

Educational system for diabetic children

Sofia Tretyakova

Østfold University College

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Abstract

This paper introduces an educational system for diabetic children. It aims to create interest in self-monitoring among children diagnosed with diabetes, to enable them to learn and follow diabetes control guidelines from childhood. Abidance by such rules supports a normal lifestyle for diabetic children. Accordingly, this paper presents an online educational game that could be part of a social network, and as such be accessible everywhere to teach kids how to deal with their diabetes.

Context

Introduction	3
What is diabetes?	4
Children diabetes	5
How parents can help their children?	7
Problem.....	9
Related work.....	11
Programs and devises for diabetic children.....	11
Devices.....	11
Educational games for diabetic children.....	14
Web resources as support for people who have chronic diseases.....	20
Method.....	22
Advantages and disadvantages of Flash technologies	22
Development of the conception of the game	24
Research on Facebook.....	24
Conception	26
System prototype development.....	30
Problem solution	33
System model development	34
Experimental part	45
The main methods of Flash animation.....	45
Basic types of Flash animation.	45
“Catch good food”	55
“Quiz”	60
Testing.	64
Discussion.....	67
Findings	72
References	74

Introduction

Chronic diseases are a very serious problem that unfortunately play a huge part in today's society and can become a real tragedy in one's personal life. A person diagnosed with chronic illness can expect to have many limits in life; one has to accept these limits and learn how to overcome the problems that these may cause. Researchers and doctors of many fields try to help such people to live a normal life by finding relief of any kind. This can be done in several ways such as working out special interesting diets to help maintain a healthy level of nutrition, introducing an absorbing physical activity and using special devices. These devices can help patients take care of themselves and support each other by establishing communication and finding an opportunity to have a constant connection in a form of game.

It is apparent that the inconveniences of chronic illness will be amplified in children who are not as strong physically and, what is probably even more important –emotionally. Additionally, chronic diseases, as well as usual diseases, make patient's immune system weaker and this is the primary reason to discuss children's chronic diseases deeper. [1]

This work consecrates on diabetes mellitus in childhood, because it is one of the most widespread chronic diseases among children around the world [2]. During recent years, the amount of people with diabetes has increased a lot. Experts called diabetes a noninfectious epidemic of the 20th century. While success was reached in the area of decreasing morbidity and death rate among children and adolescents [1], according to information of International Diabetic Federation 8-10 % of all people who have diabetes (about 30 million people around the world) are children [3]. Young people who have sugar diabetes have a great chance of becoming incapacitated from childhood, decreasing of persistence and evolvment of sequela. Children diabetes is not only a problem for young patients but also for their parents and relatives [4].

Consequently, a lot of attention should be paid to children diabetes to help them and people around them to live a more fulfilling life. Protection of future generations is a major concern around the world and therefore people should pay a lot of attention to the question of children sugar diabetes.

One of the main problems is encouraging children to learn the rules and follow the appropriate diets. This means that they will inevitably have to limit themselves in certain aspects and accept that they may now differ from other children of the same age. Our goal will be reached to an even greater extent if we could succeed at interesting children with chronic diseases in the system we are developing here.

What is diabetes?

Diabetes mellitus is a serious disease and the cause of diabetes is not sufficiently researched, which probably involves a combination of genes and environmental triggers. There are three major types of diabetes:

1. The first type of diabetes, also known as insulin-dependent diabetes, is an auto-immune disease where the body's immune system destroys the insulin-producing beta cells in the pancreas. This type of diabetes, also known as juvenile-onset diabetes, accounts for 10-15% of all people with the disease. It can appear at any age, although commonly under 40, and is triggered by environmental factors such as viruses, diet or chemicals in people genetically predisposed. People with type 1 diabetes must inject themselves with insulin several times a day and follow a careful diet and exercise plan [1].
2. The second type of diabetes also known as non-insulin dependent diabetes is the most common form of diabetes, affecting 85-90% of all people with the disease. This type of diabetes, also known as late-onset diabetes, is characterized by insulin resistance and relative insulin deficiency. The disease is strongly genetic in origin but lifestyle factors such as excess weight, inactivity, high blood pressure and poor diet are major risk factors for its development. Symptoms may not show for many years and, by the time they appear, significant problems may have

developed. People with type 2 diabetes are twice as likely to suffer cardiovascular disease. Type 2 diabetes may be treated by dietary changes, exercise and/or tablets. Insulin injections may later be required [1].

3. Gestational diabetes mellitus (GDM) or carbohydrate intolerance, is first diagnosed during pregnancy through an oral glucose tolerance test. Between 5.5 and 8.8% of pregnant women develop GDM in Australia. Risk factors for GDM include a family history of diabetes, increasing maternal age, obesity and being a member of a community or ethnic group with a high risk of developing type 2 diabetes. While the carbohydrate intolerance usually returns to normal after the birth, the mother has a significant risk of developing permanent diabetes while the baby is more likely to develop obesity and impaired glucose tolerance and/or diabetes later in life. Self-care and dietary changes are essential in treatment [1].
4. Other specific types of diabetic:
 - Genetic defects in β -cell function
 - Genetic defects in insulin action
 - Diseases of the exocrine pancreas
 - Endocrinopathy
 - Diabetes induced by drugs or chemicals
 - Infections
 - Unusual forms of immune-mediated diabetes
 - Other genetic syndromes, sometimes combined with diabetes [2].

Children diabetes

Diabetes is a severe incurable disease. Unfortunately in medical practice there is a high probability of development of diabetes among children. Diabetes in childhood is most often detected when the disease has already managed to substantially harm the child's body. Although diabetes among children is less

frequent than among adults, the disease is cured with much more difficulties and corresponds to adult-onset severe illness. [3]

The most common form of children's diabetes is type one or insulin dependent diabetes. Such patients need regular insulin injections. Most children who were diagnosed with type 1 diabetes don't have a family history of such disease. [4]. If an adult patient misses an injection, it will be virtually unnoticed, however for children with diabetes insulin injections must be systematic because missing injections can have a dangerous effect on the body. After the injection of insulin children have to take in a certain amount of carbohydrate food. Problems of child care of diabetes are often rooted in fulfilling this requirement. Sick children sometimes cannot be forced to eat the required amount of carbohydrates, but failure to comply with this rule may lead to hypoglycemic state. Children diabetes dictates its postulates, and while insulin is necessary to infuse 2-3 times a day, the best interim period for it is when the child takes food willingly. Diversity of diet, its richness in digestible carbohydrates, combined with the mode of insulin, leads to some success in treating children's diabetes. Children diabetes appears in case of malfunction of insulin producing apparatus of the pancreas, which can be triggered by past infectious or viral disease. Diabetes may be caused by various reasons, but it is often complicated by persistent infectious diseases. At such times it is recommended to use insulin therapy to greater extent than usual. [5]

Symptoms of diabetes include thirst, tiredness, frequent urination and weight loss, occurring over few weeks. Typical symptoms for children are headaches and stomachaches as well as behavioral problems. When parents recognize the first symptoms, they should immediately go to the doctor to diagnose the disease. The world practice shows that early competent treatment of such disease as diabetes among children of different ages contributes to better results in curing the disease. Children learn normally, grow well physically, catch up with peers and become full-fledged adults [5].

How parents can help their children?

It is very hard for parents to realize that their child has such an incurable disease as diabetes. Diabetes is very harmful for children but it is possible to this type of ailment is possible. There are some rules which help parents make life better for a sick child. Such rules are not very easy to follow because children experience difficulties such as restrictions in diet, activity level and compliance with instructions. Thus parents must learn how to make insulin injections and measure blood sugar. Moreover, they have to know the symptoms of high/low blood sugar and diabetic acidosis. One of the main points is to teach children how to measure blood sugar and make insulin injections as soon as children are old enough. It is also very important to inform friends and school teachers about the diagnosis and symptoms of high/low blood sugar.

Diet is a major part of the treatment and requires the child to maintain a healthy and balanced nutrition. Parents should offer food that is high in fiber and carbohydrates. Diet of a sick child should be based on plant and dairy nutrition and using natural food such as: whole nuts, vegetables, fruits, cereals, dairy products, and lean meat. Eating raw food is desirable, because it requires intense digestion work for pancreas, which triggers the production of insulin. Fresh cranberries, radishes, grapefruits can be eaten without restraint as they are very advantageous for diabetics. It is very important that the whole family eats the same food: then the child will see that this food is normal and he/she will eat it with greater motivation. Child has to know that his/her type of life is not so different from children who don't have diabetes.

Children diabetes does not exclude the possibility of exercising, in fact, doctors recommend physically developing the child with diabetes as much as possible. A child or adolescent with Type 1 diabetes should spend a lot of time in the open air, combine some simple physical exercises and educating tasks, have a rich diet and generally try as much as possible to live normal life. But at the same time the diabetic child must always be under the supervision of adults who are able to perform the first aid treatment of hypoglycemia by making insulin

injections in case of emergency. There is also a table of carbohydrate supplemental products, which parents have to be able to use, taking into account tastes of their child. Physical activities also affect the amount of food being consumed by the child and therefore it is recommended to feed the child extra carbohydrates such as bread or juice before doing exercises, sport activities or active games.

Children with diabetes must follow all rules discussed above, as these rules are the key for them to lead a normal life. Otherwise diabetic children may have various problems with their health, such as high/low blood sugar and their parents will be worried and responsible for them throughout their lives, which is abnormal.

Problem

There are a lot of mobile applications, devices, programs and interfaces which help diabetic people, especially sick children and their relatives to live with such disease as normal people. Most of them are aimed to create an opportunity of an easy life for diabetic people. There is a special factor, concerning diabetic children: the age limitation restricts them from fully understanding what is happening. It is very difficult to make these children follow simple rules; therefore it is dangerous to leave them alone at home. Of course adults have the same problem but usually they are more willing to understand the explanations and are able to draw their own conclusions.

On one hand, parents want to control their diabetic children because they worry and they want to make sure that children feel good. It is very important for parents and for diabetic children to minimize the chance of emergency situations which can happen.

On the other hand, diabetic children are normal and they do not want to feel that they are different. They need to play with friends and enjoy sport activities. Sometimes it is very difficult for them to understand that they can live a regular life only with help of special, yet simple rules to follow. It is hard for children to follow these rules systematically, for instance, measure blood sugar or take insulin injections on time. These problems can occur and should be avoided. Children want to be more independent from their parents, and it can lead to the fact that sometimes they can become irritated because of the constant care and advice that their parents are expressing towards them and as a result children feel overprotected. This feeling of irritation can stand in a way of actually following this advice and directions and as a result the child causes harm to himself and does not deal with illness.

The solution can be finding an interesting and entertaining educational game for diabetic children. Game, in an un-important way, should include rules of life with diabetes and attract children by being funny and having a child-friendly

interface. A child would enjoy this game just as he/she would enjoy any other one but at the same time will understand why and how he/she should measure blood glucose, be very careful with food and so on. In other words the child would understand the rules that he/she should follow and hopefully realize that these rules are rather simple and not overwhelming. While parents can teach diabetic children how to live a normal life, it is more likely that small children will follow the rules that they will learn from the game independently from their parents' advice that may be annoying at times.

Related work.

Programs and devices for diabetic children.

Devices

A lot of devices and programs have been developed for diabetic children and their parents to make their life easier.

One is a device which helps in parent-child interaction on the way of sending messages from a child's blood glucose monitor to their parent's mobile phone.[6] The main idea of this device is to help parents to control their children's blood sugar. Parents can make sure that everything is fine with the child. If high/low blood glucose was detected parent can tell child what to do or ask for help from somebody next to their child. Moreover, the child is obligated to measure blood sugar because messages have to be sent to a parent's mobile phone when child does the measurement. To perform this action sick child has to be instructed how to do it and what to do if the level of blood sugar is high. In such manner the wireless system for blood glucose monitoring helps parents in solving a problem of monitoring their child's blood sugar level when they are not next to the child. Another problem is that the child has to know what to do if blood sugar level is high. The device allows parents not to worry so much but the system can't teach a sick child what to do with such disease. For this purpose some assistance to parents has to be developed.

Another adjuvant is a PDA interface for dialysis patients whose diet has to be monitored on a regular basis. [7] Such PDA interface was developed to assist dialysis patients in monitoring their nutritional allowances. The interface is very useful for dialysis patients because they usually use paper diaries for self-monitoring. This program helps sick people to check their fluid, which prevents emergency situations. Taking into consideration the description of the device mentioned above, it becomes obvious that diabetic people as well as children can use such application to control their diet and allowing the parents of these children to prepare food for sick children. Application called DIMA (PDA

Dietary Intake Monitoring Application) empowers parents not to worry so much about the diets of their diabetic child. Once they teach the child how to use DIMA, he/she can be more independent from parents in choosing appropriate food. Unfortunately, DIMA helps diabetic people only to control their nutrition but does not teach them about the rules for diabetic people.

Developers also offer the use of mobile phones for health care assistance. They created software that can be installed onto a cell phone and help diabetic people in daily life with taking medicine doses to make blood sugar level stable without requiring any supplementary systems or without using extra sensors. This software is used to control people with diabetes everywhere outside the hospital. The aim of this project was to create an application which can be easy install to the mobile phone and help people with insulin dependent type of diabetes to control food which they take every day, blood sugar level and dose of daily insulin injections. The software gives the patients a possibility to control most of the things, which can influence the level of blood glucose, and to use one device, which is used by them anyway to control very important things in the regular life of a diabetic person. Developers collect information about activities of the people, as well as time and place and try to find connections and similarities. Consequently developers make list of suggestions, which are used in the program as a recommendation for the patients. Also the application includes location-awareness accuracy, which relies on GSM cellular data to obtain the location of the user. In general this software should be improved, for instance in terms of location-awareness accuracy, but users were satisfied with employing the cellular phone app as handwriting issues were no longer an issue and measurements of blood sugar were logged better than before. [11]

One of the big problems for diabetic people is food intake. People have different eating habits and preferences and dietary habits and choices influence blood sugar level as much as physical activities. That is why there are three items which have to be taking into account for diabetes self-management and blood sugar control: food intake, physical activity and medication [3]. In this case information and communication technologies were created by collaboration of researchers from University of Washington and at the Norwegian Centre for

Telemedicine. In the beginning they worked separately but then integrated their work and in the end they presented three products: two functional prototype systems and one commercially-available system.

The first system is “The few touch smartphone prototype”. This is a browser-based program, which is oriented at individuals with diabetes for quick entry of approximate records of eating habits. Food can be chosen by touching the icon on the screen and it will later be recorded as a consumed food. Immediately entered data would be analyzed by the application and compared to the individual’s previously entered daily needs.

Another system is “The commercial Web application for PC’s”. This system is designed to collect, analyze and display data about user’s food consumption, insulin and blood glucose levels. Blood sugar level is uploaded directly from user’s glucose meters. All of the other estimates should be entered by the user himself. Food consumption estimates either can be entered manually via special form or chosen from the offered list of food items. Also the patient can check the information about consumed food. The target of the application is to motivate self-control of the diabetic person.

The third program is “The Food Photo Moblog prototype”. The aim of this project is to stimulate individual’s self-control and receive feedback from healthcare provider. Patient takes a photo of a meal which he/she going to eat and enters brief comments about carbohydrate grams or other estimated values. Afterwards user posts this annotated picture to a “blog”, where he can get recommendations from the specialist as well as share this information with other users.

Without distinction of the type of application and design approach all the participants agreed on the fact that overview over individual’s food consumption is useful and motivating. This is an important step in diabetes management, though evident disadvantage of this approach is that it requires a lot of routine work registering all the necessary estimates. Participants require the possibility to adjust all these applications according their own needs and unique features.

[12]

Educational games for diabetic children.

Our century is full of computer technology and young people grow up using computers. Children start to use computers very early. They learn how to read and write with the help of computer games. Parents buy computer games to improve child's logical mentality and lots of other skills. That is why children usually begin to use computers by 3 or 4 years old. Sometimes children at 6 years of age can use regular computer programs or simple devices better than their parents. Therefore to teach children to do something with the help of computer games and other technologies is much easier than using average methods, which we used to employ. It is a complicated task to teach young diabetic children how to follow the necessary rules and one of the best ways to do it is to use computer technology and educational computer games especially.

A lot of attention should be paid to the benefits which video game can add into educational process. A look at the children who play computer games reveals how consumed they are in the process.

There is evidence that proves that a child engages a lot of useful skills with the help of computer games. For instance visualization of the objects and simulation of the actions are good possibilities for children to try and attempt a lot of things in the virtual reality that they would not be able to do in the real world. Playing a game presents an opportunity to understand the world around them and acquire different attainments. Children can play videogames that are suitable for their individual parameters such as age or behaviors. Also video games can improve poor skills and provide more information about the environment for disabled children whose communication with the external world is limited.

On the other hand videogames can be a harmful influence on the children, for instance they can become addicted to the computer or video games. Therefore parents must regulate the game process and not forget about regular games and games of skill, which are very useful for young people too. [13]

Based on the above reasons it is evident that children are consumed by the game process and may prefer this type of education over others, whether directly or indirectly.

There are lots of different educational games, which help children and their parents learn regular and emergency rules to follow to care for different illnesses.

One of those educational games is called “Packy & Marlon”. This interactive videogame was developed to increase the children’s knowledge about diabetes, increase the level of their self-confidence and motivation and to allow self-care among young people with diabetes. The videogame was created according to theoretical framework of human-computer interaction, children’s cognitive psychology, educational cognition, communication and health assistance. Animation characters help children assume they are patients, who monitor blood sugar, take insulin injections and follow a diet by choosing food to keep blood sugar in normal range. Protagonists of the game are on the way to summer camp, which they should protect from rats and mice that diffuse diabetic supplies and food. At the beginning of the game child should set the insulin option as a fixed dose of insulin four times a day and during the game players answer multiple-choice questions. After regular insulin injections players can choose the food and evaluate nutrition of it, because choosing food is one of the most important ways to control blood glucose level. The game allows children to make mistakes such as choosing food and forgetting to take insulin injection; this action causes no harm to the game characters but can lead to health complications in real life. It is possible for two people to play this game simultaneously and in that case players take care of each other. An important aspect of the game when it is played by multiple players is that if one player takes all the food and completes all the tasks but the other one doesn’t, the players must repeat the level; players must support each other to pass the level and continue to play.

Children enjoyed playing this game and after the end of testing it was concluded that this game is excellent for education and entertainment: children from the test group showed increased self-care acquirements, began to discuss the disease with their parents more than before the experiment, and show good results in the knowledge test. Thus, a well-developed interactive video game can act as educational material that can easily teach sick children how to live a normal life with a chronic disease such as diabetes. The concept of this game can be used

not only for diabetic children and adolescents but for other people with any chronic illnesses. [8],[9].

Another game for diabetic children is called “Captain Novolin”. The main idea of this game is to show children the connection between insulin, food and blood sugar measurements. Young players choose food and insulin dosage and measure blood glucose level. The game proceeds if players make correct decisions about choosing Captain Novolin’s food and insulin doses. The aim of the “Captain Novolin” is very similar to “Packy & Marlon”: to teach young diabetic patients how to choose food according to blood sugar level, take insulin injections and regularly measure blood glucose. [14], [20]

Another multimedia product which helps diabetic children is “Squire’s Quest!” .The game is not directed towards diabetic children, but it can teach them how to choose healthy food such as fruits and vegetables. This is a ten-session, psychoeducational, multimedia game. It was tested with the help of fourth-grade children from different elementary schools. The game is based on cognitive theory and the main idea is to increase fruit, juice and vegetable consumptions, associate positive thoughts with this kind of food and encourage preparation of dishes involving fruits, juices and vegetables by providing virtual recipes. This game is useful in teaching children how to follow their recommended diet. Testing results showed that children who took part in the research demonstrated changed eating habits among participants primarily indicated by increased consumption of fruits, fresh juices and vegetables. “Squire’s Quest!” is one more example how well designed videogame can change dietary behavior. [10]

All related works were compared to each other by using six criteria: understandability, ease of use, learnability, fun, availability and flexibility. All of these factors are very important in developing devices for diabetic people.

Understandability refers to the level of ease at which people understand what to do with this system, device or software for diabetic people. Ease of use is a criterion of usability quality. The goal is for the device or system to be really simple to use for diabetic people because the quality of the outcome depends on the simplicity of the project. Learnability refers to how educative the program or

device is and how useful it would be for the education process. Fun is a very important aspect of children's application and devices, because the funnier the application is, the more it will attract the child's attention. Availability is the factor that determines if the project is available for users from different places or if the user can reach the game at any time when he/she would like to play. In order to increase the availability the game should be easily accessed from the internet and allow users to play from different places as long as they have access to the internet and a computer. Flexibility refers to the need for the system or the device to be adapted for use by not only people with diabetes, but for others as well.

Table 1

	Understand able	Easy to use	Learnability	Fun	Availability	Flexibility
PChI	+	-	-	-	-	-
DIMA	+	+	-	-	-	-
MPhA	+	+	-	-	+	-
Few touch smart prototype	+	+	-	-	-	+
The commercial web application	+	+	-	-	+	+
The food photo prototype	+	-	-	-	-	+

Packy & Marlon	+	+	+	+	-	-
Captain Novolin	+	+	+	+	-	-
Squire's Quest!	+	+	+	+	-	-
Educational system	+	+	+	+	+	+

All of these criteria are very important and have to be taken into consideration when developing an educational system for diabetic children.

The game should be made as a regular arcade game to allow users to understand what they should do from the first seconds of the game. It would be easy to play this game, because players use only some key buttons and mouse to move the main character and get the target of every part of the game. Since the goal of the educational system for diabetic children is to motivate children to learn more about diabetes children can get information easily. The system has to be funny, because the simplest way to interest children of learning some information is to make the educational process funny. When children have fun during the educational process they will improve skills and increase their knowledge about diabetes more effectively than if they will just watch TV or read books. Children have to have the opportunity to play the game whenever they want, therefore the educational system for diabetic children should be available through the internet. The user should only have internet and a computer, free time and of course be ready to learn some new information about diabetes. Frame work of educational system can alternatively be used as a base for other educational games. Some of the tasks can be used not only for diabetic people but for all children and adolescents to learn more about a healthy way of life. Other tasks can be used for different educational goals by changing content.

In such manner to develop the concept of an educational system for diabetic children should take into account all main criterions, advantages and disadvantages of related work, and of course users' opinions.

Web resources as support for people who have chronic diseases

Chronic illness in humans leads up to a lot of psychological problems. Teenagers with chronic diseases are limited in many things that are normal for their peers. Sick children feel worse than healthy adolescents in regular life, because they need to make some procedures or follow a diet. It can be a reason for occurrence of problems with social interaction that can lead to emotional and psychological issues. Sick children are sometimes less active than other children, and they can't spend a lot of time with others as they often cannot eat the same food. They need to follow their private diet and follow lots of simple rules. It is difficult for young people to do something, which is really different from their friends.

Healthy children sometimes cannot or do not want to understand that chronically ill children are the same children and they can communicate all together in spite of them being a little bit different. Healthy children only understand that there are some limits for chronically ill children.

Sick children have to spend more time with their parents because they need injections or special food and parents can help their children to do it.

That is why researchers developed an Internet-based support system for children. The aim of this system was to create a web-based support service for adolescents with chronic disease.

This web-service helps children learn more information about sickness and ask doctors different questions about their disease. They can discuss different problems, which healthy children will never face in their lives.

During the testing process of Internet-based support system participants believed that they have more friends who relate to the same problems than they had at the beginning of the experiment. Doctors and other medical staff noticed that children increase their knowledge about the disease. And what is more interesting is that some of participants wanted to meet each other in real life after online communication on the web-site.

Consequently Internet is a safe area for children with chronic disease, where they can find friends, increase knowledge and take pieces of advice from other children, their parents, doctors or from the special support team.

Method

The aim of the research is to develop the concept of the educational system for diabetic children.

The goal of the research is to interest children in topics that they need to learn. Therefore this paper is oriented on information about diabetes and rules which are necessary to follow for people that have diabetic disease.

Advantages and disadvantages of Flash technologies

Flash technologies or technologies of interactive web animation were developed by Macromedia. These technologies combine a lot of different methods of multimedia. Flash technologies are oriented on the vector graphics as a main tool of program developing. Flash manipulates vector and raster graphics to provide animation of text, drawings, and still images. It supports bidirectional streaming of audio and video, and it can capture user input via mouse, keyboard, microphone, and camera. Flash contains an Object-oriented language called Action Script. Flash is not the first vector format, but developers found the best combination between pictorial graphics, workbench and arrangements for including graphics inside web-applications. Flash content may be displayed on various computer systems and devices, using Adobe Flash Player, which is available free of charge for common Web browsers, some mobile phones and a few other electronic devices.

The small size of the final application is one of the advantages of Flash technologies. At the same time the result of the application does not depend on the user screen which is important requirement for internet projects. User can see a dynamic interactive web-page full of color which has small size. This is perfect for applications which can be used on the internet. It becomes possible with the help of vector graphic and information compression algorithms.

The main tool of flash technologies is the frame. Viewing frames in a different ways can be possible because of system of links, marks and variable parameters usage. That is why size and downloading time of the final project is minimized.

The use of vector graphics combined with program code allows Flash files to be smaller — and thus for streams to use less bandwidth — than the corresponding bitmaps or video clips. For content in a single format (such as just text, video, or audio), other alternatives may provide better performance and consume less CPU power than the corresponding Flash movie, for example when using transparency or making large screen updates such as photographic or text fades.

Possibilities of Action Script, the programming language which is integrated to Flash, are also useful and interesting for developers. The final product is Flash movie. It is an element of active-x, which is independent application but it can be easy combine inside HTML-document as an active-x object.

Action Script allow flash movie to go to cgi-gateway inside the movie and hid request place from the user. The disadvantage of such method is the limitation of the gateway information; it means that HTML-code cannot be interpreted by flash movie. This disadvantage can be removed if the developer creates a special Action Script module for parsing answers of cgi-programs.

Another disadvantage is that to play flash application users need to install a plug-in on the computer, but the most popular browsers have it inside the program or link for a free flash plug-in download. Also flash movies have high system requirements, but it influenced only on the speed of playing and flash movies and games are playing on all PCs'.

Therefore Flash technologies optimal for creating and developing small movies, cartoons and games. Flash games on web-pages attract users' attention. It makes web pages more informative and retainable. One more advantage for the flash games is that if user liked to play flash game he/she will return to it again and again.

Games based on Flash usually are realization of simple but engrossing scenarios. They are on the front burner and popular now.

The Flash-technology applications can be used on different operation systems such as Windows or Mac OS.

As a result of analysis of Flash advantages and disadvantages Flash is optimal development environment to reach the target of the project: to create an educational system for diabetic children. To use this set of tools project can be realized on the best way. [15], [16], [17]

Development of the conception of the game

Research on Facebook

It is very enlightening to conduct topic research on international social network Facebook.com. Such research is very effective and different types of results can be found. The main point is to find information about diabetes on “pages”, groups and web pages. It is worthy of noting that this small social network research is focused on children’s and adolescents’ diabetes. Looking through different headings, the main idea all of them have is discussion of diabetic problems, making activities for diabetic children, answer questions etc. Parents’ communications, doctors’ recommendations, and relevant links are useful for people whose relatives and children have diabetic problems. Thus, all results are very similar and the purpose of them consists in supporting diabetic children to live normal life and show that this is easier than they can imagine.

It is valuable to give consideration to some of different results, which are sometimes very typical and sometimes very special.

A search by the phrase “Children with diabetes” was performed. There are different types of results such as fan pages, groups and web pages.

It is important to know the difference between pages and groups on Facebook. Both look very similar, but they have their own advantages and disadvantages, and their own specifics also. [18] Pages are better for businesses, organizations or celebrities. They help people to communicate and engage their fans and capture new audiences virally through their fans’ recommendations to their friends. Also pages are visible to unregistered people and are thus indexed. Pages are better for long-term relationships with fans, readers or customers.

On the other hand, groups are used for promoting and organizing people around a specific area, interests or cause. All members of a group have the ability to

contribute content that appears on the groups' wall, photos, and discussion threads. Groups allow for sending out invitations for all your friends and are generally better for invitations because all of one's friends can invite their friends also. Using groups also allows users to better host an active discussion and attract quick attention. [17]

Pages

Pages are all very similar because of their goal [18]. People who take part in such diabetic pages give information and links about their problem, which can be very practical to others. They also ask questions about diabetes and give answers. For instance one of participants asked: "True or false. People with diabetes can never eat cake." This is a regular question and it is very important for diabetic people. Such pages can give them an answer. Pages also provide information about social activities such as the Chicago 2009 Conference. This conference was focused on children diabetic technology. Participants spoke about how important the use of technology is to make easier life of children with diabetes. Devices, which were presented on the conference, helped children to measure blood sugar.

Groups

The second type of searching results involves Facebook groups. In general, all of these groups carry the same purpose [17]: to help diabetic children and their parents and relatives. All of these groups have their own specifics in how to help and support children while helping them solve their diabetes problems. All groups can be divided into four classes according to their particularity. Firstly, there are groups for parents. Such groups are focused on providing support for parents and sharing ideas with other parents of children with diabetes Type 1. They discuss problems of cure and offer help in perceiving the fact that their child is diabetic ("Parents of children with type 1 diabetes"). The parents upload photos of their children and pictures from different events and some parents write blogs about their children.

The second type of groups is children groups. This type focuses more on helping adolescents than small children to find friends with the same problems. The children describe their problems and offer advice to each other. They arrange

live meetings and activities and take part in them (“Help us, help children with diabetes”).

The next type is groups that focus on coordinating activities and movements for diabetic children. For instance: “Summer camp for diabetic children” or “Special food for diabetics in school cafeteria.” This type of groups helps diabetic children communicate not only virtually but in reality too. Ideas such as summer camps are helpful for parents, because their children will have special attendance while in camp and parents don’t have to worry as much about the health of their child. At the same time, children will enjoy summer as normal children do, with sport activities and games, balanced food and medical care.

The next big class of groups is called “supporting diabetics” groups. This class includes groups, which offer countenance, financial aid or informational support. In general, such groups’ goal is to provide support to families, children and people who have children with diabetes within the area. Sometimes doctors take part in support groups to give advice and help children and their parents.

Also there are groups that discuss technology that can be used for diabetics or the possibility of using technology for such cause and developing new applications. One example would be the group called “Can mobile technologies assist Type 1 diabetics’ insulin calculations”. This group is dedicated to the research by The Australian Diabetics Association that aims to investigate whether mobile technology can deliver a service that assists Type 1 diabetics who use carbohydrate counting in calculating their insulin needs.

Conception

To develop an educational system for children the implementer has to remember two basic rules:

- To make the right choice of the set of tools;
- To choose the optimal conception of game parts.

To develop an interesting and advantageous game that which can be useful for diabetic children, the people who are truly concerned with the topic of diabetes: children with diabetes, their parents and friends were approached first-hand.

Interviews were conducted through Facebook and the data collected from the audience was used as a framework to create main questions. Discussions were opened in special diabetic groups and pages and included questions to gather information that can be used for further development.[23],[24].

The main goal of the project was described to the users on Facebook. The aim of the interview was to research into the problem, find out what information should be included inside the project and which scenarios are the most interesting to the users and attract the most attention.

The replies received were from users from different countries and different age groups. All messages were similar in one aspect: developing such system is an efficient idea and will be very useful and helpful for diabetic children and their parents as it is shown on Chart 1.

All results can be divided into groups:

- The first group consists of the users from 30 to 55 ages who are parents or relatives of diabetic children or people who have diabetic disease and were diagnosed in childhood.
- The second group includes children, mid-childhood and middle school ages. These answers consisted of experience and facts, which helped to get deeper inside the problem from the children's. This allowed for better understanding of the underlying issues and an estimation of which matters require more attention. Participants of this group came up with a lot of ideas about what the game could look like: as an arcade or a conundrum because they are small and interesting for children.

Additionally the results of the interview revealed that one of the most popular forms of education is a quiz form used as an assemblage of questions, which control people's knowledge. Creating appropriate questions can increase children's knowledge about diabetes substantially. A properly designed interface will focus their attention without distracting them too much and motivate them to continue education and increase their diabetic attainments.

During the process of interview participants suggested the questions for the quiz which can be effectively included in the game tasks. Thus the first presumptive task for the educational game was formulated in a form of a quiz that invites children to check their knowledge about sugar diabetes. The quiz includes general information about diabetes, and main rules which diabetic people have to follow and questions about necessary rules and the disease. By answering the questions children can assess their knowledge and learn more about sugar diabetes.

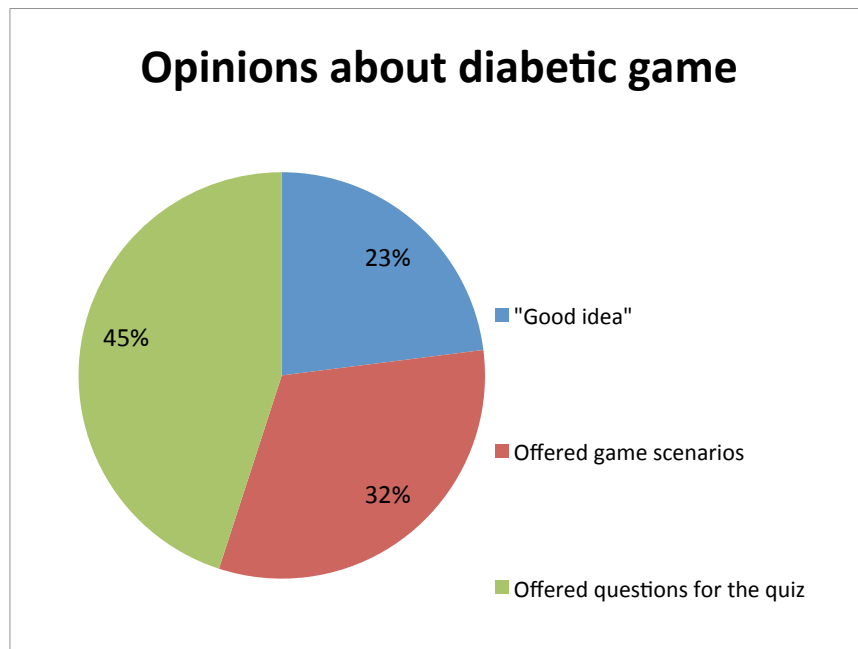


Chart 1. Opinions about diabetic game from Facebook [23], [24].

Quiz was the most popular, but not the only proposal offered by the users. Another suggestion was to use conundrums, where children should choose the right choice from several options, or a puzzle, where user should compose a picture or a crossword about diabetes.

On the final step of the game conception developing a problem was encountered that limiting the educational game by only one task is not enough for such a system and that it is necessary to create an educational system for diabetic

children, which would consist of different tasks and games. Small scenarios should cover general questions about diabetes: taking medication, making insulin injections and, of course, following a diet; also the information how to except emergency situation have to be included in the system. [23], [24].

On the basis of all data collected from the earlier research the final conception of the educational system for diabetic children was choosing a game. This game would have to consist of different tasks of different levels and game goals with all of them concentrated on the diabetic problems. At the same time the results of the game will be collected in a special table to demonstrate their level of knowledge to the small players and their parents. After every level the child and parents can look at transitional statistics, such as percentage of correct answers or quantity of good food collected. Such statistics data can be used by parents and doctors to understand what the child knows after the game and allow the parents to draw conclusions on which aspects of life should be offered more attention and the doctor can create a more useful scheme for the child to get well and live normal life without any emergency situations.

System prototype development.

This section observes stages of project development, tasks choices and program realization.

Development of a general algorithm

The purpose of the system is to teach diabetic children to take care of themselves and follow the necessary rules and diet without assistance of adults. Accordingly, the objective is as following:

- Increase child's interest in learning the required information
- Build up motivation to learn about his/her disease
- Provide the child with opportunity to act on his/her own
- Give parents the opportunity to control their sick child indirectly

On the basis of such a natural process of integration of child's interests with the entire environment it is possible to suggest the following operation algorithm of the system.

Chart 2. demonstrates the principle of operation of the program. Program offers the user to choose the mode of exploitation: to start the game (having previously fulfilled required conditions) or to review reference materials. Having chosen the second option upon reviewing the material the program brings the user back to the mode choice through the required condition. If a required condition is not fulfilled, the program shuts down, whereas if it is fulfilled, program switches to a task choice. If a task is not chosen, program shuts down through statistics output and processing blocks.

When a task is chosen, program switches to its execution block. After a completed task provisional statistics are displayed. Thereafter program checks availability of tasks and returns to the block of fulfillment of required conditions. After all tasks are completed, statistical data on each task is retrieved and general statistics are processed. Thereafter the resulting statistics are displayed on the screen.

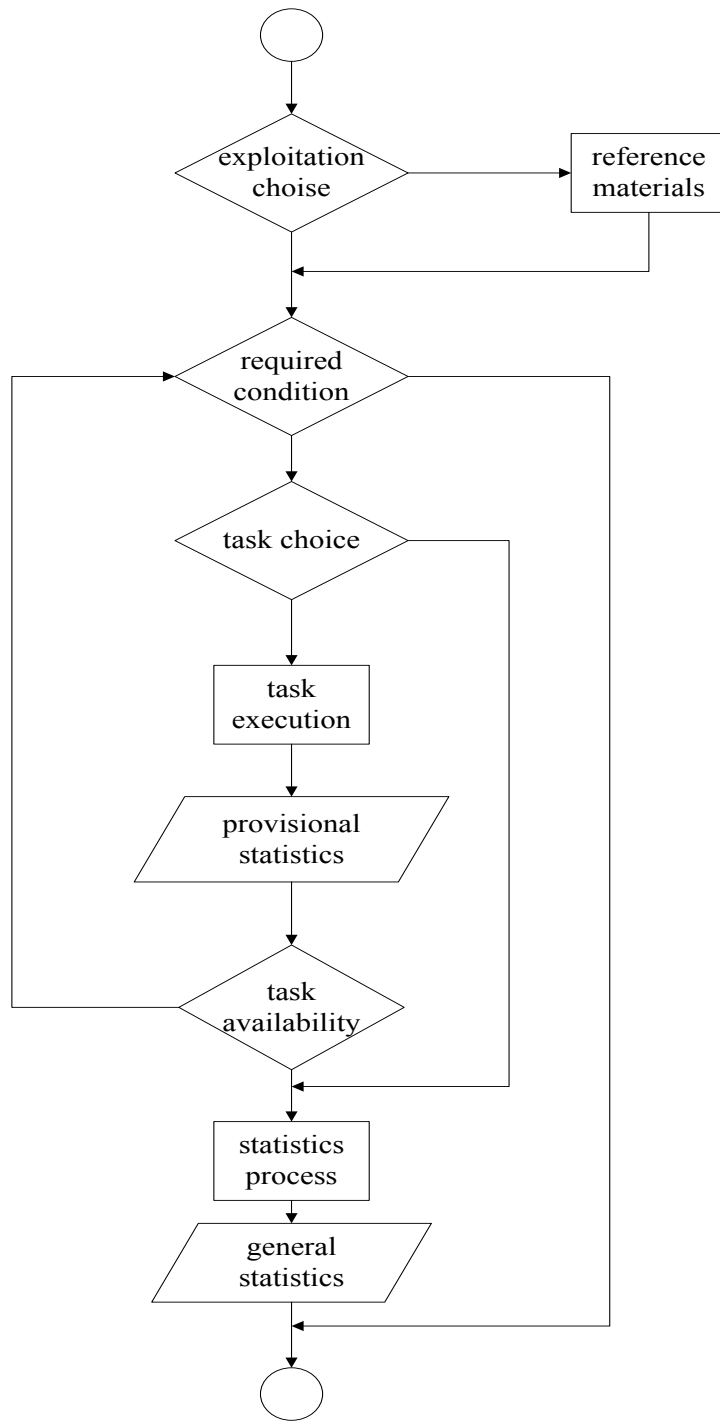


Chart 2. The principle of operation of the program

The following chart (Chart 3.) demonstrates the teaching system for diabetic children.

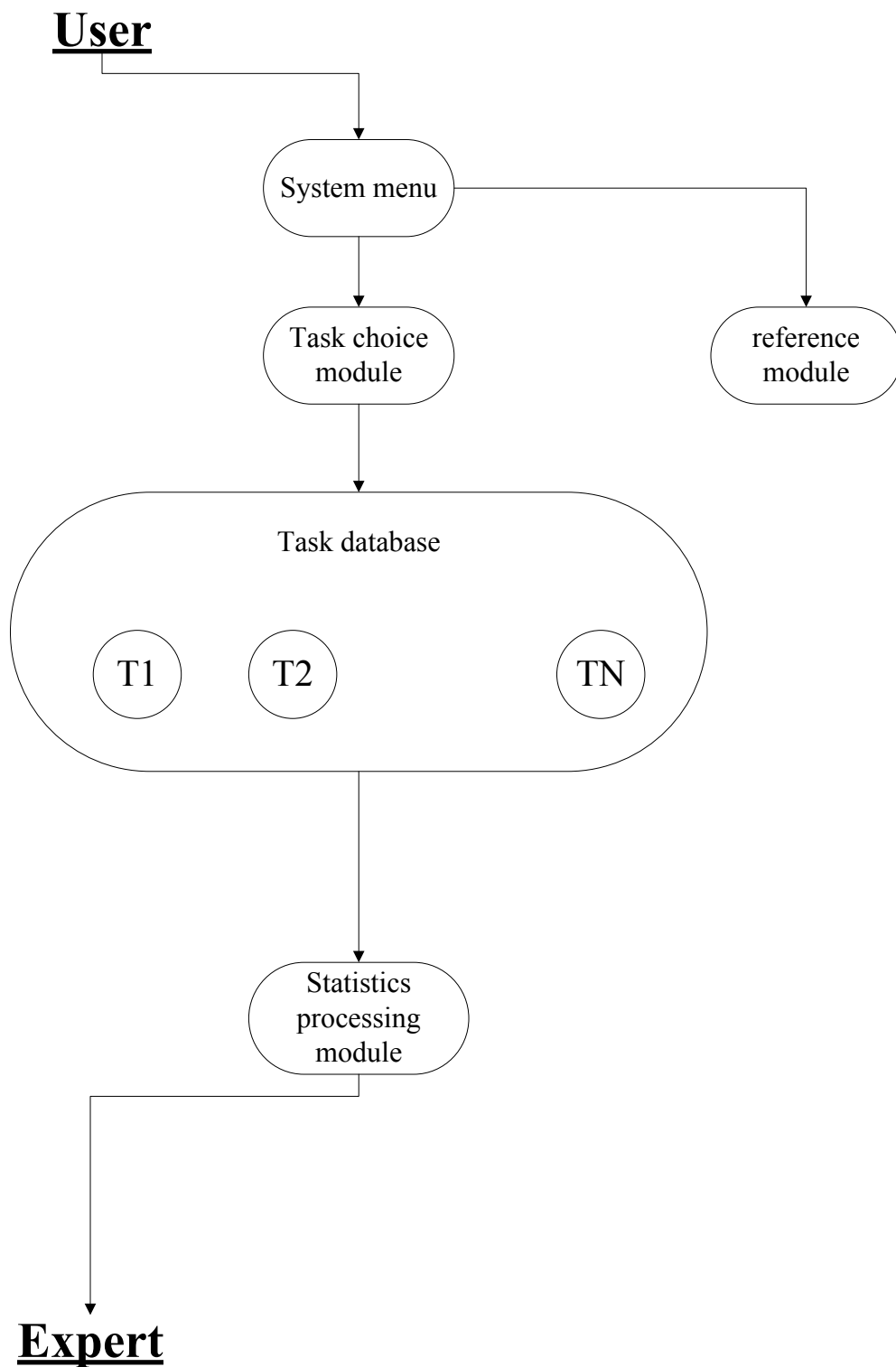


Chart 3. System architecture

The system consists of five blocks:

- System menu block, which allows the user to choose operational mode of the system (task accomplishment or review of reference materials)
- Task choice block, which allows the user to start playing the game after fulfilling required conditions
- Task database block, which encompasses all the variants of the offered games
- Statistics processing block, which allows experts (parents and doctors) to review the results of completed tasks.

Problem solution

An educational game is a compound systematic formation that allows various modes of presentation. In particular, it may be realized as:

- a) activity,
- b) process, integrated to another type of activity,
- c) a particular form of educational activity.

The main requirement that one has to bear in mind in the course of development and usage of a game in educational process is that purposes of the game (victory, record, prize, jackpot etc.) include educational purposes as well. Educational PC games are intended for an increase in motivation, stimulus of initiative and creative thinking of a child.

A conception of an educational system for diabetic children has been developed. On the basis of the latter conception it was necessary to start developing a scenario of the game and elaborate its plot.

The plot of the game consists of step-by-step accomplishment of different tasks. The user transfers to a new task when the previous is completed successfully. It stimulates the child for an efficient digestion of information and careful task accomplishment. After completion of every task statistics of the game and scores are displayed on the screen. If the result is positive, the player may proceed to the next level. If not, it is necessary to repeat the task accomplishment again. The player is assisted with the main character while proceeding from one level

to another. The main character is diabetic and needs insulin injections periodically.

System model development

In the case of using the methodology described above the educational system acquires the following structure, showed at Chart 4.

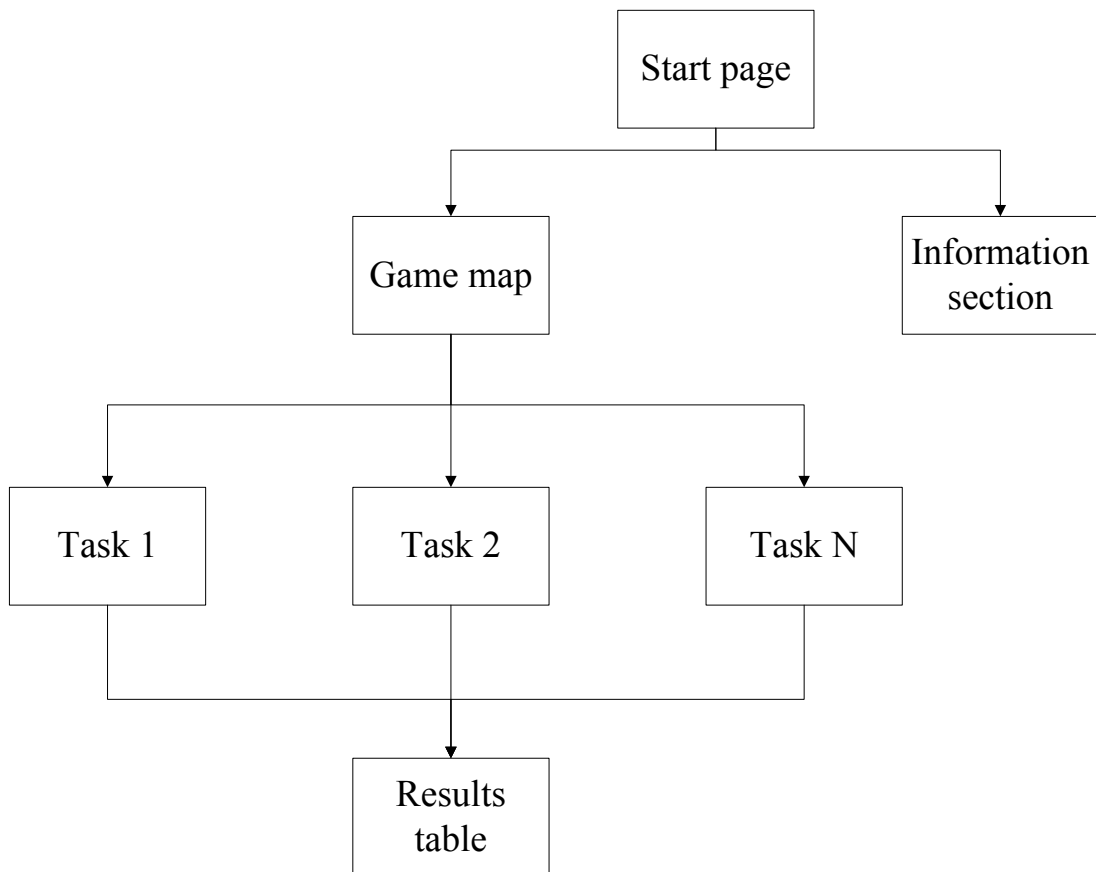


Chart 4. Structure of education system for diabetic children

The start page is a colorful window, where the aim of the game and its name is displayed. There are two buttons – “Play” and “Learn”. (Chart 5.) The aim of the game is education of a diabetic child in a proper manner and teaching a necessary knowledge volume about diabetes.



Chart 5. Start page

From the start page the child can easily switch to a map (Chart 6.), where he/she is able to start accomplishing tasks and reach a goal. The second option on the start page is diabetes information section (Chart 7.).

Children are introduced to the main character on the map – the Fox (Chart 8.) –, which is made to follow players along the whole gaming process.

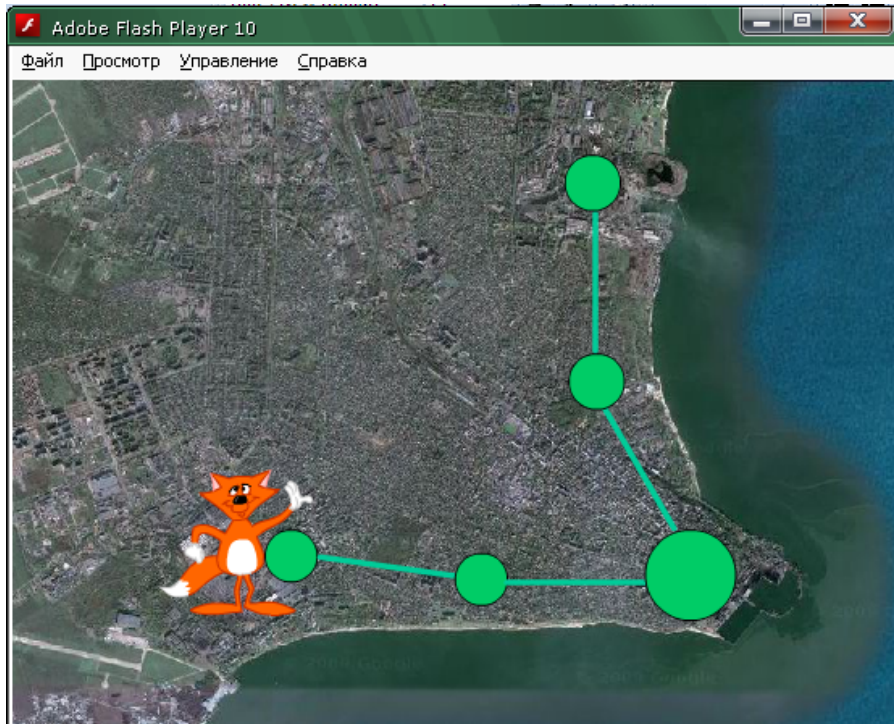


Chart 6. Game map

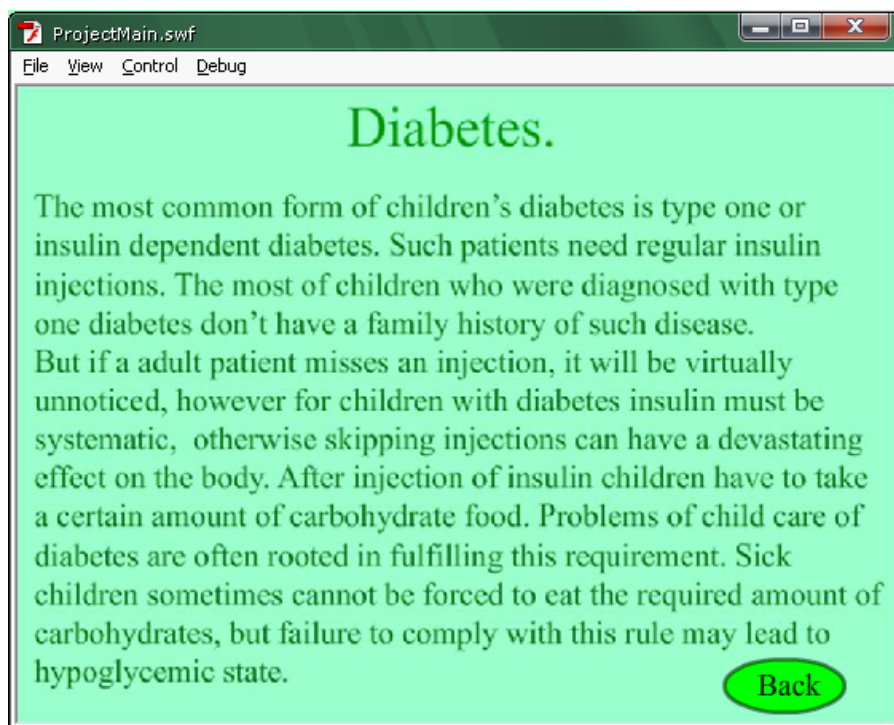


Chart 7. Information section

As it was mentioned previously, the Fox is diabetic, therefore it requires periodical injections (which the child is reminded of) (Chart 9.).

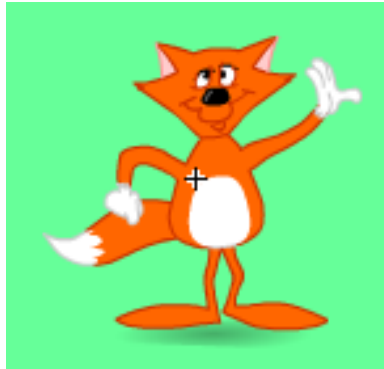


Chart 8. Main character

After an injection the Fox thanks the player (Chart 10.). If an injection is not made on time, the whole game is considered to be failed.

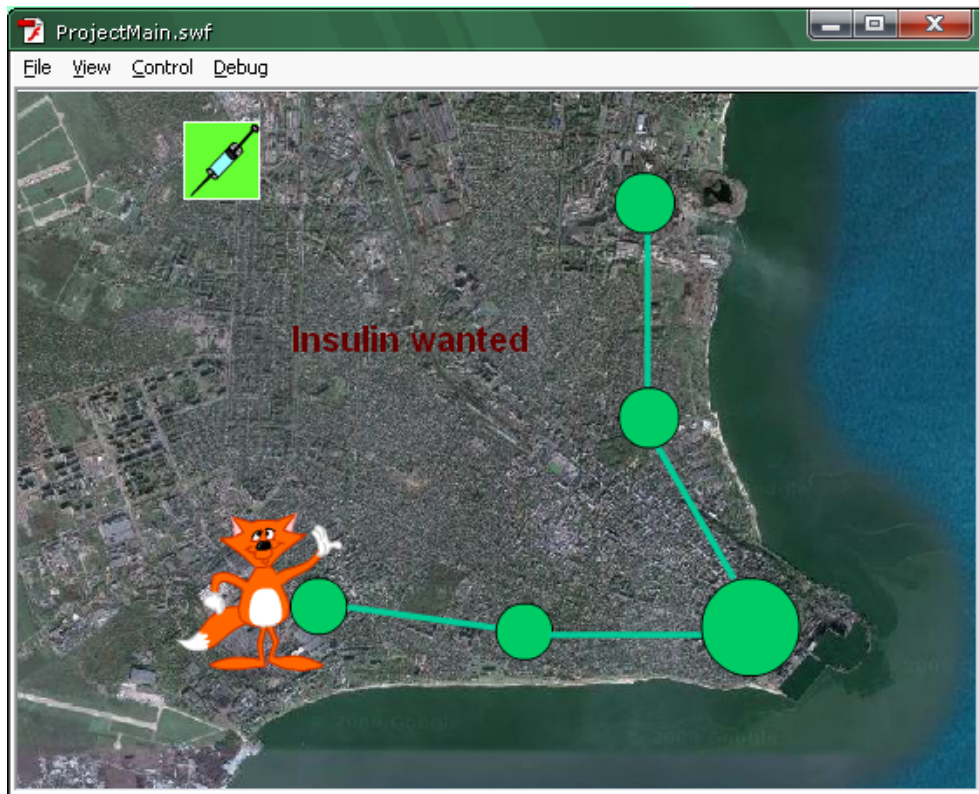


Chart 9. Insulin injection reminder

Fields of the game are denoted with circles, pressing on which the player proceeds directly to a task accomplishment.

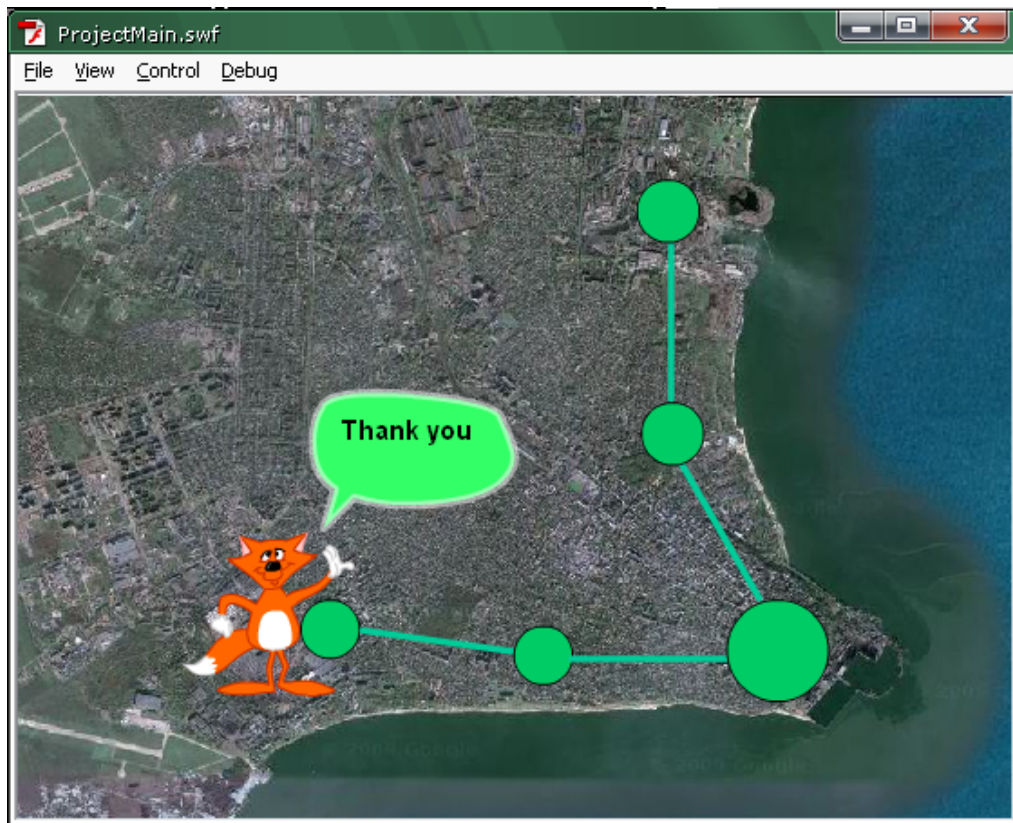


Chart 10. The Fox thanks the player for insulin injection

From the map page the child proceeds directly to tasks. Tasks present a set of games, which presumably improve child's knowledge of healthy diet, way of life of people, having diabetes, and about the disease itself.

The first task is a game, the aim of which is to teach children the diet, suitable for diabetic people (Chart 11.).



Chart 11. First frame of the “Catch good food game”

The plot of the game is the following: the Fox moves on a horizontal plane (from right to the left and back) in the bottom of the screen, trying to catch products that fall out of a fridge (Chart 12.). Right and left arrow buttons control the Fox.



Chart 12. Main view of the game

Products fall from random places to the bottom of the screen at random time. In addition, there are two product categories. The first category is represented with so-called “good” products that are allowed for a diabetic diet and the second category is “bad” products that are not recommended for consumption by diabetic people, but are very often eaten by healthy children and adults. After a certain amount of products has fallen out, the game is over. The score is calculated in the following manner: when the Fox catches “good” food, the gamer gets scores, whereas when it catches “bad” food the scores are lost. At the same time, the score cannot go beyond zero. In the end of the game percentage of caught “good” food is displayed, thus showing if the task is completed or not (Chart 13.).

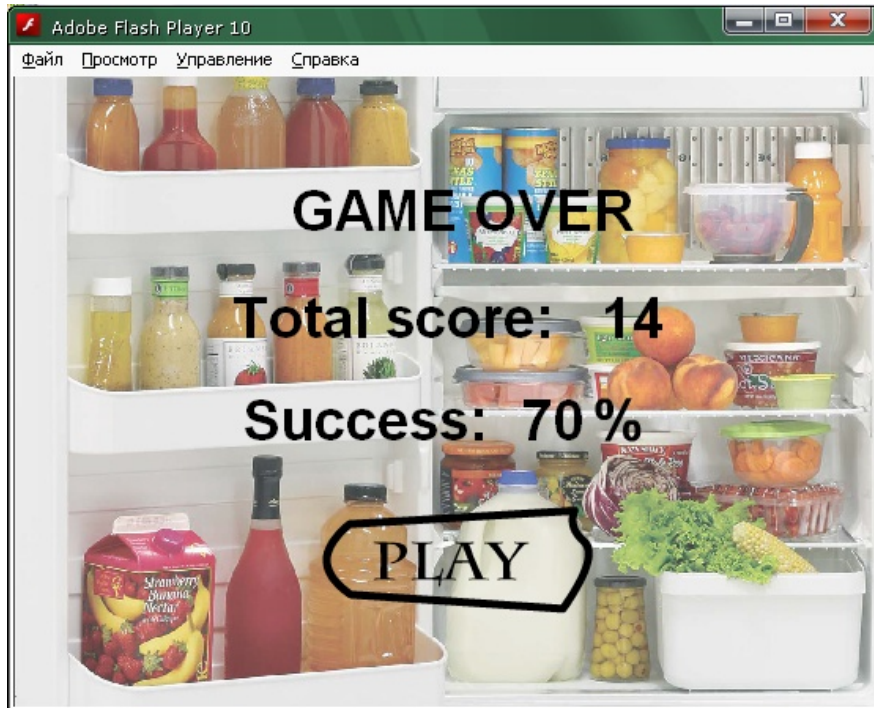


Chart 13. Final frame of the game

The task is designed in a manner, that allows the child to memorize, which products are good for him/her and which ones are not.

The next task is called “Quiz” (Chart 14.). The task consists of a variety of test questions. There were used questions provided by Facebook users concerned with problems of children diabetes for the creation of this task [24], [25].

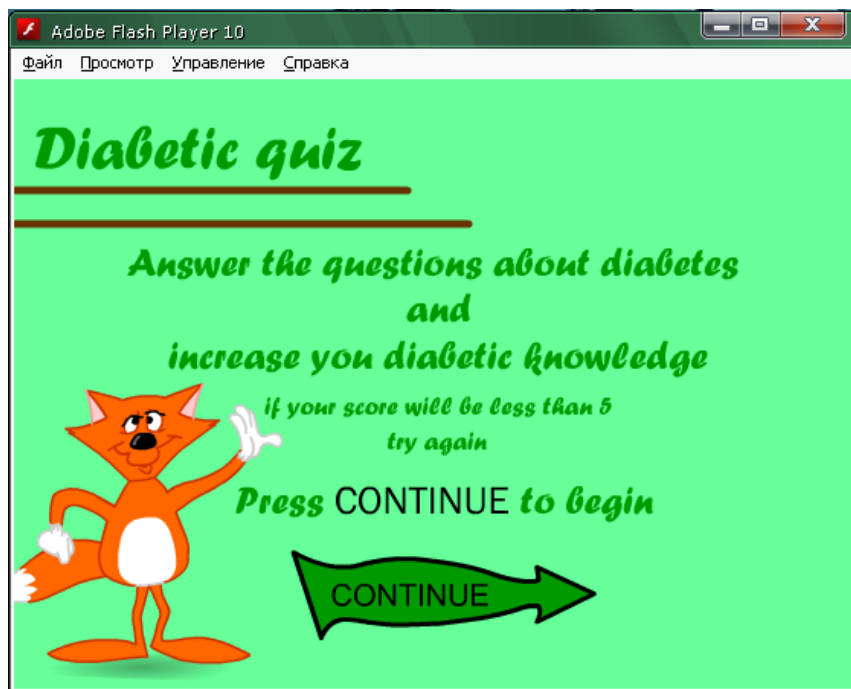


Chart 14. The game “Quiz”

To sum up, questions (Chart 15.) for the current task reflect main rules of behavior for a diabetic child [24], [25].

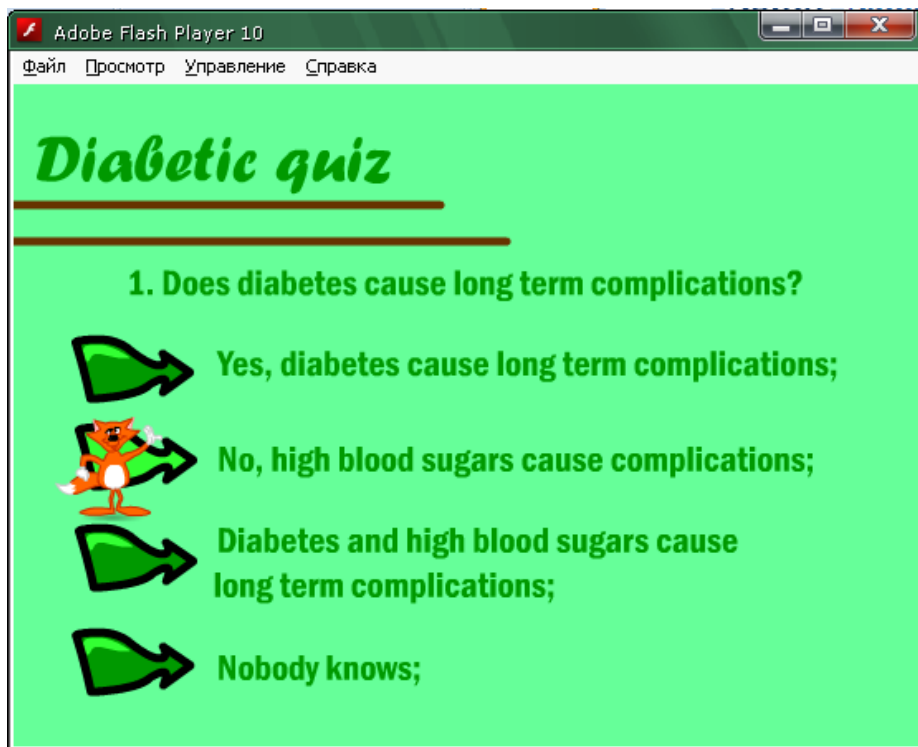


Chart 15. Quiz question

After the task completion the number of correct answers and final score is displayed on the screen (Chart 16.).



Chart 16. Game final

After the completion of the “Quiz” parents are able to see what aspects were learnt by their kid and what needs improvement.

Further there could be presented various types of tasks that have their aim in teaching the kid to take care of his/her own health. At the same time, tasks could be educating games for children of pre-school and elementary school age. Such a game, for instance, is the “Match” game (or a memory game). It is a rather simple game, it is easy to get used to play it and it may be oriented not only towards the development of kid’s memory, but towards a particular topic (diabetes, in our case). Consequently, the system has a potential of improvement and it is possible to enrich it with new task elements.

In summary of the above, an educational system for diabetic children ought to present the complex of tasks and statistical information, which are bound

together with the help of intermediary sections. Such sections bring cohesion to the system, which makes it most suitable for usage.

Experimental part

This section is focused on programming realization of the project: aims and aspects, which apply to educational system for diabetic children developing.

The main problem of the programming realization is to make it very entertaining and interesting for children, to reach the primary goal – to interest child in learning rules of behavior for diabetic people. At the same time parents can get the information which manipulations the children can make by themselves and when children still need their help, using this system. Thus developer would have to use all the uttermost feasibilities of Flash-technologies to reach the goal of the project.

As stated before the application should consist of several parts. All parts of the project were represented as separate applications, which were compound in one big project. Consequently the final system represents as a game where the player goes from level to level. The main hero, the fox, follows the player as well.

Next subdivision will describe the mechanisms of animation developing. It is very important for the final result to choose the right form of animation and affects to add it to the Action Script. Affects, mechanisms, animation and other Flash features are necessary for this project because they help reach the goals of the project most efficiently.

Creating a prototype is also important because a test is required to know exactly if the project is useful for diabetic children or not. After the test step results and observations may be discussed.

The main methods of Flash animation

There are for different types of Flash animation. Developers can use different combination of these basic animation types. All types have their own advantages and disadvantages. That is why all this types should be defined. The explanation why we choose this or that method to get different targets will be done later.

Basic types of Flash animation.

There are four types of animation in Flash:

- Frame-by-frame animation;
- Keyframe animation or tweening:
 - Motion tweening;
 - Shape tweening;
- Timeline effects animation;
- Action Script animation;

Animation frame-by-frame is the type of animation where every frame is made by hand similarly to a real movie. Each frame contains different content and this type of animation is a difficult task to complete.

Keyframe animation is created by putting content inside keyframes only; other frames fulfill automatically. Developer has to create the first and the last frame and the program will interpolate other frames. This type of animation is called tweening and is divided into two subgroups: shape tweening and motion tweening. In shape tweening the objects change their figuration and in motion tweening the objects change their position on the frame field.

Time line effects were first used in Flash MX 2004. They allow adding animation and visual effects to movies and symbols. This type of animation enhances scenarios previously made and which can be managed by parameters from the dialog window.

Creating Action Script animation is more complicated than other types using coding in the animation has lead to interesting solutions, new effects and can be widely used in project scenarios.

This project presented all types of animation, with tweening being most commonly used. Some scenarios include animation frame-by-frame, Action Script and timeline effects animation. Video clips made by Flash cannot exist without two main components: timeline and layers (Chart 17.).

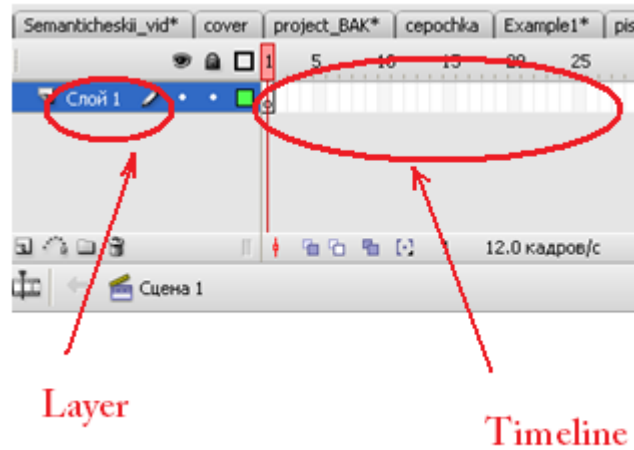


Chart 17. Timeline and layer

Frame-by-frame animation

Frame-by-frame animation is the most basic type of animation. Every frame is filled with unique content and that makes this type of animation perfect for creating of elaborate clips such as face mimic animation. At the same time such animation type has some disadvantages. Creating this animation can be very time-consuming and such frames increase the size of the video clip.

Frame-by-frame animation is commonly used to create the main character of the project. Developing the Fox character who accompanies the player during the game process is examined later.

Elaboration of the man hero was made in two projections: front (Chart 18.a) and on the side (Chart 18.b,c).



Chart 18.a

The Fox, front view

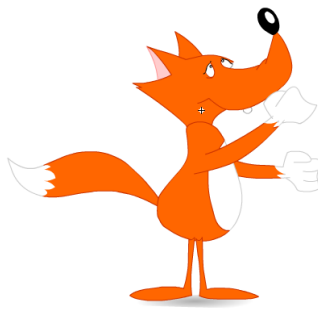


Chart 18.b

The Fox, side view



Chart 18.c







The Fox, side
view, game
“Catch good
food”

Additional side view was brought into existence for one of the parts of the system – “Catch good food” (Chart 18.c).

All three images include animation that was used to make characters look alive and attract the child’s attention from the first seconds of the game. Fox from Chart 18.a has a tail animation. Animation of legs was added to the characters from the Chart 18.b and Chart 18.c, because they are used in parts of the game where the Fox moves (runs or walks) through the screen. The character from Chart 18.b moves without any users commands. Fox from Chart 18.c moves by help of the user when he/she presses the “right” or “left” buttons. To make the main hero more realistic tail animation was added to the image from Chart 18.c and animation of hands was added to the image from Chart 18.b.

Frame-by-frame animation was used on the “legs” of the character. To make the character’s actions more natural we defined the primary inversions of legs for running or walking. There are six main inventions and all of them are shown in the Table 2.

Table 2

Number of keyframe	Content
1	
2	
3	
4	
5	
6	

Sequence of images in the table above shows how to implement the animation frame-by-frame. Tail waving and hands movements have been developed following same principles.

Advantages of frame-by-frame animation.

Frame-by-frame animation makes possible control of animation itself. It allows to implement all small nuances of animation.

There is only one way to implement deletion of images – slide show.

Disadvantages of frame-by-frame animation.

1. Modification of frame-by-frame animation is tedious and time-consuming. In case of interconnected animation, as opposed to discrete set of images, it is necessary to change all frames.
2. Also, frame-by-frame animation files have big size since each frame should have all necessary information.
3. Special consideration should be given to the increase in size of specific parts of the system, such as start page, map of the game and tasks.

The start page consists of animation elements, such as movements in a predetermined path and motion tweening by the keyframes. Motion tweening was used to make text effects, such as effect of showing of the text on the screen in a slow motion.

In order to better understand how such effects have been accomplished reached, it will be beneficial to discuss what can be achieved by motion tweening animation.

Motion tweening animation

Motion tweening is the kind of animation where the developer has to define the initial position and the end position, while the rest will be completed by Flash; and is one of the easiest ways to make a flash animation.

In spite of object movements, this type of animation allows to make transformations (scaling duplication, distortion, etc.) of the objects and colors

effects (brightness, gradations and alpha-channels). The following rules of motion tween animation should be taken into account:

- It is possible to create animation of object position and transformation of the objects only for groups of objects, text or symbols, but not for vectors primitives.
- It is not allowed to use mixed content inside the keyframes, for instance groups and vector objects together. The animation can be incorrect or not function at all.
- Animation of every object has to be done on a separate layer.

Text effects of the start page were made with implementation of motion tweening (Chart 19.)

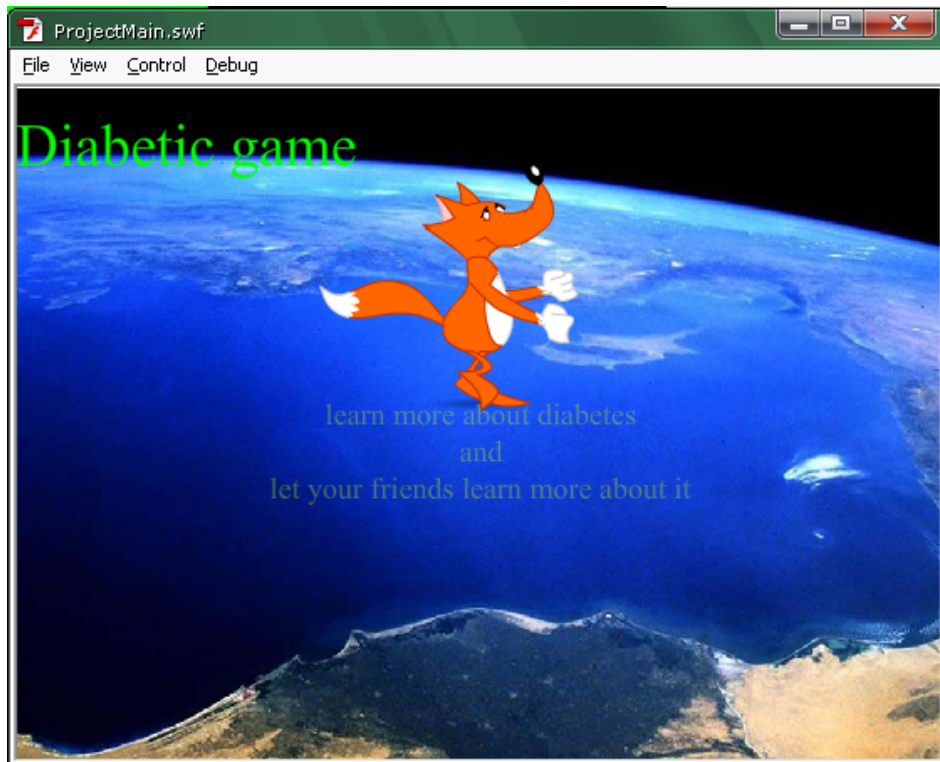


Chart 19. Effects of start page

The effect which is called “Appearance” is one of the simple ones. Use of this effect leads to showing of the text one letter or word at a time, and can be used for separate words and phrases or for parts of the text. The effect is based on

combination of motion tween animation and parameter, which is used to manage transparency of the object. There is motion tween between two keyframes.

The Chart 19. Shows how text, which is in the middle of the screen, becomes visible during the clip. At the end of the video the screen looks as is presented on Chart 20.



Chart 20. The transition frame from start page to the game

Start page shows two more animated objects - heading “Diabetic game” and the main character , the Fox. The Fox is running through the screen and the text is moving to the screen center. Such effect was reached with the help of two different types of layers: regular layer and motion guide layer.

To create an animation, where objects will be moved not strait only but follow the trajectory, developers need to use special layer. It is called motion guide layer. Using this layer, the trajectory of object moving can be set. Chart 21.

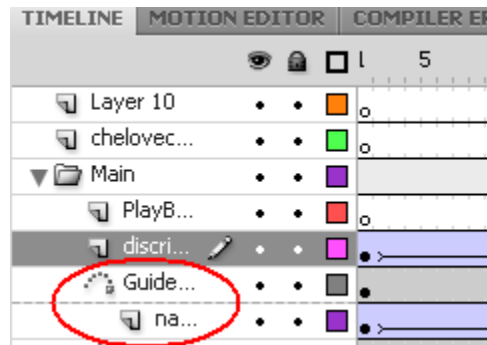


Chart 21. Motion guide layer on the Timeline panel

The general algorithm of movements by the trajectory is as follows: after motion tween is created on the regular layer, the guideway is created on the motion guide layer with help of paint tool called “Brush” or “Pencil”. The object has to be caught by the guideway. Later on, the object will follow the trajectory painted of the motion guide layer, but the shortcut between start and end points. Use of this effect makes the clip more dynamic. Trajectory movements are presented on Chart 22..



Chart 22. Use of the motion guide layer

Brightness of the background (The Earth picture from the outer space) is well-matched addition for the start page, and effectively catches user's attention. Two buttons "Learn" and "Play" come to the start page after the video, and present two possibilities to the user: learning of the information about diabetes and playing of the game itself.

One of the main elements of the system is the game map. The map includes two buttons: task selection button and insulin button, which reminds the user to make insulin injections for the main character (Chart 23.).

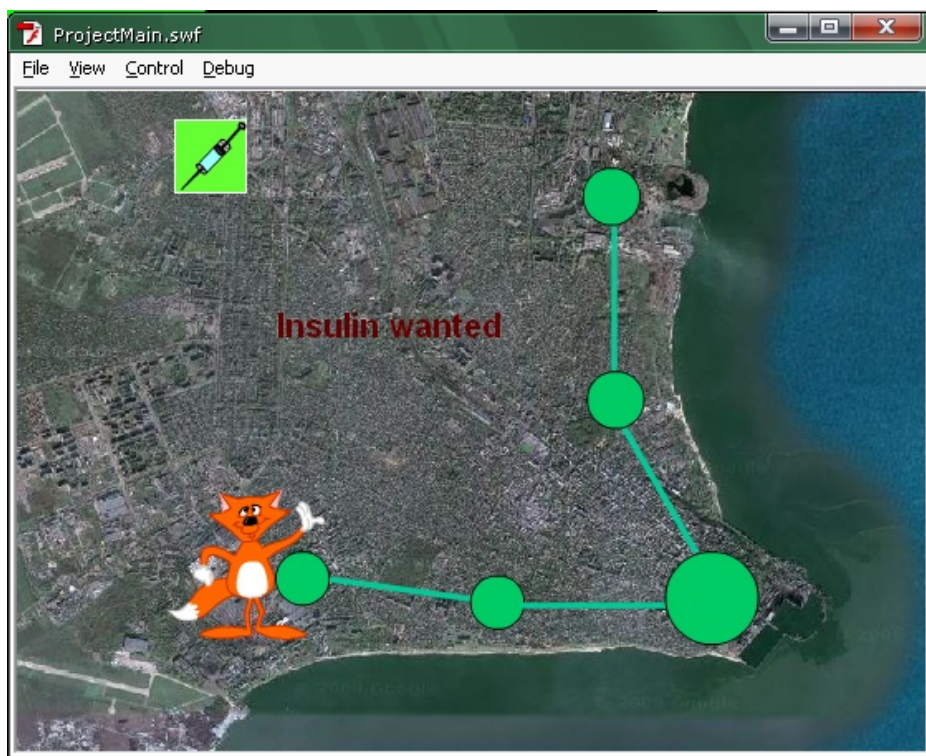


Chart 23. Frame of tasks connection

The Fox on the game map runs from the start page to the map and stays there. It needs regular insulin injections, which is the necessary requirement. That is why in order to start play, user has to press the insulin button first and then select the task.

Take a detailed look at the tasks, which compose the general part of the system. The prototype of the system introduces only two tasks: "Catch good food" and

“Quiz”. Scenarios for the both games were introduced earlier. This chapter presents the programming realization only.

“Catch good food”

The first task is called “Catch good food” (Chart 24.)



Chart 24. The game “Catch good food”


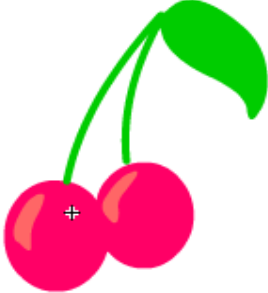

This game is of type “catch or let pass”, and has some outstanding characteristics, such as management of the object or the character, moving from right to left on the bottom or the screen. Other objects (for example, meal) are falling down from the top. The player has to catch the objects or deviate from them.




The Fox can be managed by the buttons “right” and “left” and moves from side to side, when the user holds the button. The fox will stop automatically next to the frontier.

The food falls down from the random points on top of the screen and from arbitrary time interval, but not very often. The game is finished, after fixed numbers of food are fallen down. If the player catches food, which is included into the diabetic diet, he/she get one point. If the food is not included in the diet, he/she loose one point. The total score cannot be less than zero.

The game includes two clips. The first clip consists of “good” food pictures and the second includes the “bad” one. The first clip is made up of 6 numbers of foods (Table 3)

Table 3



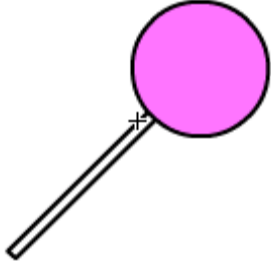

The name of useful food	Picture
Apple	
Cherry	
Milk	

Fish	
Carrot	
Meat	

Various food items in the table above have been chosen from the diabetic food list and can be eaten everyday by diabetic people.

The “bad” food clip consists of five names of food (Table 4).

Table 4

The name of harmful food	Picture
Ice cream	 A sundae in a light blue glass dish with three scoops of ice cream: yellow, purple, and pink.
Chocolate candy	 A vertical candy wrapper with alternating blue and pink horizontal stripes.
Lolly pop	 A round pink lolly pop on a white stick.
Cake	 A round cake with pink frosting, a yellow layer, and brown frosting. It has six lit candles on top.

Hamburger	
-----------	--

“Bad” list consist of the food items, which are popular between healthy children and totally forbidden for diabetics.

When the food falls down from the top, it can be good or bad. Code will show the frame from one of the clips.

The main functions of the game (“initGame”, “moveFox”, “dropNewFood”, “moveFood”) are collected inside the clip “actions”.

The function “initGame” initializes list of variables. It makes Fox clip, which is created programmatically and cannot be added to the main clip because the fox has to be over the food.

The function “moveFox” allow users to manage the fox actions. The object Key checks condition of the keyboard. Functions Key.isDown(Key.RIGHT) and Key.isDown(Key.LEFT) control, whether the buttons “left” and “right” are pressed. To make sure that the fox is inside the screen, coordinates were set. Coordinate values of the fox are compared to the border coordinates. The fox stops moving, when values are equal.

The function “dropNewFood” is called once in every frame. Three requirements define timing of ne food item creation:

- moment of last food creation,
- total amount of food items, in comparison to the current number;
- and, lastly, ten per cent probability that the food will be falling down.

This entails that interval between two downfalls will be different every time.

The random place should be chosen to create a food item; that is why all items are falling down from the random points on the top of the screen.

The function “MoveFood” invokes movement of the food. It has to change the vertical position and checks, whether the food item falls to the bottom on the screen or inside the basket. To find out, whether the food item is on the ground or inside the basket, the function should check the food position. Check for item location can be done in the following way: initially, define whether the distance from food to the fox is inside given range. If the food is in the range of 10 pixels down and 25 pixels across, that means that the food is inside the fox basket. The center of the fox clip is in the center of the basket (Chart 25.).



Chart 25. Center of the clip

As soon as the food is inside the basket or is located at the ground, the counting function increases the score of total food and another function deletes the food frame from the game.

“Quiz”

Task “Quiz” is used to examine a child’s knowledge about diabetes. The program is written with the understanding, that the quiz is not the funniest game for children and aims to design an interface, which will attract child’s attention and invoke interest in taking the quiz. Following this idea, the first frame of the quiz consists of the picture of the main character and description of the game; the frame was made using green colors. Green color has the anodyne effect, which makes the task easier to pass (Chart 26.).

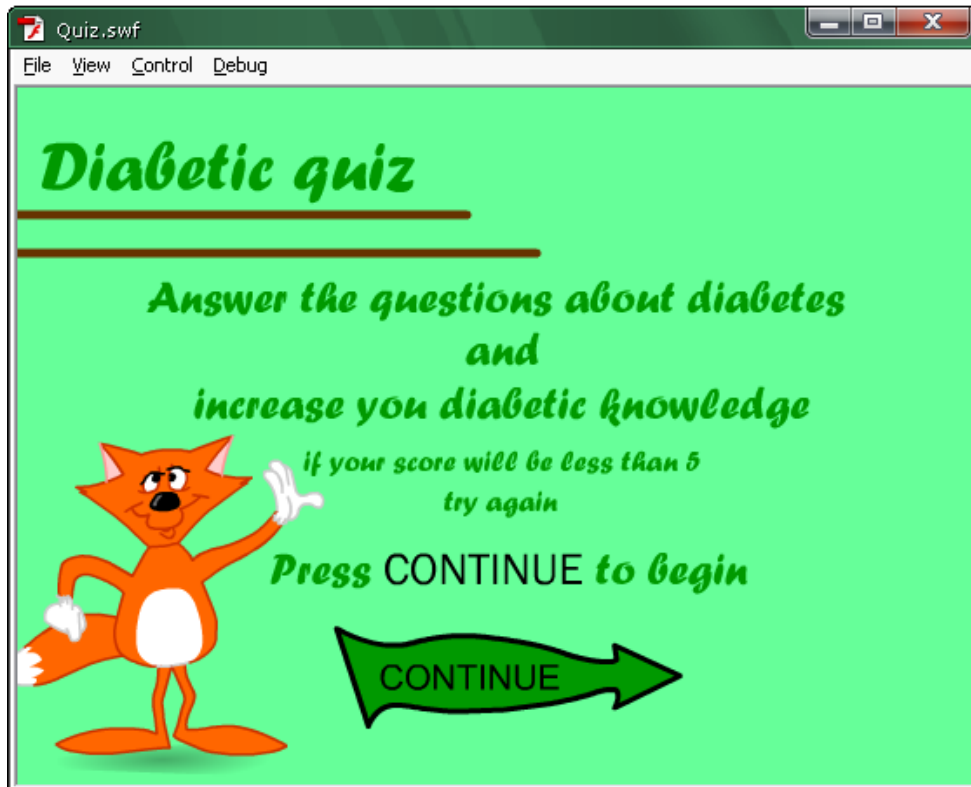


Chart 26. Main view of “Quiz”

Every frame of the game contains different questions. Navigation from question to question is done by pressing button next to one of the answers. If the player did not choose an answer, he/she cannot move on to the next question. The cursor is represented by an image of the fox – the main character (Chart 27.)

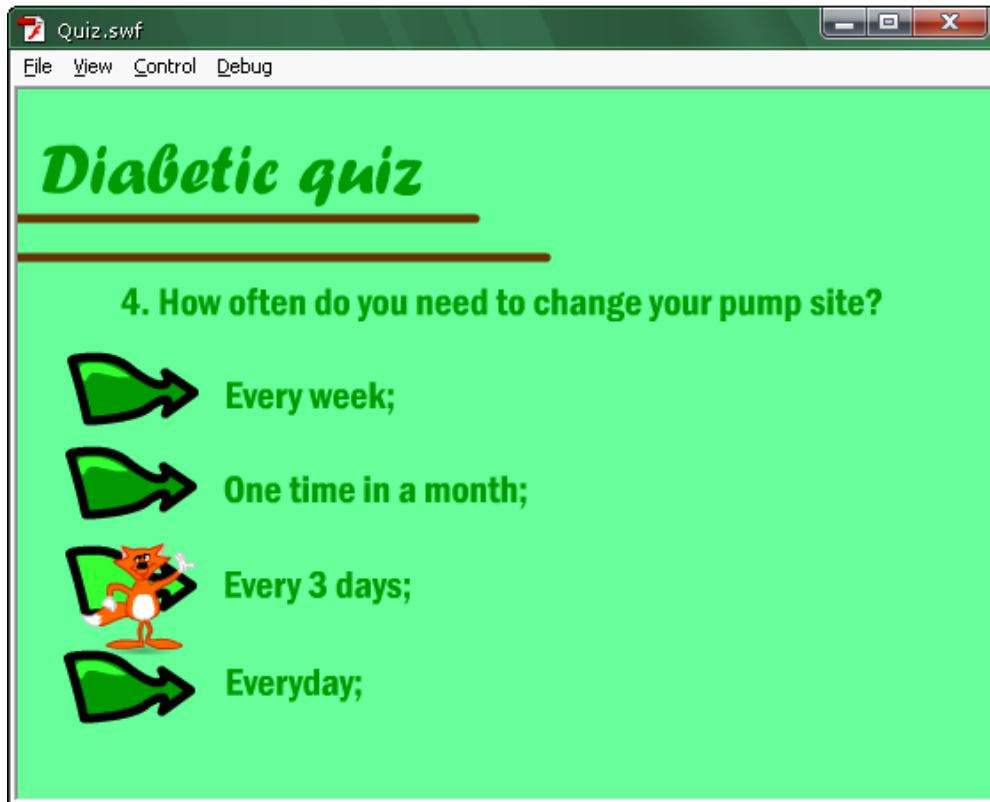


Chart 27. Quiz

When the user chooses the answer, the fox starts wagging its tail, indicating that the answer was chosen and user can proceed to the next question. The quiz is completed when all the questions have been answered. The counter is used to indicate the number of correct answers and the percentage of correct answers from the total. The total score and statistics are output to a screen at the end of the quiz (Chart 28.).



Chart 28. Total score output

The total score defines whether or not the player can move on to the next task. The same data is used for summary statistics, which parents, children and doctors can analyze once the game is over.

The last 10 results are recorded, which allows users to see the child's progress.

The game can be played online. That is why every user should have his/her own account and results.

Testing.

The quality of software products is defined by conformance to the set of specific requirements, set forth by design engineers, where concerns of marketing specialists and customers have been taken into consideration.

During quality assurance testing, level of compliance to the requirements is verified and recorded.

Testing process consists of several steps:

1. Quality assurance testing, which aims to ensure quality of the software product, which meets the previously set requirements
2. User acceptance testing - participation by the potential customers in the testing of a new product

The following goals should be achieved during the testing process:

- Correction of identified problems
- Analysis of data collected
- Developing recommendations for improvements

Let us consider an example of such testing of a software system, which can be used as a prototype for testing of the software described in this paper.

The aim of the testing process is to verify that an educational game program for diabetic children adheres to the requirements. Also, it is important to find out whether children will play the game. Detailed analysis of what can be improved to make the game more attractive should be provided.

The testing process should include the following elements:

- Check whether the tasks correspond to the level of the intellectual development of a child;
- Whether a child will manage the tasks,
- Whether the tasks serve their educational function.

One of the main goals of the research during testing process is to find a way to improve the system, while paying attention to possible reaction of parents.

It is important to define a setting where the testing process will take place. The fact that this program can be played online, allows selecting and involving participants to be easier.

The testing group consisted of 11 participants, mostly elementary school students and their parents. Participants were offered one version of the system, and were informed about the research's goals. Participants were expected to use the game during a period of 10 days, and then provide the feedback to the programmers.

Generally positive feedback from all the participants was received. However, the following remarks were made:

- 5 out of 11 participants suggested adding more tasks.
- 4 participants suggested adding some food items, since fruits and vegetables are not the only appropriate food for healthy diet, and sweets are not the only thing which is highly undesired
- 2 participants indicated that the questions 2 and 5 are formulated inappropriately.
- 6 participants mentioned the task "Catch good food», pointing out that speed of items' flow can be too high, making it difficult for children to react; children might not be able to catch food on time.

In the next stage the following changes were made:

- We added several food items to the task «Catch good food», such as fish and hamburgers.
- We reformulated the questions 2 and 5 according to the remarks from participants
- Speed of items' flow has been decreased

These changes have been implemented into the educational program for diabetic children presented here; then the final prototype was tested by the same focus group over the period of three days. After completing usability testing the testers

sent in their opinions by mail. All of them were positive, for instance: “Children liked Foxy and enjoyed the game. I found the main hero funny and was catching food with great relish. Thank you.” Maria, Moscow.

Discussion

The ultimate objective of the project is to inspire children to better deal with their illness, and hence to make life easier for them in spite of suffering from a chronic disease. The goals were defined as helping diabetic children to learn more about their disease, and helping to teach the children what to do in emergency situations and how to live normal life and communicate to healthy peers. Throughout the development process, we have tried to adapt advantages of related successful solutions and to eliminate drawbacks of the previous diabetic software projects. The main idea was for the application to be funny and easy to play, allowing the users opportunity to enjoy the game process.

General criteria were discussed in Chapter 2. They include value of the project and connections to the related works, which comprised the framework for creating a new game idea. Related works about diabetes were compared to each other, and after this step a new, original concept was formulated.

The idea of teaching children through playing is not a new one. Similar products let children to play a complicated game, which presumably needs to be installed on a computer. A “complicated game” in this case means a game which has plotline and requires significant amount of play time from its users. “Packy & Marlon” and “Captain Novolin” are good examples.[8], [9], [14], [21]

Educational system for diabetics introduced in this paper takes a different shape: that of a small arcade game. Arcade games are a type of game genre defined by fast pace and requiring good hand-to-eye coordination skills to play. Pinball games for PC would be considered an arcade game [22]. The main point is that arcade games demand a fast tempo of playing. “Educational system for diabetic children” concept views this as an advantage. Our game can also be accessed from the internet. Correspondingly, a player can reach his/her own game account if he or she can reach the internet.

Neither the concept of an arcade game nor the idea of a diabetics-specific game is new. But educational system for diabetic children provides for different game

scenarios meant to teach diabetic children to do the same things which healthy children do while taking into consideration their own specific needs. For example, knowing how to choose appropriate food.

One of the common objectives defining most developments (devices and software) for diabetic children is the need to mitigate conflicts between parents and children. These conflicts occur because children often wish to be more independent from parents (as would any healthy adolescents), but parents are concerned about their diabetic children's health, naturally. Such misunderstandings could easily lead to a conflict within family.

So, one of the objectives espoused by this project was to try to resolve this issue. And, as the usability testing showed, it did so rather successfully. The game is simple to use, so children do not need to spend a lot of time learning how to play. Generally plotline-based games are not easy to play since a user has a lot of possibilities in choosing game strategy and ways of controlling the main characters. This makes the game process more complicated and children tend to lose sight of the main idea of the game. Also parents do not need to explain to children what they should do. The colorful main character has one more function besides amusing the player: it will help the children to forget that this is a "special game" and thus lead them deeper into the game process.

Another problem solved here has to do with the past requirement that games must be installed on a specific computer. This generated numerous complications e.g. old software could not be installed to a machine with a newer operating system. That is why "educational system for diabetic children" was created as a portable system. This means the game can be accessed from the internet and linked to from a website such as Facebook, or some other social network. This makes the game considerably accessible when compared with old-fashioned games disseminated via compact disks.

Devises which were introduced in Chapter 2 are designed to help people with diabetes cope physically i.e. make insulin injections, count carbohydrates and create customized diet plans. Three of the earlier generation games were real-life simulators. For instance, "Packy & Marlon" is a sophisticate diabetic game

which teaches children to take care of themselves[8], [9]. However, the game was developed more than ten years ago. The latest related game was introduced more than five years ago. Yet the game described in this paper is considerably newer, developed using more advanced technologies.

When speaking about the interface, there are several criteria which can be used to compare educational system for diabetic people with related works and specifically games.

The game is laid out in an intuitive way, so to be easily understood by the user. Simple interface affords the user an opportunity to play in a much more comfortable, uncluttered environment. It is one of the most important considerations in interface design - comprehensibility. Comprehensibility means that if the user cannot understand the interface, he/she will likely choose not to use it. In the case of the “Educational system for diabetic children”, the system lay-out is very simple to use for different people, including small children. Because play scenarios are small and easy to understand, there is no need to have a long user guide and all the rules can be found within the first frame of every game.

Also, the game was designed to be easy to learn. This means that the user can spend his or her time getting useful information from play instead of trying to figure how things work. As already mentioned, there is a small user guide is on the front frame – providing all the information required to learn how to play. Thus we can see how comprehensibility and learnability are connected to each other. And, in order to achieve the best result, both of these were taken into account. According to the testers, the game is simple to understand, easy to learn and, in general, compares favorably with similar products.

One of the serious limitations of earlier diabetes-related games was the fact that they were targeted only at people with the sugar diabetes. But “Educational system for diabetic people” can be used as a framework for educational systems for people afflicted with different diseases, not only diabetics. The game continuities can be directed at a different area. For instance, the system can be used as educational system for teaching children about healthy food. If one

looks through related work, one will find that games “Packy & Marlon” and “Captain Novolin” [8], [9], [14], [21] are directed only at diabetes patients and cannot be changed to reach other goals. “Squire’s Quest!” [10] is an example of a game which can be used by diabetic people as well as by children learning about other diseases or just healthy food choices.

The problem of memorization is a frequent occurrence when developers create software, particularly for children. If the program’s rules are easy to remember than it can be said that the efficiency of the design of the program is increasing. It is easier to learn and to use. In the case of the Educational system for diabetic children, memorability has to be carefully taken into account is we are to achieve our main goal: to interest diabetic children in learning more about diabetes. If we are successful, children will pay more attention to useful information. This becomes possible because of the way the information is presented. The game consists of actual information as well as of the play tasks, animation, funny pictures and a nice image of the main character.

And the last problem which was solved is the problem of availability. Every player would like to have access to the game whenever he or she wants to play. Games previously introduced in this field had this problem: they could only be played if and when a user had access to computer with a game installed on it. “Educational system for diabetic children” solved this problem because it was made as a web-based application. Users access the system from the internet and every user can have personal account. Such account stores information about the user and his or hers game play scores. Games which were discussed in Chapter 2: “Packy & Marlon” and “Captain Novolin”, “Squire’s Quest!” [8], [9], [14], [21], [10] do not offer these functions or internet access.

Our aim was to develop an interesting and engrossing game, yet not have the youngest users turned away by its complexity. This program is effective because it provides sufficient information and all the necessary clues and instructions a user might need.

Usability testing showed that users were quite satisfied with the game playing experience. They also liked the concept and were involved in the game process. At the same time test users had a lot of different creative ideas on new game scenarios and were enthusiastic about sharing them. This was a clear sign of interest in the game such as this.

Therefore we can confidently say that the “Educational system for diabetic children” a new step in custom educational game development, distinguished from the like systems that came before it, adding new useful features while keeping and further developing its predecessors’ successes.

Results and findings of the work will be described more carefully in the Chapter Findings.

Findings

This paper studied specific technologies: devices and software related to the field of diabetes education. Comparative characteristic of the examined technologies, defined their advantages and disadvantages. Also the main principles used in the design of the Educational system for diabetic children framework were determined. Comparative analysis of various Web resources, helping people suffering from chronic diseases to make their life easier, was performed. The area of system distribution of the program was defined. The research and data collection related to end user experience and opinions was done both in terms of immediate user experience and suggestions for future improvements.

Goals of the project was formulated and implemented. The aim of the project is to interest children in an educational game thus allowing them to get the necessary knowledge and skills during the game process.

Prototype of the Educational system for diabetic children has been implemented and tested. In its current form it has proven successful in improving coping skills and teaching new information about diabetes thus making children's lives more comfortable.

Usability testing performed after the system's conception showed rather successful results. The goal was to confirm that the game system is able achieve the main objectives of the project. A prototype of the system was created specifically for usability testing. The prototype incorporated main components of the system such as main page (where children can meet the main character, the Fox), some sample tasks (to illustrate the main idea of the game) and statistics collection for every sample task. Usability testing helped to reveal mistakes and successes as well as to confirm the correctness of initial suppositions on which the project was based. A follow-up bug correction effort also allowed us to incorporate useful ideas generated by testers.

We were also able to confirm that the Educational system for diabetic children can be updated with inclusion of artificial intelligence elements thus allowing for

an increase in numbers and types of tasks. These will in turn improve quality of player's gaming experience and knowledge.

The system is designed to be portable and can be reached from any place with Internet access. Players can use either full version of the system or some parts of it. The system can be used not only by diabetic children but by other classes of users.

The project is useful and would be helpful as an additional way of educating and treating children suffering from diabetes.

The principles, ideas and goals espoused by this project can be used for other educational systems meant to help people living with other chronic diseases.

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