondo.
- Cykler du i skole?
  Nej, men skal til at gøre det efter sommerferien.
- Har du en computer derhjemme?
  Ja.
- Hvad med intetnet?
  Ja.

Results

First test

End user read the text.

- The end user finished the program in 7 minutes.
- The participant obtained a score of: 90 point of 100 point. The answers were as follow:
  - Normal questions
    nej, ja, ja, nej, nej, ja, ja, nej, ja og nej. (5 point for each right answer)
  - Bonus questions
    ja, nej, ja, nej og ja. (10 point for each right answer)

The Benchmark settings for the test were met.

Second test

I read the text for the participant.

- The end user finished the program in 6 minutes.
- The participant obtained a score of: 85 point of 100 point. The answers were as follow:
  - Normal questions
    nej, ja, ja, nej, nej, ja, ja, nej, ja og nej.
  - Bonus questions
    ja, nej, ja, nej og ja.

The Benchmark settings for the test were met.

Post-test Questionnaire

This questionnaire is used to acquire preference information from the end users. The focus is on opinions and feelings.

- Var teksten svær at læse?
  Nej, ikke rigtig.
  - Hvilke ord var mest besværlige?
    (We went through the program again. The suggestion from the end user for renaming is written after the arrow.)
    Care → **andet navn**; Type 2 diabetes → **sukkersyge**; insulin; bugspytkirtel; race; miljø → **levemåde**; McDonalds → ***her kunne symbolet for McDonalds anvendes af hensyn til jævnaldrende, der ikke kan læse ordet.***
  - Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
    Skala = 1-2.
- Forstår du hvad type 2 diabetes er?
  Ja.
  - Hvis ja, beskriv med egne ord, hvad det er.
    Det har noget at gøre med arv og miljø. Man mangler vist insulin. Og hvis man spiser usundt, så får man sukkersyge. Sukkersyge har brug for medicin ligesom pigen, den tog den dér sprøjte.
- Var spørgsmålene svære? Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
  De lå midt imellem. Skala = 4-5.
- Hvad synes du om, at du får point for dine svar i programmet?
  Jeg synes, det er en god idé. Så kan man sammenligne sine point med ens kammerater.

- Synes du de billeder, der er brugt i programmet, er billeder, der hjælper dig til at forstå programmets tekst?
  Billederne var ok.
  (We went through the program again.)
  Smiley-billede: det var som om, smileyen siger teksten.
  Bugspytkirtel-billede: ville være rart med en pil fra ordet til billedet.
  Insulinshot-billede: var glad for billedet.
  Familie-billede: kan godt slettes.
  Race-billede: glad for den, men ønskede forklaring til billedet.
  Miljø-billede: kan godt slettes.
  Madpyramide-billede: rigtig god.
  Gymnastik-pige-billede: godt billede.
  Mus-billede: havde ikke tænkt så meget over det uder programmet. Men synes lidt, at lagkagen var et symbol for noget usundt. Så det undrer mig nu. Kunne her have brugt en smiley i stedet for.

- Hvad synes du om de farver, der er valgt?
  Dem kunne jeg godt lide. Foretrækker ikke andre farver.

- Hvad synes du til at blive undervist omkring et emne ved brug af et computerprogram?
  Det synes, jeg er rigtig god ide. Så kan man nemlig forstå emnet i ens eget tempo.

- Efter at have prøvet programmet, hvad føler du omkring din egen livsstil? Dvs. dine følelser omkring, du spiser rigtig, dyrker nok motion osv.
  Jeg føler, jeg har en god livsstil.

My observations

The test participant was seeking my approval for his choices under the start of the test.

Test participant 4

Background (Pre-test) Questionnaire

This is used to confirm and elaborate info from the screening prior to the test and to collect demographics.

- Hvad hedder du?
  xxxx.

- Hvor gammel er du?
  12 år.

- Hvad er dit køn?
  Dreng.

- Hvor høj er du?
  1,46 m.

- Hvor meget vejer du?
  37 kg.
- BMI = 17,3.
- Har du type 2 diabetes?
  Nej.
- Har din mor eller far type 2 diabetes?
  Nej.
- Har du før hørt omkring type 2 diabetes?
  Nej.
- Spiser du grøntsager og frugt?
  Ja, lidt.
  - Hvis ja, og en skala fra 1 til 10 bliver brugt, hvor 1 er meget lidt og 10 er rigtig meget. Hvor ligger du i forhold til grøntsager og frugt?
    Skala = 3.
- Går du til noget sport?
  Ja.
  - Hvis ja, hvilken eller hvilke?
    Jeg går til taekwondo.
- Cykler du i skole?
  Ja.
- Har du en computer derhjemme?
  Ja.
- Hvad med intetnet?
  Ja.

Results

First test

End user read the text.

- The end user finished the program in 6 minutes.
- The participant obtained a score of: 75 point of 100 point. The answers were as follow:
  - Normal questions
    nej, ja, ja, ja, ja, ja, ja, nej, ja og ja. (5 point for each right answer.)
  - Bonus questions
    ja, ja, ja, nej og ja. (10 point for each right answer)

The Benchmark settings for the test were met.

Second test

I read the text for the participant.

- The end user finished the program in 6 minutes.
- The participant obtained a score of: 90 point of 100 point. The answers were as follow:
  - Normal questions
    nej, nej, ja, ja, nej, ja, ja, nej, ja og ja.
  - Bonus questions
    ja, nej, ja, nej og ja.

The Benchmark settings for the test were met.

Post-test Questionnaire

This questionnaire is used to acquire preference information from the end users. The focus is on opinions and feelings.

- Var teksten svær at læse?
  Nej.
  - Hvilke ord var mest besværlige?
    (We went through the program again. The suggestion from the end user for renaming is written after the arrow.)
    Type 2 diabetes → **sukkersyge**; insulin; bugspytkirtel.
  - Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
    Skala = 3.
- Forstår du hvad type 2 diabetes er?
  Ja.
  - Hvis ja, beskriv med egne ord, hvad det er.
    Det er noget, man kan få, hvis man bare sidder hjemme og spiser. Det er godt at spise grøntsager og sådan noget. Og man vist også få sukkersyge, hvis ens forældre har sukkersyge.
- Var spørgsmålene svære? Hvis en skala fra 1 til 10 bliver brugt, hvor 1 er meget let og 10 det mest svære, du kan tænke dig. Hvor ligger sværhedsgraden?
  Lidt. Skala = 3.
- Hvad synes du om, at du får point for dine svar i programmet?
  Jeg synes, det er ok. Så kan jeg sammenligne mine point med min søsters.
- Synes du de billeder, der er brugt i programmet, er billeder, der hjælper dig til at forstå programmets tekst?
  De var i orden. Jeg kan lige nu kun huske drengen med den røde boks tegnet på maven. Det gør det sjovere at læse. Det ville have været kedeligt med kun tekst.
  (This participant expressed that there were no need to go through the program again.)

- Hvad synes du om de farver, der er valgt?
  De var okay. Måske kunne man også bruge grøn.
- Hvad synes du til at blive undervist omkring et emne ved brug af et computerprogram?
  Det synes, jeg er bedre end normal undervisning.
- Efter at have prøvet programmet, hvad føler du omkring din egen livsstil? Dvs. dine følelser omkring, du spiser rigtig, dyrker nok motion osv.
  Jeg synes, jeg spiser og motioner fint nok.

My observations

The test participant was more secure under the test compared with the other test participants.

Test evaluation

Successful Completion Criteria (SCC)

The SCC is used under the interpretation of the results. The SCCs for the test are as follows:

- The participant has to go through every user interface.
- Furthermore the end user has to answer all the questions in the program.

The above mentioned SCC for the test has been fully completed by the test participants.

Benchmark setting

The benchmark settings are defined to be the "hard numbers" for the performance. The benchmark settings for the test are:

- The end user has to finish the program within 15 minutes.
- The participant has to obtain a minimum score of: 60 point of 100 point.

The above listed benchmark settings are not acceptable for test participant 1's first test. In all the other tests the benchmark settings have been met. These tests include test participant 1's second test and test participant 2, 3 and 4's first and second test.

Appendix F

Screenshots - version 2

All the GUIs for the new version of PreD2Care is presented in this chapter. The interfaces would appear in the same order as they would do in the program. The GUIs are changed according to the test results from the usability test.

Introduction interfaces

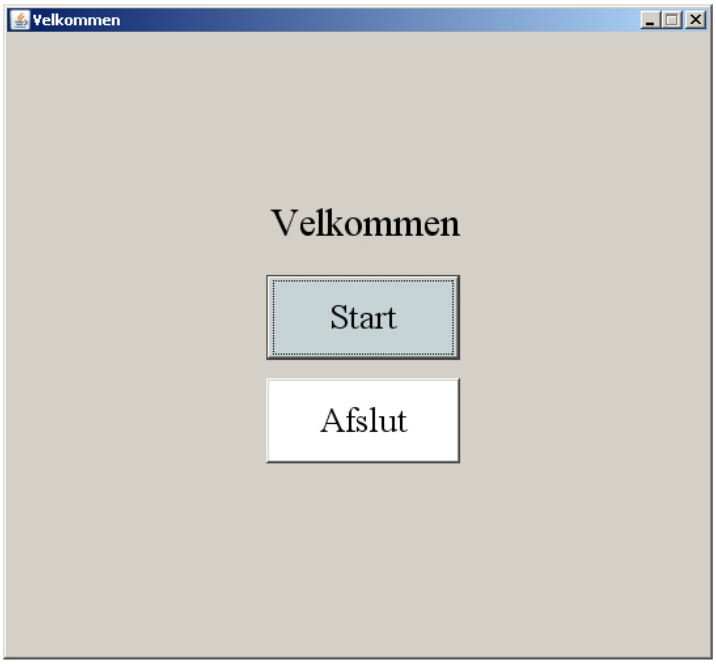

Figure F.1: *Interface 1.*

Figure F.2: *Interface 2.*

Interfaces about diabetes

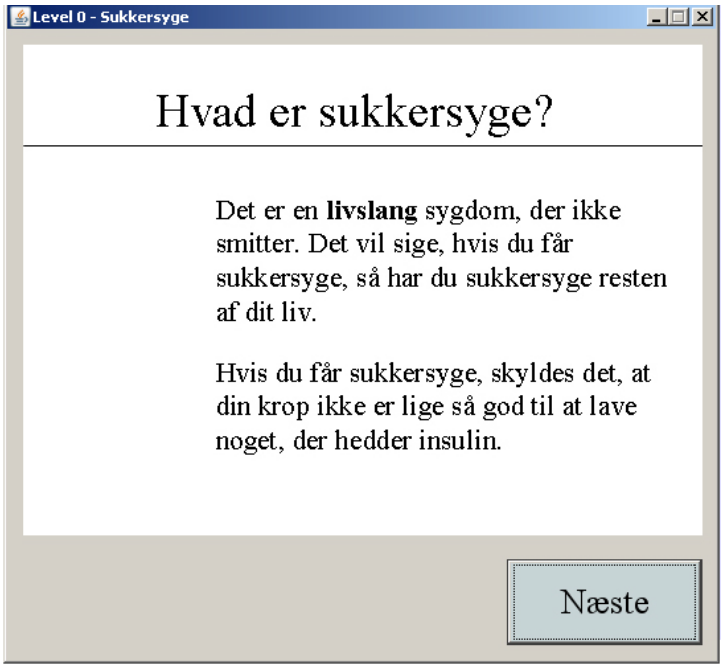

Figure F.3: *Interface 3.*

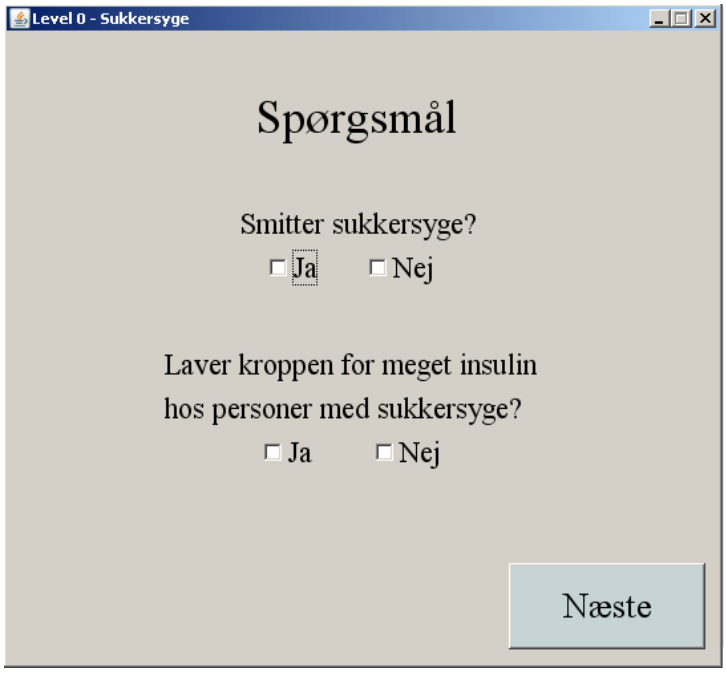

Figure F.4: *Interface 4.*

Interfaces about insulin

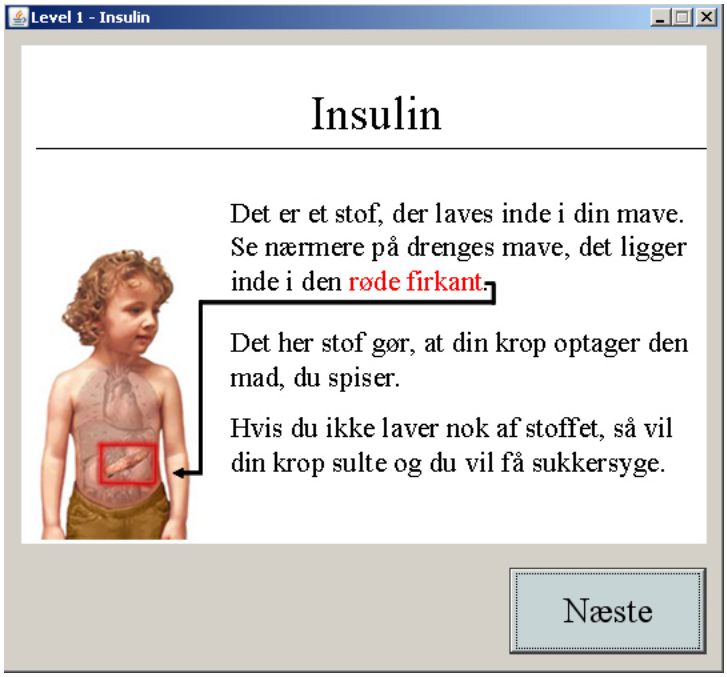

Figure F.5: *Interface 5.*

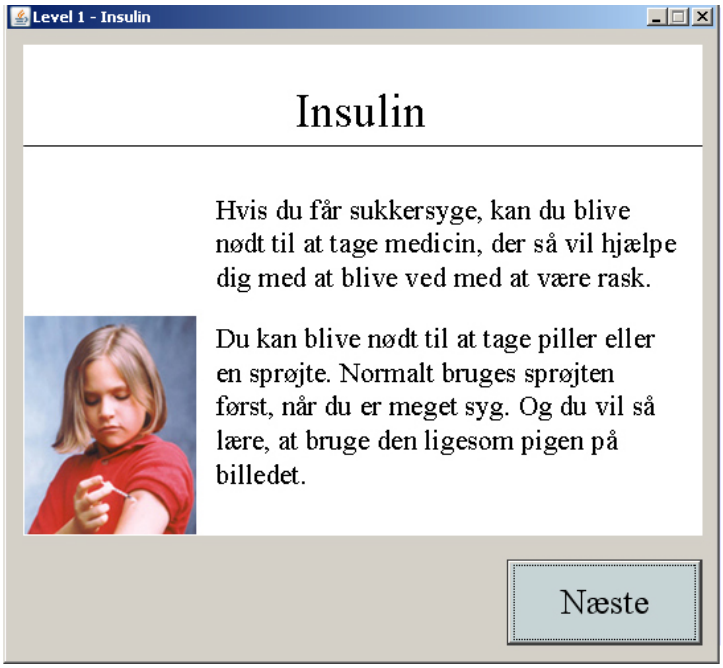

Figure F.6: *Interface 6.*

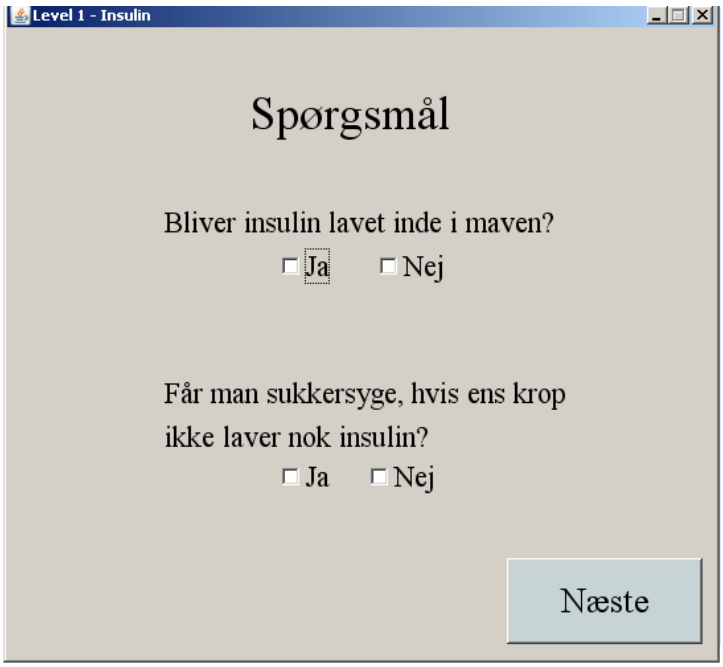

Figure F.7: *Interface 7.*

Interfaces about inheritance

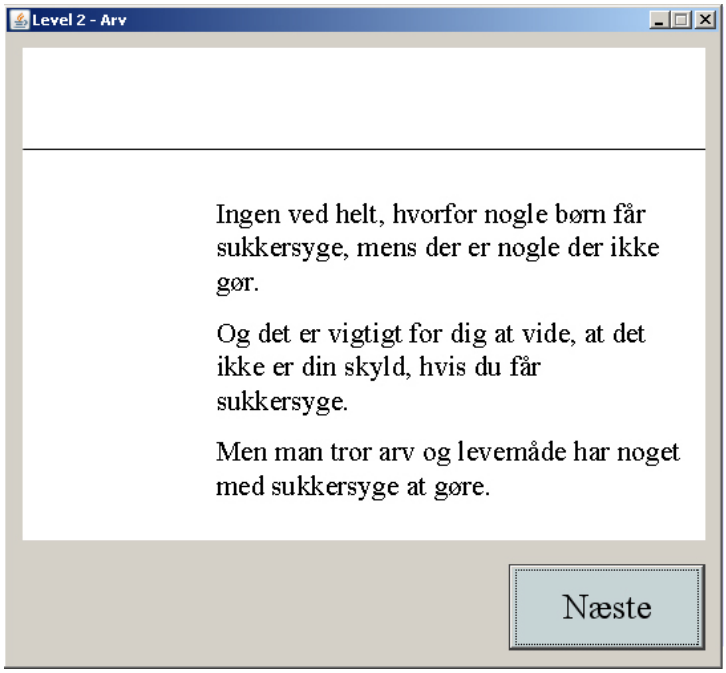

Figure F.8: *Interface 8.*

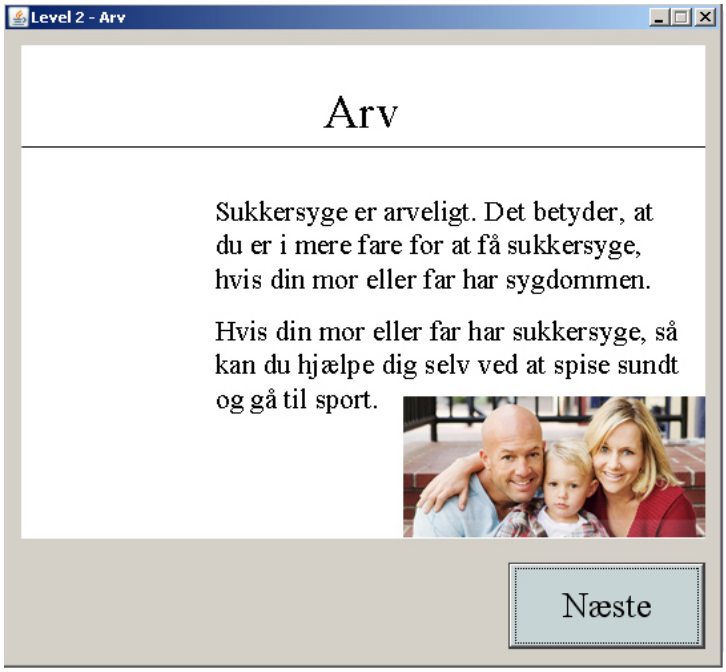

Figure F.9: *Interface 9.*

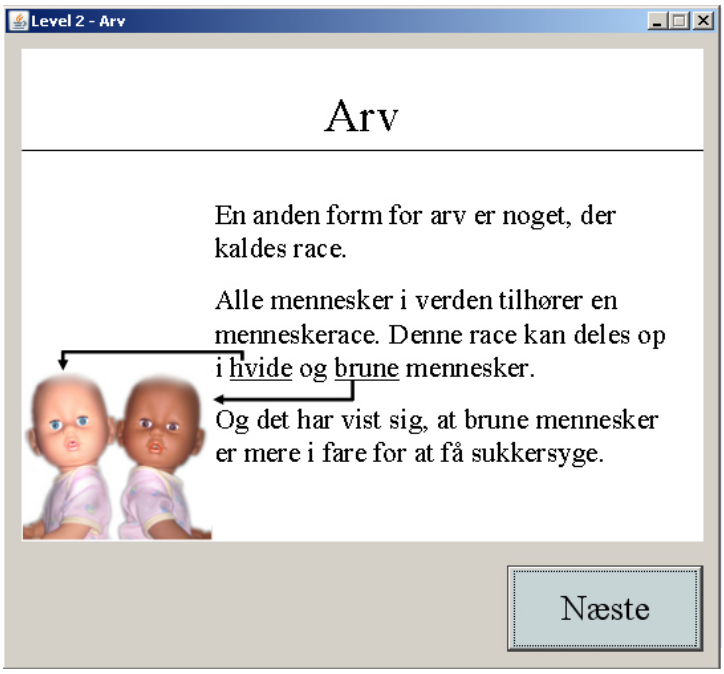

Figure F.10: *Interface 10.*

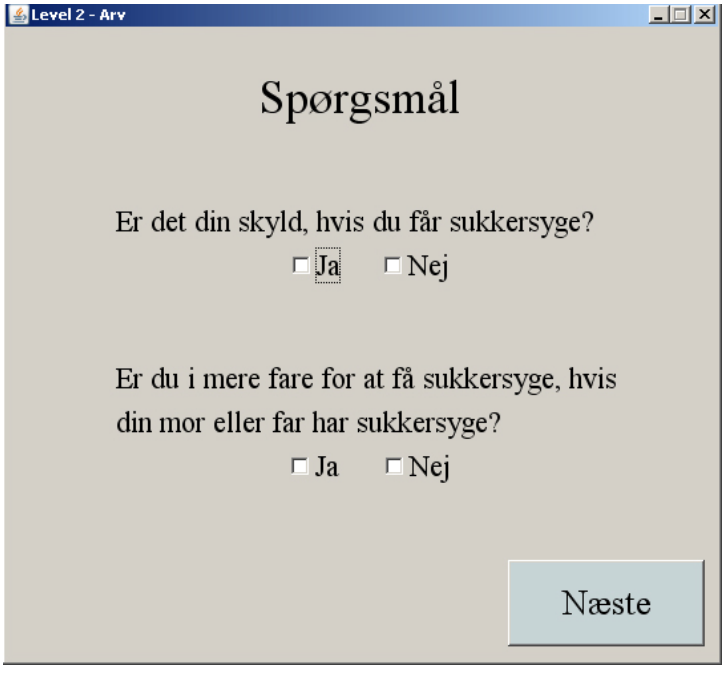

Figure F.11: *Interface 11.*

Interfaces about diet

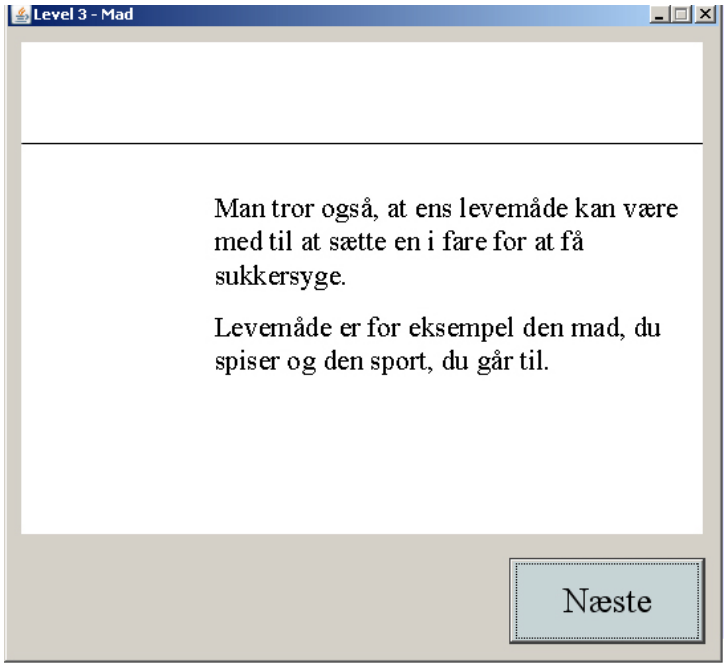

Figure F.12: *Interface 12.*

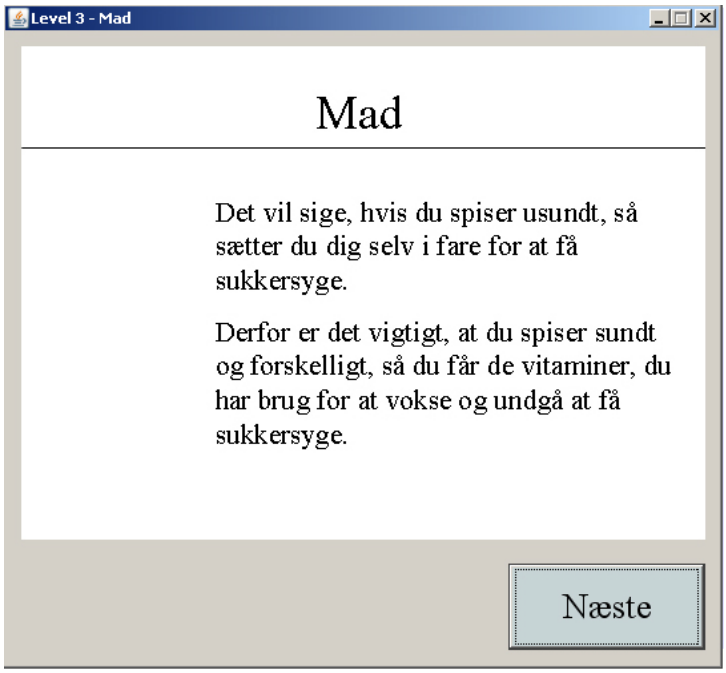

Figure F.13: *Interface 13.*

Figure F.14: *Interface 14.*

Figure F.15: *Interface 15.*

Figure F.16: *Interface 16.*

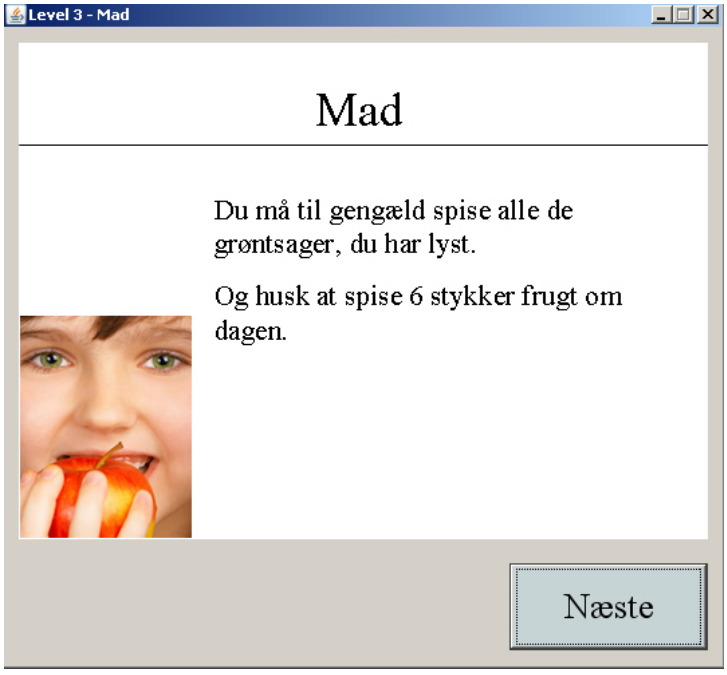

Figure F.17: *Interface 17.*

Figure F.18: *Interface 18.*

Interfaces about exercise

Figure F.19: *Interface 19.*

Figure F.20: *Interface 20.*

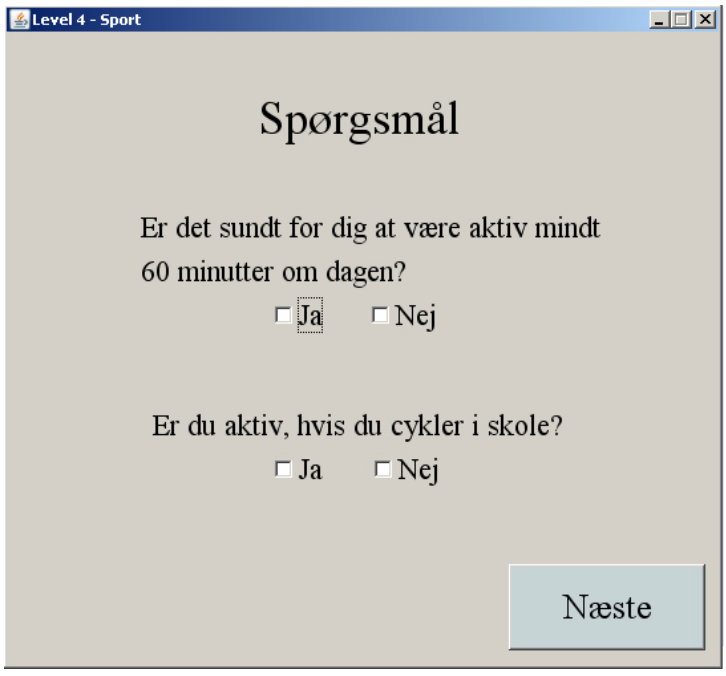

Figure F.21: *Interface 21.*

Second reminder interfaces

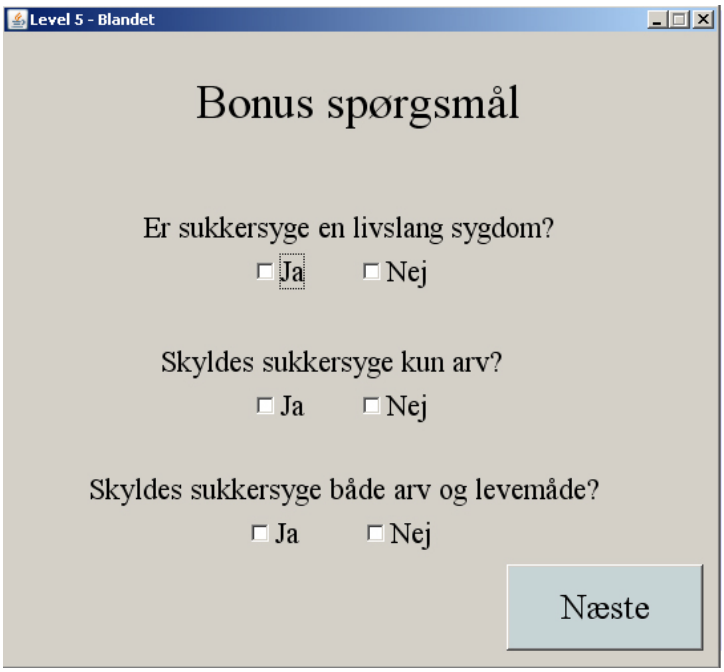

Figure F.22: *Interface 22.*

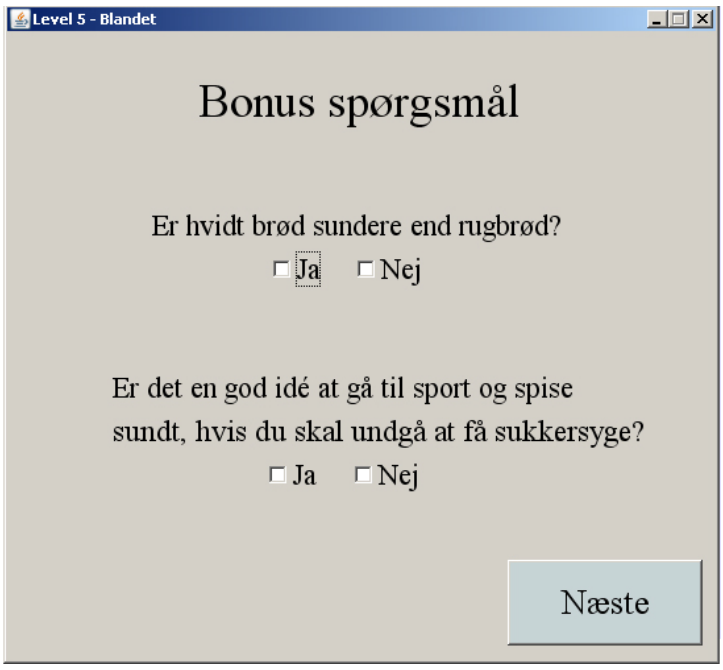

Figure F.23: *Interface 23.*

Last interface

Figure F.24: *Interface 24.*

A Pedagogical Tool for Lifestyle Intervention in Children at Risk of Developing Type 2 Diabetes

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Abstract

Type 2 diabetes is emerging among children all around in the world. The reason is the modern lifestyle, which is characterized with high caloric intake and little physical activity.

It is not known, if Type 2 diabetes can be prevented by using a pedagogical tool to intervene with children's lifestyle.

Four test subjects (two girls and boys; mean age=9.75; mean BMI=15.6) conducted heuristic evaluation of the system over two courses. The first test was conducted, where the test subjects went through the program's user interface by reading on their own accord. In the second test the reading was done by the experimenter.

The mean point (out of 100 point) achieved after the first test was 70 point and second test was 81.25 point.

The results indicate that it is possible for children to gain knowledge about Type 2 diabetes and lifestyle using a pedagogical tool. Knowledge is believed as the first step towards lifestyle changing behaviour and finally improved health.

'***Keywords: Type 2 diabetes, children, pedagogical tool, prevention and heuristic evaluation.***

Introduction

The incidence of Diabetes Mellitus is increasing worldwide. The World Health Organization (WHO) has in 2003 estimated 150 million diabetics worldwide and furthermore predicted this number to rise to 300 million people by 2025. Type 2 diabetes is generally believed to counter 90% of the cases of diabetes and Type 1 diabetes, secondary diabetes etc. the remaining 10% [1].
This tendency has lately also been noticeable among children, in both developed and developing countries [2] Recent studies indicate that 8-45% of new-onset pediatric diabetes cases in USA may be Type 2 diabetes. [3,4,5,6,7,8,9]
Furthermore researchers have predicted that the prevalence of Type 2 diabetes in American children is expected to exceed that of Type 1 within 10 years [5].

The problem is however not urgent in Denmark, where <1% of children and adolescents are diagnosed with Type 2 diabetes [10] But it is thought to be a major health issue in the future in Denmark. Therefore it is of crucial importance to realize the possibility of a worst case scenario, where the health situation in Denmark becomes as it is in USA. In order to prevent or at least reduce the impact it will be causing the individual, health care and society, the time has come to take action.

Type 2 diabetes results from both inheritance and lifestyle. And it is believed that modifiable risk factors such as obesity and physical inactivity play a viable role in Type 2 diabetes. [11] It is therefore in these areas, the prevention of Type 2 diabetes should be done.
The first step towards influencing the children's lifestyle is through the gain of knowledge of the optimal lifestyle and how unhealthy lifestyle can increase the risk of Type 2 diabetes. The steps towards improved health are shown in figure 1.

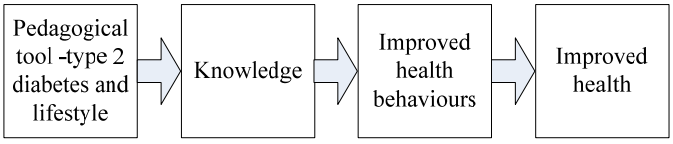

Figure 1- The steps towards improved health.

This paper presents a study that investigates a pedagogical tool for lifestyle intervention in children between 7 and 12 years at risk of developing Type 2 diabetes. It is furthermore investigated how this program intervene with the current lifestyle of the target group

Materials and Methods

System design

The design of the pedagogical tool is based on the following structure:

- Information interfaces concluding with a reminder interface (level 0-4: diabetes, insulin, inheritance, diet and exercise).
- Second reminder interfaces (level 5).

Information interfaces concluding with a reminder interface

These interfaces treat the topic of Type 2 diabetes and lifestyle. One issue regarding this topic is information about

where insulin is produced and that reduced production of insulin will result in diabetes (see figure 2).

After this information has been presented for the user, a reminder interface with questions regarding the completed topic will appear. The purpose of the reminder interfaces is to unconsciously reminding the user of the information, the user has been presented (see figure 3).

The answers given by the user to the questions indicate how much knowledge the user has gained in matter of short-term-memory knowledge.

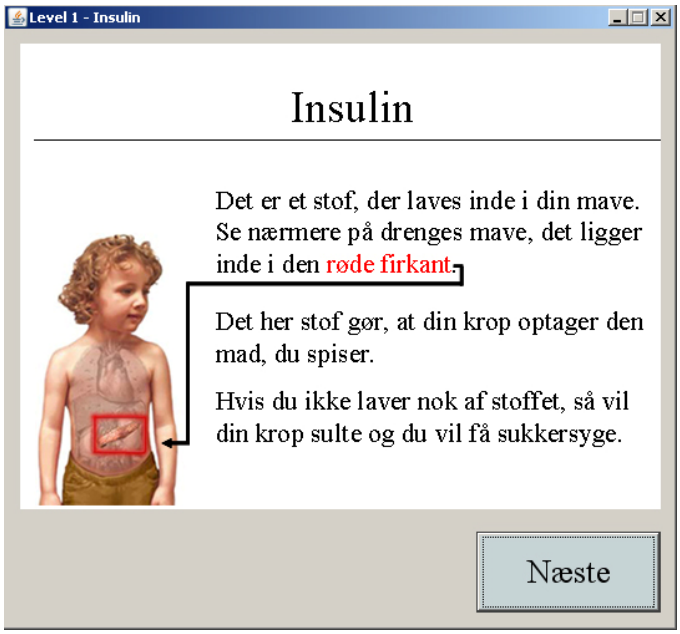

Figure 2- Screenshot o f one of the program's information interfaces about insulin.

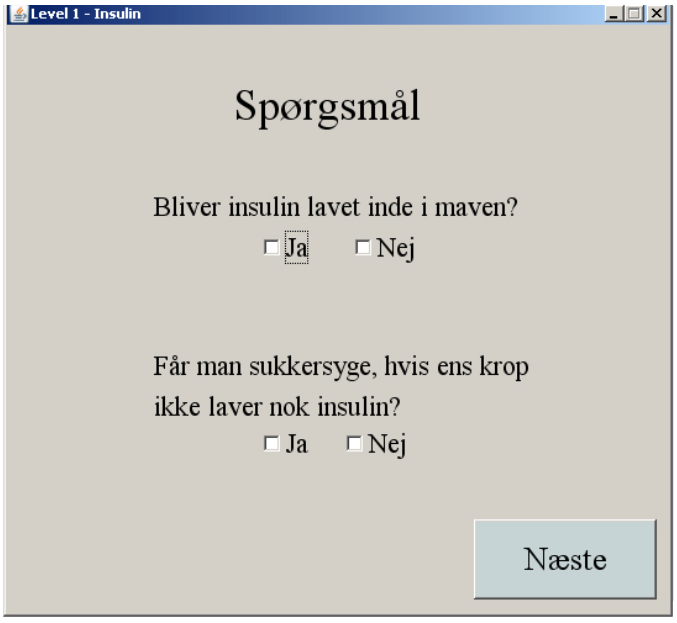

Figure 3- Screenshot of the program's insulin reminder interface.

Second reminder interfaces

These interfaces are the last attempt to get the user to think about the information the pedagogical tool has been presenting.

The answers given by the user to theses questions indicate how much the user has gained in matter of long-term-memory knowledge.

In the end of the program, the user was given a gain score. This number is based on the answers the user has given under the first reminder interfaces (5 point to every correct answer) and in the second reminder interfaces (10 point to every correct answer). The maximum gain score was 100.

Figure 4- Screenshot of the program's last interface.

Patient data and selection criteria

The data available to evaluate the system were gathered in 2009 from children in Denmark.
All children were non-diabetic. Data contained information about the scores achieved from the first and second test. The inclusion criteria for test subjects in this study were that the subject was between the age 7 to 12 years and non-diabetic. Four test subjects were selected for this study.

Table 1 – Description of test subjects used to evaluate the system.

Test subject	Age	Sex	BMI	Diabetes
1	8	Female	14.9	No
2	9	Female	16.6	No
3	10	Male	13.6	No
4	12	Male	17.3	No

Data analysis

The system was implemented and evaluated using Java (Netbeans IDE 6.5).
This study examined a pedagogical tool about Type 2 diabetes and lifestyle by the use of heuristic evaluation. Average gain scores
This study examined the average gain scores. The first test was conducted hence the test subjects did go through the program's user interface by reading on their own accord. In the second test the reading was done by the experimenter. Gain scores were used as evidence for the obtainment of knowledge. The second test was conducted to determine, whether there were a need for implement audio in the system. To this there were also collected an additional factor, the length of the test.
A post-test questionnaire has also been completed. This has been used to evaluate the pedagogical toll's level of difficulty and to determine if this level was appropriate for the target group.

Results

The children testing the system all expressed enjoyment by using a computer program as an alternative to conventional learning about the topic.
Furthermore the collected data indicated that the level of difficulty was higher than acceptable and it was decided together with the test subjects that the use of medical terms should be as limited as possible.

Table 2 presents the gain scores and the collected length of the tests.

Table 2 – The test subject's gain scores and test lengths.

Test subject	Test 1		Test 2	
	Gain score (max. 100)	Test length [min]	Gain score (max. 100)	Test length [min]
1	50	16	75	10
2	65	12	75	9
3	90	7	85	6
4	75	6	90	6

Table 3 presents the average gain scores and test lengths for test 1 and 2 for all test subjects. Furthermore average values from test subjects 1+2 (aged 8 and 9 years) and test subjects 3 +4 (aged 10 and 12 years) have been shown in table 3.

Table 3 – The average gain scores and test lengths.

Test subject	Test 1		Test 2	
	Ave-rage gain score	Average test length [min]	Ave-rage gain score	Average test length [min]
All	70	10.25	81.25	7.75
1+2	57.5	14	75	9.5
3+4	82.5	6.5	87.5	6

Discussion

Type 2 diabetes has recently been observed in children and adolescents in both developed and developing countries. Researchers has stated that 8-45% of new-onset pediatric diabetes cases in USA may be of Type 2 diabetes [3,4,5,6,7,8,9]. Furthermore researchers have predicted that the prevalence of Type 2 diabetes in American children is expected to exceed that of Type 1 within 10 years [5].

In Denmark <1% of children and adolescents are diagnosed with Type 2 diabetes [10]. But it is believed to be a major health issue in the future in Denmark. Therefore it is of crucial importance to take precautions in order to prevent the outbreak of Type 2 diabetes in children and adolescents.
It is believed that knowledge about the issues Type 2 diabetes and lifestyle is the first step towards lifestyle changing behaviour and finally improved health. This knowledge is therefore needed to be presented for the children in a way they understand it.

In this study the performance of a pedagogical tool about Type 2 diabetes and lifestyle was evaluated.

System performance

This study demonstrated that a pedagogical tool for children can provide knowledge obtainment in the area of Type 2 diabetes and lifestyle.

The performance of the program was evaluated using four test subjects and therefore the obtained results can't be generalized to all children but rather express a tendency. But experience has shown that four users will expose 70% of the usability problems when using heuristic evaluation [12]. This experience-based evidence has indicated that the results from this study can be generalized for children between the age 7 and 12 years.

The results from table 3 indicate strongly that the program's level of difficulty is a little high for the children aged 8 to 9 years and a little low for the children aged 10 and 12 years. From these results it can be concluded that a one-size-fits-all program can not be used in the age group between 7 to 12 years. It is necessary to implement two entries to the program. So children aged 7 to 9 years will be introduced for the

program in a lower level of difficulty than the children aged 10 to 12 years.
The possibility to include audio assistance for the youngest participants should be considered. This conclusion is based on the results from table 2, where the youngest children (test subject 1 and 2) obtained a higher gain score under the second test. Test subject's 1 gain score under the second test was 33.3% higher compared to the first test. For test subject 2 this number was 13.3%.

Future developments

The pedagogical tool could also be delivered online. The use of internet has worldwide risen in the last couple of years, where it in the period 1994 to 2000 has risen from 3 to 377 million users [13].
This increase has not only happened in the developing countries. Recent studies have indicated that the demographics of the internet use is shifting, the typical user is changing from being a white man with a socioeconomic status. The internet moves towards becoming a commercial medium. [14]
Research has emphasized a tendency, where children and adolescents are using internet to search for health information [15]. The internet enables the user to explore topics in a confidential and anonymous way [16].
Furthermore the use of internet as a delivery source would allow the program to be updated with new features and the user would continue to be motivated to use the tool.

As the technology becomes more powerful, it will be possible to design a health education tool that assesses individual preferences, abilities and learning styles. Furthermore the tool would make it possible to tailor the content and format (e.g. ± audio) to suit the need of the individual.
This is mainly because a pedagogical tool with a variety of content and challenges would have a better chance of maintaining interest of user than one that is one-size-fits-all.

If children's present lifestyle were changed, then the future would be more attractive for the individual, health care and society. This will not only reduce the cost diabetes hold on the health care.
Other obesity relating diseases would also be reduced. These diseases are: hypertension, cardiovascular diseases, stroke, increased risk for cancer and especially for women obesity cause reduced fertility, complicated pregnancies and childbirths [17, 18, 19].

At last it is of importance to mention that if the habit of a healthy lifestyle is successful incorporated in young children, there is a high possibility for that these habits would company these individuals in their adult life.

Conclusion

This study indicates that a pedagogical computer tool can cause lifestyle intervention in children between 7 and 12 years. This, because it is believed that knowledge about the issues in Type 2 diabetes and lifestyle is the first step towards lifestyle changing behaviour and finally improved health.

A major advantage of the computer tool is that children will use it willingly and enthusiastically during leisure time compared with conventional learning about Type 2 diabetes, which are mainly books.

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