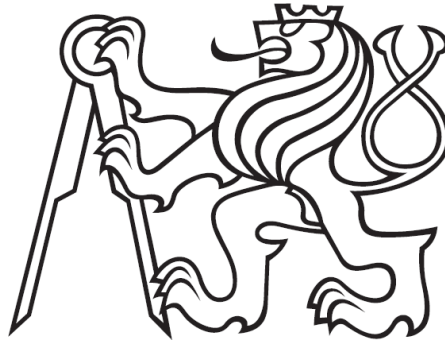


Czech technical university in Prague
Faculty of electrical engineering
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Diploma thesis

Implementation of serious game to support children's education
in diabetes mellitus I

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Study programme: Cybernetics and robotics
Field of study: Robotics
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Czech Technical University in Prague
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DIPLOMA THESIS ASSIGNMENT

Student: Bc. Lukáš R u b e š
Study programme: Cybernetics and Robotics
Specialisation: Robotics
Title of Diploma Thesis: Implementation of Serious Game to Support Children's Education in Diabetes Mellitus I

Guidelines:

1. Study problematic of serious game design in clinical practise.
2. Design a platform for finite automata description according to a general game scenario.
3. Implement the platform in Unity.
4. Extend the game using gaming principles (e.g.minigames, quiz) for diabetes treatment.
5. Validate the game concept on 5 users.

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Author statement for undergraduate thesis:

I declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with the methodical instructions for observing the ethical principles in the preparation of university thesis.

In Prague, 25 May 2017

Lukáš Rubeš

Abstract

This work deals with the creation of a finite automaton of a tutorial for a serious video game. The tutorial helps to understand the main actions connected with diabetes mellitus I. It teaches players what is the correct order of the actions and what should be done in a course of a day. Another finite automaton is created to understand the concept behind doing sports. A minigame Balloon is added to the serious video game to entertain players and increase its playability. In the end, a qualitative research is conducted in order to examine an acquisition of the game. The game emphasises added value in knowledge about type I diabetes.

Keywords: Unity; finite automaton; tutorial; diabetes mellitus I; Balloon.

Abstrakt

Tato práce se zabývá vytvořením konečného automatu pro tutoriál do naučné video hry. Tutoriál slouží k pochopení problematiky diabetes mellitus typu I a akcí s tím spojené. Učí hráče správné pořadí akcí, které se mají vykonávat během dne. Další konečný automat je vytvořen pro pochopení omezení ve sportu. Do naučné hry je přidána minihra Balónek za účelem zábavy a zvýšení hratelnosti. Nakonec byl proveden výzkum za účelem zjištění přínosu samotné hry. Hra klade důraz na přidanou hodnotu znalostí diabetu typu I.

Klíčová slova: Unity; konečný automat; tutoriál; diabetes mellitus I; Balónek.

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1 Introduction

There are more than 420 million people worldwide with the disease of diabetes (1), from which 5–10 % of all cases belong to diabetes mellitus I. Each year there are 80 000 children, who develop this disease and must deal with it for the rest of their lives.

It is very important to teach children how to take care of themselves as soon as possible. Without proper care, many other diseases will develop and it can lead to death. The first step is always talking to a doctor but there is no guarantee that the child remembers everything.

One way of approach is through games and gamification.

1.1 Goal

The goal of the thesis is to improve children's knowledge about diabetes mellitus I through gaming. For that, I created a tutorial to the MyDiabetic game (2). The tutorial guides a player through an ordinary day of a person with diabetes. It starts with dinner and ends with breakfast when the tutorial is over and the normal game begins. Each step is accompanied with a voice and text output. Actions connected with diabetes are executed in the correct order. The player cannot change the order and is taught the right way how to take care of himself/herself.

I also created rules for doing sport. This should teach children what actions must be done right before physical activities.

For purpose of entertainment, I made a simple minigame. This should attract children to play the game more and with that learn more about diabetic habits.

For testing, we (test part was put together in a group of people, who worked on the project this semester, namely Natálie Zubková (3) and Bc. Dušan Jenčík (4)) found 7 children with diabetes and compared their knowledge before and after one week of playing the game.

All parts are implemented in Unity.

1.2 Diabetes mellitus I

Diabetes mellitus I is an autoimmune disease affecting mostly children and teenagers. In the pancreatic islets, there are β -cells that produce insulin, which is needed for the

body cells to be able to absorb glucose. Without glucose, the body cells begin to starve and start digesting the fat. The lack of the insulin in the body of a person with diabetes mellitus I is caused by the immune system that destroys the β -cells. The glucose is then present in the blood without anything absorbing it and leaves the body through the kidneys in a form of urine.

The symptoms of the disease are frequent urination, hunger, thirst, and loss of weight. They usually develop in a short period and need to be treated as soon as possible. The cause of the disease is still unknown up to this day. It is believed though that the reason is hidden in genetic and environmental factors. There is also no way how to prevent it, even healthy lifestyle does not prevent the body from developing the disease.

The treatment of diabetes mellitus I is very difficult as there is no cure for the disease yet. The patient is dependent on the regular intake of insulin after every main meal. The insulin is injected into the body through a needle under the skin or it can be delivered in the body by an insulin pump. Neglecting the treatment (injecting the insulin, lack of movement) leads to various illnesses and can be even the cause of death.

1.3 Gamification

Gamification is a technique that helps with the learning of non-game context through game principles. In the recent years, gamification has been a trending topic (5). Interest is reflected in an academic context as the number of scientific papers is growing.

There is a study (6) of several serious games about diabetes and the influence of the user. Usually, the main principle was to balance insulin and food to keep the character's blood glucose in a wanted range. Throughout the repetition of basic tasks, the player gains some knowledge about the problem. By playing a game the player enters a state of flow. It states that when the physical skills of the user are matched by the level of challenge posed by the game, the user loses track of time and enters a state of complete focus. The benefit of the flow state is that the user becomes completely focused on the game and everything else vanishes.

1.3.1 MDA framework

In (7) MDA framework (Mechanics, Dynamics, and Aesthetics) is presented. It is designed to bring game design and development together.

Aesthetics describes the desirable emotional responses evoked in the player when he/she interacts with the game system. Designers and players have both different perspectives as what is the most important part of the game. Usually, this is the main

breakpoint as whether the player likes the game or not. Several criteria need to be involved for a game to be entertaining and later successful. Here are some of the points of view that need to be considered:

- Narration – Does the game bring good storytelling and drama?
- Challenge – Are tasks and obstacles still challenging after a while of gameplay?
- Competition – Can you defeat other players and become the best?

Dynamics describes the run-time behaviour of the mechanics acting on player inputs and each other's outputs over time. It is desirable that the players see the end of the game and know under which conditions they win. By developing models that can describe and predict gameplay dynamics, we can avoid design pitfalls. There are games that increase the differences through the game based on initial position or luck and are enjoyable after a while only for the winners. The ones on the bottom lose interest as they are unable to climb back on the top.

Mechanics describes the components of the game at the level of data representation and algorithms. By changing mechanics only, a bit, a new game emerges and can be entertaining for another period. For example, a different condition of winning the game leads to different strategies and forces the player to see the game from another point of view.

By understanding this concept, we can easily visualise the dynamics of the game. And focusing on each of the three levels we improve the gameplay and the desired behaviour.

1.3.2 Design philosophy

Having three parts, play, meaning and reality, the design philosophy is introduced in (8).

The play component stands basically for everything a player interacts with. The goal is to keep the player entertained and motivate him to keep on playing and finishing the game. The key to achieving this state is like the one described in 1.3.1, such as decision making or rewards. But most of all, the player needs to have fun while playing.

The meaning component is based on psychological theories. The game should ensure achieving the desired goal, which is in most cases a change of lifestyle.

The reality refers to the similarity with the real world. It has, however, two sides of a coin. On one hand the more detailed game the better, on the other hand, it can mislead players into unrealistic thinking. But usually, the serious video games try to represent the world as realistically as possible.

2 Concept

2.1 Selection of an avatar

When a player firstly opens the game, he/she must enter some information about himself/herself. After that, the player must choose his/her own friend in a form of an avatar. There is a girl, Emma, and a boy, Adam. They have different clothes and a different model of a face. However, throughout the game, the player can buy new clothes and for instance dress Adam with the same clothes Emma has.

In the previous versions of the game, the player could change the sex of an avatar during the gameplay. I wanted to create a bond between the player and the avatar. This should somehow represent life, where friends are not that easily replaced. It also simulates a situation, where the player takes care of someone who has a severe disease. It is not possible to abandon the person.

The only option how to change the avatar during the game is to reset the game. With that, the player loses his/her progress and must go through everything again.

2.2 Finite automaton for tutorial

When designing a solution, I used the actual principles of the MyDiabetic game. In the game, there is an avatar with diabetes type I disease and a player must take care of it. The avatar simulates basic needs, such as hunger, need for usage of a toilet, need for sleep etc. Then there are actions connected with diabetes. The avatar can measure glycemia level and inject an insulin dosage.

My goal was to design such tutorial so that the player goes through all the important parts. In the game, there is a doctor, who advises the player throughout the day what should be done. In the tutorial, the doctor guides the player through given tasks. This helped me accomplish the state, that every correct or wrong move is accompanied with voice feedback. This part is crucial especially for those, who don't have vast knowledge about the disease. The game teaches children how to take care of themselves and there is nothing more important than the proper explanation in the beginning. The instructions from the doctor may differ in the current version of the game.

The first task was to come up with time, when should the tutorial in the game start. The avatar must go through all the activities from which one is sleeping. People with diabetes must apply two types of insulin, short-term and long-term. The former one works almost immediately (up to 30 minutes) and is applied during the day before a meal. The latter has a gradual effect and must be applied before going to bed. The union of these two preconditions is 17:30, the time before dinner.

For purpose of better visualisation, I created a scheme with the state machine. The legend to the scheme is shown in Figure 1.

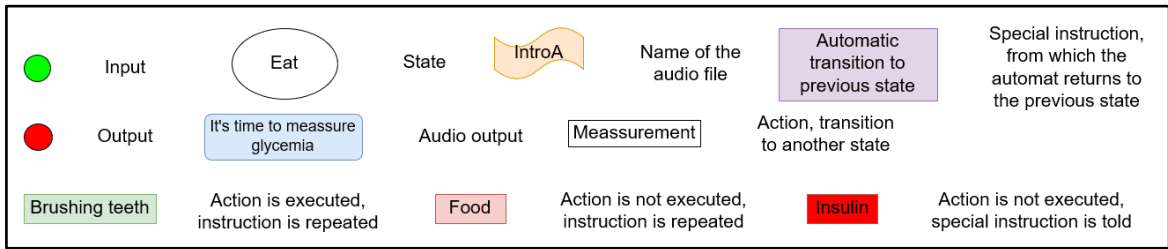


Figure 1: Legend explaining the state machine

When it's time for dinner, several actions need to be executed. One must wash hands, measure glycemia level, apply short-term insulin before a meal and then have the meal. Washing hands is the least significant task, nevertheless, hygiene is a good habit to be taught. The next three tasks are crucial to have the correct order in which they are listed. The food increases glycemia and needs to be suppressed by insulin. Therefore, insulin is applied circa 30 minutes before a meal, so that the glycemia level is in balance. However, a dosage of insulin is dependent on the actual glycemia level and on the meal which is to be consumed. Measurement of the glycemia level is an integral part and must be done as a first step. This part is depicted in Figure 2.

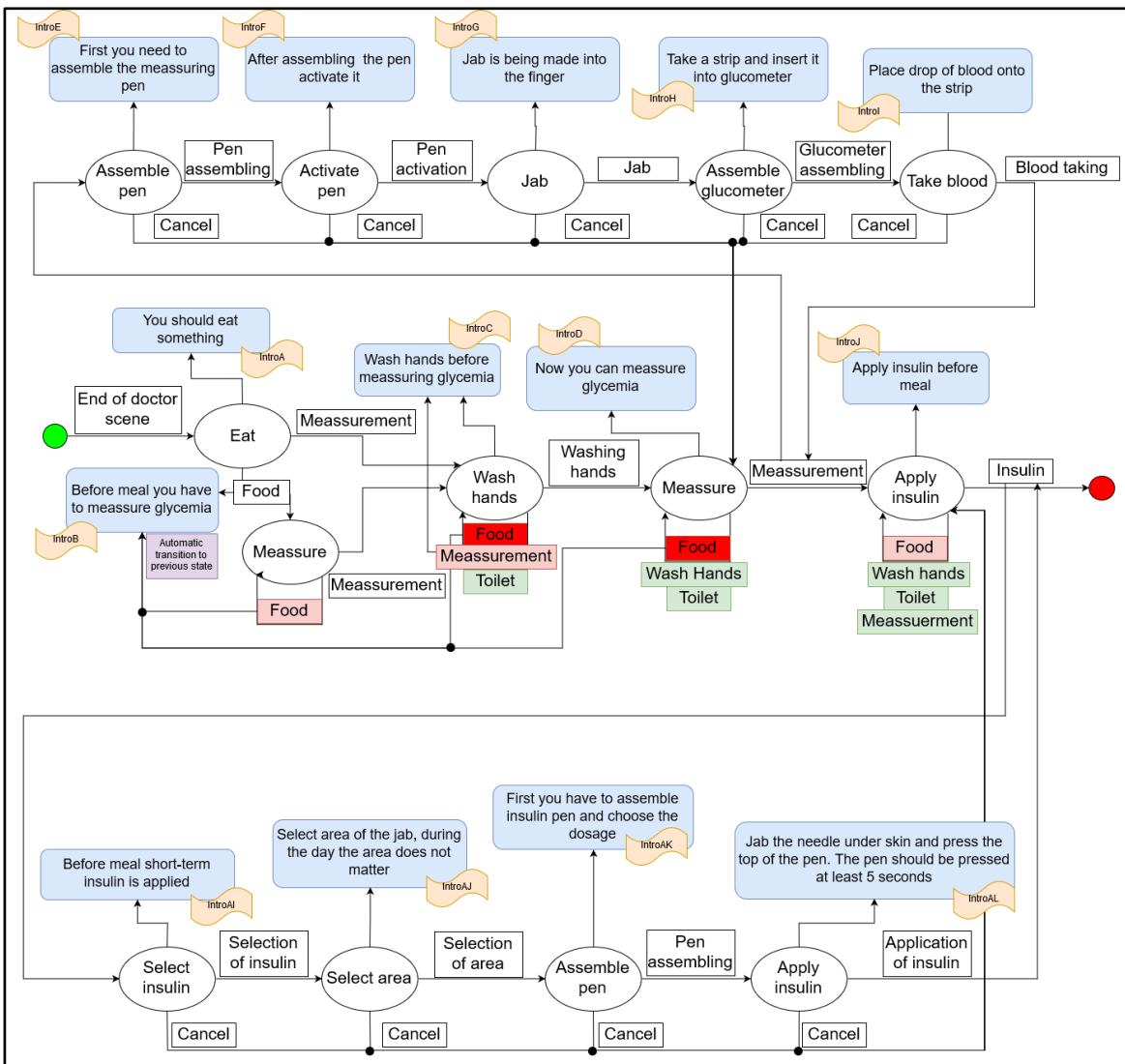


Figure 2: The first part of the state machine

When the diabetic part is done, it's time for other needs. The avatar should go to the toilet, do a physical activity and take a shower. This represents the daily regime. After that, the player is advised to rewind the time forward to the second dinner. The second part of the state machine is very straightforward forcing the player to move forward. The process is shown in Figure 3.

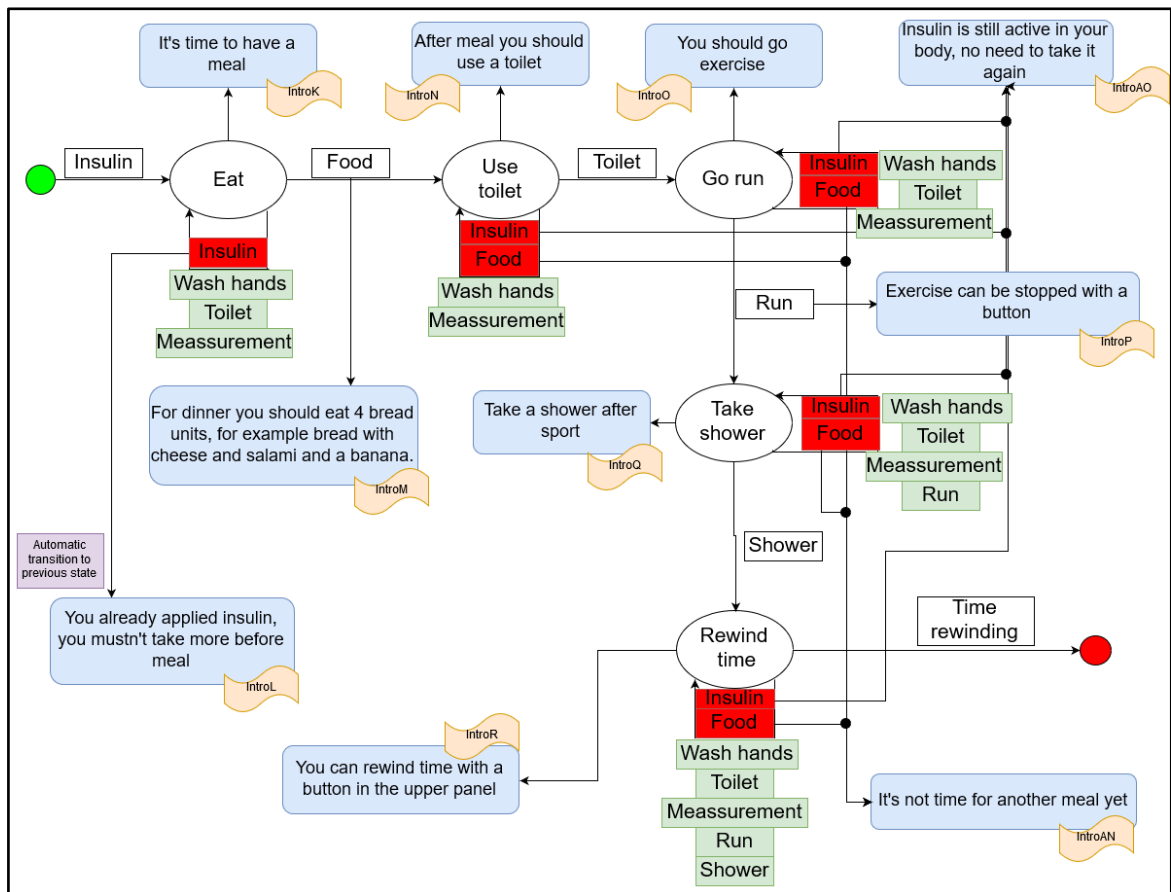


Figure 3: The second part of the state machine

The second dinner is, however, different. The meal is eaten first and then the glycemia level is measured and the insulin is applied. This is due to the fact, that before sleep long-term insulin must be applied and its application is done after the second dinner. What is left, is brushing the teeth and going to sleep. Again, the player is advised to rewind the time forward, which ends the tutorial and the game continuously passes into its normal regime.

In Figure 4 the last part of the state machine is visualised.

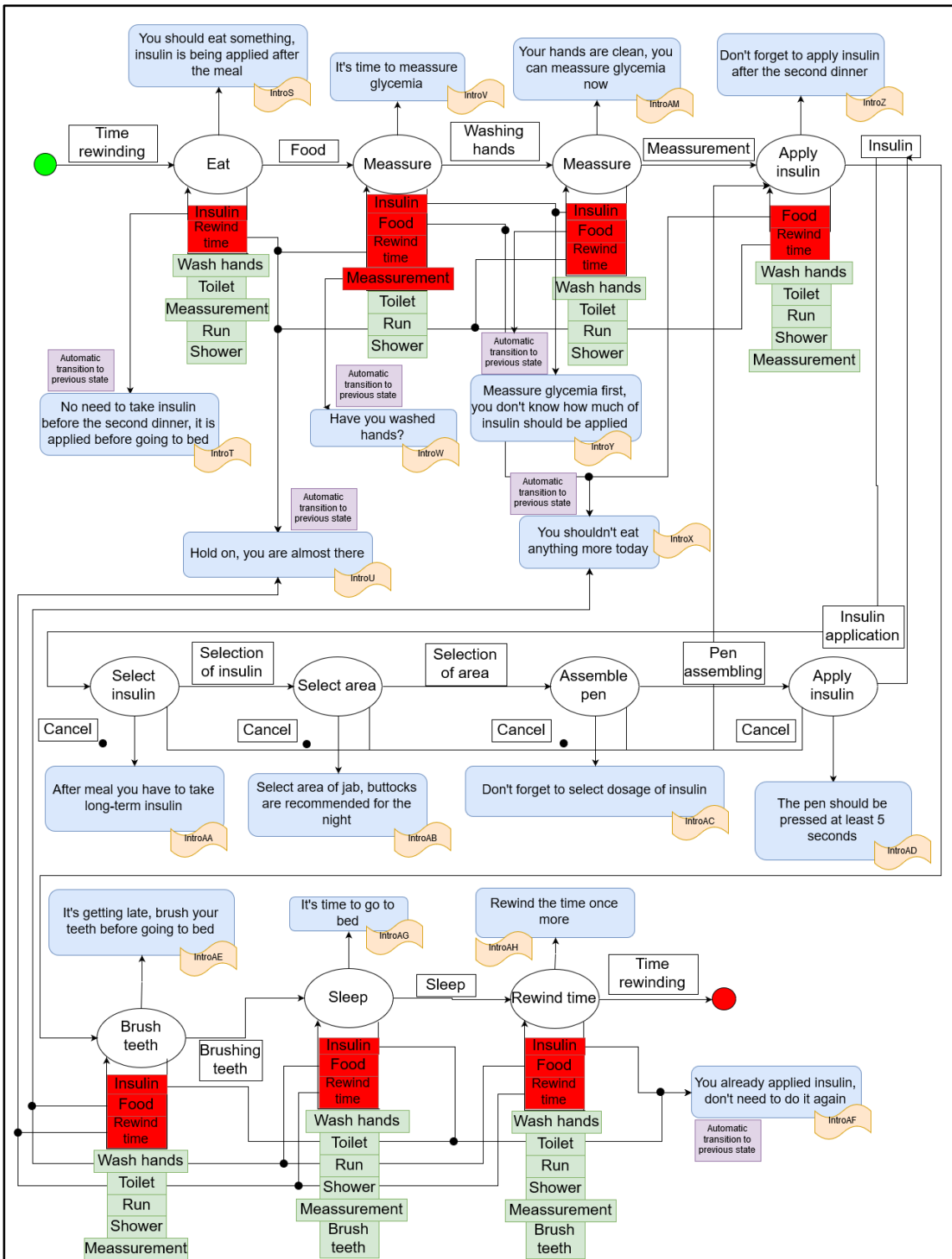


Figure 4: The third part of the state machine

2.3 Finite automaton for sport

As a part of the task, I also created a model for sport in the game. A player must react to the current situation before going for a run.

Sports and physical activities in general lower glycemia level and a person with diabetes must take that into consideration. There are several sports that are not suitable for them, such as adrenalin sports, diving or activities in heights. Other sports are totally fine with a small precaution. To prevent falling into the hypoglycemia state, there are two options. First is to lower the insulin dosage in before. This, however, needs to be done about 30 minutes before. The other option is to eat some bread-units right before the activity. For a person on a diet, who wants to lose some weight, the former solution is recommended.

In the game, I simulated the variant with food intake right before sport. There is a simulator for the glycemia level and it is designed the way that a player applies insulin before the main meals. It would be inconvenient for a player to enter information that he/she wants to do sport after the meal.

Before every activity, a player must measure the glycemia level. Without is he/she is not allowed to start doing the sport. The result of the measurement is dependent on the length of the activity. The restrictions are shown in Table 1.

Table 1: Restrictions on doing sport

the length of the sport	30 minutes	60 minutes	90 minutes
glycemia level			
under 4	Eat 1 bread unit before sport	Eat 2 bread units before sport	Eat 4 bread units before sport
between 4–7	Eat 1 bread unit after sport	Eat 1 bread units before sport	Eat 2 bread units before sport
between 7-10	x	Eat 1 bread units before sport	Eat 2 bread units before sport
between 10-16	x	x	Eat 1 bread units before sport
over 16	Avoid sport with hyperglycemia	Avoid sport with hyperglycemia	Avoid sport with hyperglycemia

2.4 Minigame Balloon

The Balloon is a game created for the purposes of entertainment in the MyDiabetic game. I got the inspiration from the „Up there “game, however, it is an old game and I was not able to find it and make a reference to it. The initial layout is shown in Figure 5.

There is an object of an air-balloon that moves upwards. Using accelerometer in the devices, the balloon moves from left to right by tilting the device. The goal of the game is to reach as highest as possible. There are also obstacles along the way. The obstacles are in a shape of two parts next to each other. There is a gap between them throughout the player must fly the balloon. The balloon can slide on the surface of the obstacle and there is no penalisation for that. The game ends when the balloon is below the screen.



Figure 5: The beginning of the game Balloon

There are 4 sections in the game representing 4 different environments. The first section is inside of a house. The background is a blue wallpaper and the obstacles are bookshelves. The second one is supposed to be above the house in the trees with green background and branches as obstacles. Then there is sky section with clouds as obstacles and sky as a background. The last one looks like the space with stars as obstacles and the universe as a background.

All sections are equally long and a player must fly through 20 obstacles for the section to change. The game is endless, therefore there is nothing else after the space part, only deeper space. The camera in the game moves upwards with a constant speed per

section. Every section adds a constant value to the speed of the camera. In the space section, the speed is increased with the same formula, after every 20 obstacles.

The balloon moves upwards with a constant speed, which is a lot higher than the speed of the camera. There is an invisible ceiling that holds the balloon from escaping the screen. There are also invisible walls on each side preventing the balloon from disappearing. Once the balloon gets stuck under an obstacle and disappears from the screen, the game is over.

I designed the game Balloon using gaming principles mentioned in section 1.3. First I wanted it to be very simple. The control of the game is trivial and suitable even for the smallest children. Then it had to have an illustrated graphics. Luckily I didn't have to draw anything and could find free vector images (9) for that. Lastly, I wanted to bring joy and support the competition quality. The only thing that is comparable is the high score and it challenges the players in overcoming it.

The game Balloon serves as an addition to the MyDiabetic game. It does not teach children anything new in diabetes. However, this game represents the fun part and hopefully will motivate children to play the serious game even more often.

3 Implementation

3.1 Selection of an avatar

In the very beginning, a player chooses an avatar he/she will play with. For that, I created a scene, where two possible avatars are present. The player should select an avatar for him/her to be able to continue to the next step. The scene is accompanied by a text saying „you will not be able to change it later “. The option of a sex change was removed from the game. The idea is mentioned in 2.1.

When the player selects an avatar, the circle underneath him changes colour and emphasises the selection by changing its scale back and forth. The selected avatar changes its mood to „happy “and starts to smile and dance. The other one gets „sad “and lowers its head. I did not create this animation and will not describe it more thoroughly, it was created as a part of (2).

If one of the avatars is selected and gets deselected, both avatars return to their original position. They both have a positive expression in their faces and stay straight. All three situations are shown in Figure 6. When the player clicks on the arrow in the bottom right corner to continue, I save the selected avatar into the PlayerPrefs (10).



Figure 6: Screen with selection of avatars, case where Emma is selected and case where Adam is selected respectively

3.2 Finite automaton for tutorial

The root of the automaton is an enum defining all possible states. In Figure 1 the state is defined as an ellipse. However, in the code, I defined the states per the names of the audio files. I wasn't creative with naming them, I simply labelled them as "introX". The "X" value goes alphabetically from A through Z all the way up to AQ. The total number of the states is 43. This way the name is not connected with the meaning of the state and stores the information how far in the tutorial the player is.

Next, I defined transitions between the states. The transition is conditioned by an action connected with a button. Each time a player clicks on a button, something happens. There are several types of actions that are in general available.

There is an action that causes the automaton to move to another state. In the scheme (Figure 2, Figure 3, Figure 4) this refers to the white coloured rectangle. After the transition, the player is instructed with new instruction.

The green coloured rectangle in the scheme represents mostly actions that are not directly connected with diabetes. These actions can be repeated several times without affecting the game. Also, there is no new audio output, the last instruction is then repeated. The only action that is tied with diabetes and can be repeated is the measurement.

The light-red coloured rectangle stands for disallowed actions. Nothing happens after selecting the action, the last instruction is repeated.

The dark-red coloured rectangles are forbidden actions. These are a major violation of the daily regime. The actions relate to new instructions explaining why it's not a good idea to perform it. Since I defined the states as names of the audio files, the state machine transitions to a new state. By these audio files, there are purple rectangles with a message „Automatic transition to the previous state “. What it means is that I store the last states in a variable. After reaching the extra state, the automaton automatically transitions to the previous state, as it knows where to. I decided not to wire it back because it would overfill the scheme. Also, I would not have had an action defining another transition back.

For the tutorial, I did not create any new scenes. I took already created ones and duplicated them. There were a lot of changes needed and I didn't want to break the already functioning game. In every script, there would have to be a condition, whether the player is still in the tutorial. This way I could change whatever I wanted to.

In the game, there are a lot of buttons with various functions. However, I want to show the player its functionality piece by piece. I created a method „updateButtons“ that handles its visibility. For an unknown reason, the buttons kept appearing when transitioning between scenes even though they should have stayed hidden. I am calling the

method in the `InvokeRepeating` (10) so that the method is invoked every one-tenth of a second. This method also gives the player hint as what he/she should select. The hint behaves the same way as in 3.1, the button changes its scale to smaller and then to bigger repeatedly.

The beginning of the tutorial starts in the kitchen as shown in Figure 7. The instruction from the doctor is that the avatar should eat something. Now, there are only 2 buttons visible, namely food, and measurement. As part of the instruction, the food icon flickers. Buttons in the bottom of the screen lead to other rooms, but there is nothing to do in there yet.



Figure 7: The beginning of the tutorial

After selecting the button food, the measurement button starts to flicker, that is the only result from the action. Then the player is forced to click on the measurement button. Again, apart from the new instruction from the doctor, nothing happens. However, new buttons appear, such are a button for washing hands and a button for the toilet. The button for washing hands flickers, but the player cannot see it from the kitchen.

Washing hands takes place in a different scene. The player must apply soap on hands, rinse them with water from a tap and dry them with a towel. Any moment cancel button is pressed, the whole procedure needs to be repeated. The player moves on to the next state after he/she accepts a reward for successful washing hands.

With clean hands, the measurement is now possible. The measurement itself consists of several steps. Firstly, the player must assemble measuring pen and activate it. Then

a jab into a finger is made. A strip is taken out of the box and inserted into glucometer. A drop of blood is placed onto the strip and the glucometer returns the result. After selecting the option to continue from the result of the measurement, the automaton transitions to the new state. Again, any moment the cancel button is pressed, the whole procedure of measurement need to be repeated.

After completing the measurement, the insulin must be applied before having a meal. At this moment, a new button appears, concretely the insulin button that flickers. The first part is to select the type of insulin. Before a meal, the short-term insulin must be applied. The player cannot proceed to the next state until he/she selects the right type. Then a selection of a jab area follows. After that, the insulin pen needs to be assembled and a few units of insulin pushed out. The correct dosage of insulin must be set. The player can change it, however, until he/she does not set the right value (that is recommended), he/she cannot continue. The needle of the pen is jabbed into the skin and the application is being made by the button on top of the pen. After accepting reward the player finishes the insulin application section.

It's time to eat something. The food button flickers indicating that everything necessary was already made and there is nothing important to do before the meal. In the scene, there is a food tray and the player's goal is to place the food from an inventory onto the tray. For the first dinner, 4 bread units are recommended to be eaten. The inventory contains several items, from which the desired amount can be put together. However, there is an item containing more than 4 bread units. If this item is located on the tray, the player cannot continue and is advised the correct combination. In the scene, there is a button with a list of all foodstuffs. The player can learn there the content of the bread units.

After eating the meal, the bathroom button turns orange in the bottom of the screen. This indicates the need to use a toilet. Usage of a toilet is straightforward, containing only an animation.

The bathroom button turns blue and the player is advised to do some sport. This is the first time the sports button appears in the living room. The sport in the tutorial is limited, the player can select only 30-minutes run. When the avatar starts running, the doctor tells the player that he/she can stop the sport with a button. Whenever there is a physical activity ongoing, the stop button appears on the screen. Also during the sport, the player is not able to do anything else in other rooms. The player now has two options, either to wait the 30-minutes period or to press the stop button. In either way, the next state evoked.

The next task is to take a shower. The shower button appears in the bathroom. The process of showering takes place in a different scene. On the table in front of the shower, there are two bottles. The first one contains a shower gel and the other one a

shampoo. The player must apply at least one of those on the avatar and then rinse it with water. After accepting the reward, the player moves on to the next state.

Since there is nothing left to do, the doctor tells the player to rewind the time in the game. After pressing the rewind button, the time in the game speeds up. Every second is equal to 15 minutes in the game. The goal is to reach the time of the second dinner. During the rewinding, the player can invoke all the actions that are allowed. However, the time then is slowed down to the normal speed and the player must press the rewind button again. The rewinding works the way, that it stops every time the new phase of the day occurs. This means that in the moment of the second dinner the time slows down to the normal speed and the player does not have to take care of it.

The second dinner differs from the first dinner; the insulin is applied afterwards. The player is advised to eat something small. After entering the food scene, there are two items in the inventory. There are an apple and a plate with pasta with poppy seeds and sugar. In this phase, I do not check the choice of the player as what to eat. If he/she eats more bread units that are recommended, the player is awarded fewer stars and the avatar seems sheepish. A number of stars (the best result is 5 stars) indicate the quality of income and gives feedback to the player.

After the second dinner, the whole routine needs to be repeated. The player is told to measure glycemia. This is a tricky order since one must wash hands before measuring. The button for washing hands flickers and indicates the player what is the right action to execute now.

With clean hands, the measurement takes a turn. The procedure is the same as in the previous case. The measuring pen gets assembled, activated, a jab into a finger is made, a strip is inserted into the glucometer and a drop of blood gets placed onto the strip. Accepting the reward for the measurement leads to the next state.

Application of the insulin before going to bed differs in the used type. After the second dinner, the long-term insulin must be applied. It works gradually over the time and covers the whole night. For the night, the area of buttocks is recommended. The insulin is absorbed from that area the slowest. Then the insulin pen is assembled and after selecting the correct dosage, the insulin is applied.

Everything important was already done and now it's time to go to the bed. But before that, the teeth should be brushed. After pressing the newly appeared button for brushing teeth, a new scene gets started. There, there is a huge open mouth with dirty teeth and a toothbrush. The player moves the toothbrush over the teeth and cleans them. When all teeth are cleaned (its colour is white), the player is rewarded and exits the scene.

The very last button in the tutorial appears, namely the button for sleep. It is in the bedroom. After clicking on the button, the avatar lies down and starts sleeping. During

the sleep, all activities are disabled in the game. The player is advised to rewind the time one more time. The avatar sleeps during the night and wakes up at 6 a.m. With this, the tutorial ends and the player enters a normal mode of the game, where he/she can do whatever he/she wants.

3.3 Finite automaton for sport

Before doing sport, a player must measure glycemia level. I store information about last successful measurement in a global variable of the type DateTime (10). I do not store this value anywhere else since it's not that important. After the game is closed this variable is destroyed. The time in the game elapses the same way as in the real world and if the player changes manually time on the device, the time in the game changes as well. I wanted to stay uniform throughout the process and force the player to even repeat the measurement.

When a player proceeds to start the sport, I compare the saved value with the local time in the game. When the elapsed time from the last measurement is bigger than 15 minutes a doctor shows up with an appropriate message. All the sentences that are being used by the doctor in this section are depicted in Table 1.

Then based on the result of the measurement the doctor instructs the player what to do next after he/she clicks on the sports icon again. If the glycemia level is higher than 16, the player is not allowed to start sports. When there is no advice in Table 1 (represented by a value „x “), the player can then proceed to sport. There is one situation when the glycemia level is between 4–7 and the player choose the 30minute option of sport. The doctor tells the player that he/she should eat 1 bread unit after the workout. However, this is only a recommendation and I do not check whether the player did it.

In all other cases, the player is advised to eat some bread units before sport. This is mandatory and cannot be avoided. The doctor keeps repeating the advice until the player eats something. A number of bread units are recommended and it can differ in the life. Therefore, I do not check how much the player ate, only that it was a non-zero amount. After ingestion of a food, I store the current time in a global variable. Then I check whether the elapsed time from the last food was bigger than 10 minutes. After that period the player must repeat the process of eating.

3.4 Minigame Balloon

The concept of the game is an endless type of games, where everything is generated automatically and there is no end. The whole idea of generating new levels is presented in the Unity tutorial (11). All methods are called from the FixedUpdate (10) method, that is being periodically called by the Unity.

In the beginning, I add the first background to the position of the balloon. Then I need to save the value of the screen height, which states the strategy of generating levels.

Once the difference between the balloon's vertical position and the background's top-most value is smaller than the screen height, I add another background on top of the previous one. The same applies with removing objects. If there is a background that is not visible anymore, I delete it, so that the memory is not being filled up. I am also checking a condition, whether the number of generated obstacles divided by 20 is bigger than the previous value. Simply put, after every 20th obstacle I change the background and obstacle type. Also after a change of the level, I increase the speed of the camera.



Figure 8: The first and the second level

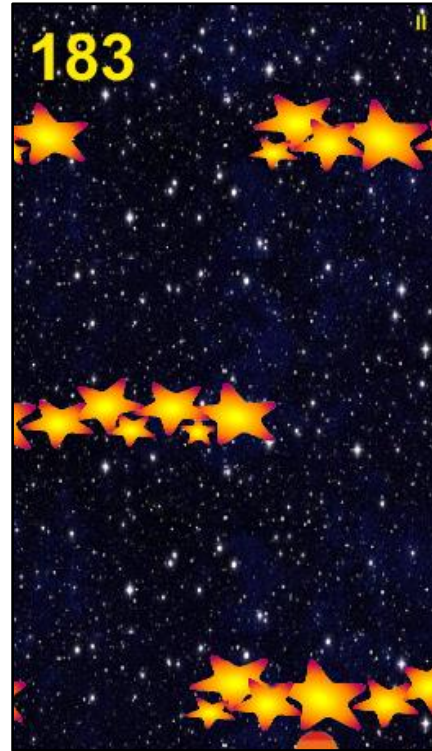
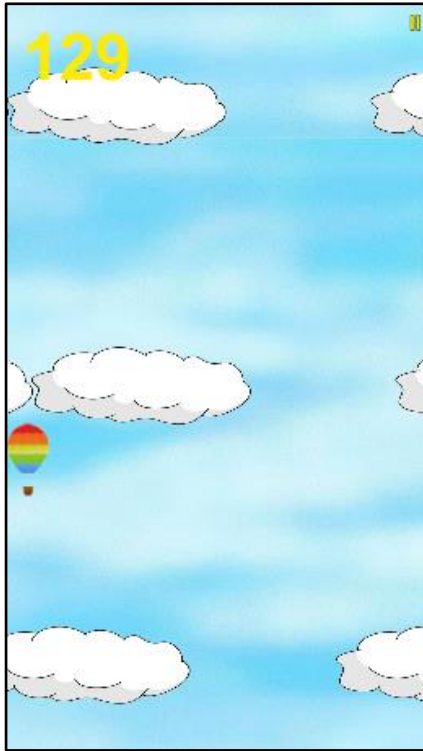


Figure 9: The third and the fourth level

Generating obstacles is very like the background. The same rules apply here as well. The distance between two obstacles is the same and there are approximately 3 obstacles in one piece of background. However, the horizontal value is random, its boundaries were set the way the gap in the obstacle is still present on the screen. This is the only trick that makes every game unique.

The main component of the game is the balloon itself. It is an object of several qualities. It has a RigidBody (10) attached, which is used for giving the object a physical quality. I set its mass to 1 kilogramme and gravity to -3. These two constants declare how fast the balloon flies up. Since the balloon has a shape of an ellipse, I attached a Circle Collider (10) to it. With this, Unity can then detect collisions of the game objects and react to it. However, the collisions are computationally difficult and the easier shapes the faster response from the application. I also created a material for the surface of the balloon, so that the balloon does not have any friction with obstacles and does not bounce.

All obstacles have the same gap between the two parts. The width was set the way so that it is equal to the twice the width of the balloon. Every obstacle has a Box Collider (which is only the rectangular version of the earlier mentioned Circle Collider) attached. When I was testing the game, I concluded that the sharp edge of the collider in the gap does not work well at higher speed. I had to add another collider, namely Circle Collider. The composition is depicted in Figure 10. Once the balloon gets in contact with the Circle Collider it moves automatically upwards.



Figure 10: Colliders attached to the obstacles

The scene of the game is surrounded by walls and a ceiling. These are invisible components that move along with the balloon. At the beginning of the game, I am calculating its position and its size. The height of the walls is equal to the height of the screen of the device. The position depends on the width of the screen of the device. Resolution of every device is different and the horizontal position of the walls must correspond to the border of the screen. The ceiling has a static size. Its vertical position is set to approximately $\frac{1}{4}$ of the screen height from the top. All the three components have Box Collider attached.

The input values for control are being acquired from the accelerometer sensor of the device. The horizontal position of the balloon changes with the input. The vertical position is only affected by the negative gravity, which is constant. The input also changes the rotation of the balloon. The axis of the rotation is equal to the z-axis. With input value being equal to zero, the rotation of the balloon returns to the original value.

In the top left corner, there is a numerical value of the distance. The distance is simply calculated as a vertical difference between the actual vertical position of the balloon and the original position of the balloon. After the game ends I check PlayerPrefs whether the new score is bigger than the saved high score. In the case of a better score, I save the value into the PlayerPrefs and display it on the welcoming panel that is shown in Figure 11.

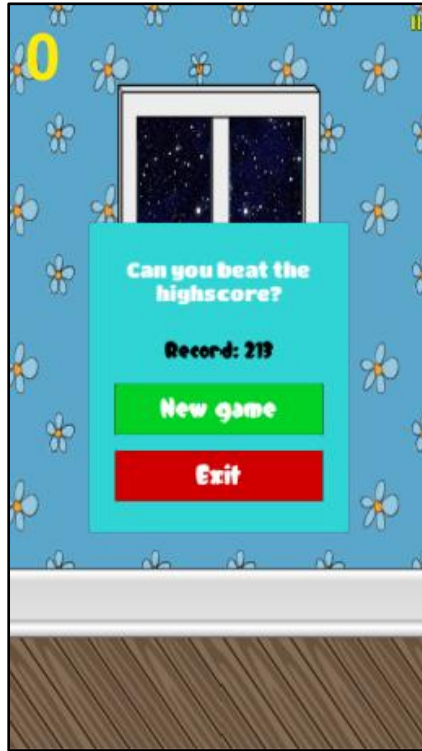


Figure 11: The welcoming screen in the game

In the top right corner, there is an option to pause the game. The player has then an option to continue the game or to quit the game. Quitting the game does not save the high score.

After the player loses, the game is reset to the original state. The welcoming panel is shown with the options to start a new game or to quit it.

4 Testing

As I mentioned earlier in 1.1, the testing phase was conducted in a group. Each of us came up with a questionnaire. The three questionnaires were then united into the final form. We wanted to ask several questions covering a few topics. The assignment is to conduct a testing on at least 5 users. For that, we were looking for children with type I diabetes who like to play games occasionally. The age range was set from 5 years to 15 years. The users also had to have their own device (a phone or a tablet) on which the game could be played. The screener is shown in section 8.

The testing users were found through groups on Facebook. Our idea was to arrange a personal meeting with a child and give him/her the questionnaire. Then we installed the game on their phones and let them play it. The playing part took in average about 15 minutes. Finally, we asked several questions of it. We then asked the children to play the game for at least a period of one week. After the week, we contacted them and asked few more questions regarding the feedback.

In the beginning, we found 5 children that satisfied our prerequisites. However, after a couple of meetings, we were not sure, whether 5 are enough. The main idea was to get feedback on the gameplay and to compare gained knowledge from the game. We then obtained 2 more children that were willing to take part in the research.

We visited all 7 participants in person and went through it all. Fortunately, all the participants were from Prague and we did not have to commute outside of the city. However, there was a complication with one of the child during the week he was supposed to play it. His parents called us that they are very sorry, but cannot take part in the research now. Even though we have all the questions from the first session answered, we don't have any feedback. Therefore, we decided not to include him in the thesis. The research is then conducted on 6 participants.

In the questionnaire, we were interested in general information about the users. First, we asked about gaming and their relationship with it. Then there were a couple of questions concerning the beginnings with diabetes and the everyday habits. Lastly, we were interested in knowledge of diabetes. After the gameplay, we wanted to know the first reaction to the game and we also asked the parents several questions about their child.

We also added Google Analytics (12) to the code. We wanted to keep track of player's activity in the game. The analytics were attached to start of every scene so that we know what the flow in the game is. It can also tell us how much time is spent on each screen.

For my thesis, I wanted to observe something different. First, I added the analytics to the game Balloon to keep track of the score in it. Second, I added the analytics to the tutorial. The tutorial itself is straightforward and there is no need to keep track of the

screens. However, I was interested in how well it is designed from the user experience point of view. I measured elapsed time in several parts of the tutorial to know how much it took to complete. Then I compared the average value from all the children with mine. As I designed the process I should have the fastest time in all the parts. I wanted to find out what were the most problematic areas and possibly come up with a solution.

4.1 Gameplay

During the time spent with the participants, we let them play the game for about 15 minutes. While they were playing, we were observing it and making notes. We focused on immediate reactions of the players. During the session, we did not help the participant in any way. We wanted to know how he/she would play it by himself/herself. Only when the child was desperate enough we gave a small hint. Usually, it had to do with not listening to the doctor or not being able to hit the interactive object. Also, many participants have an insulin pump and applying insulin via an insulin pen was very new to them.

The first thing that we were taking notes of was player's interaction with the game. There were instances when the player was clicking on objects that were not interactive. By the look on their faces, they were not sure, whether it is broken or not. Sometimes it took them quite a while to figure this out. Children, in general, have a specific way of playing games. They tend to press all the buttons as fast as possible and do not think about it much. They also don't listen to the instructions carefully and do it their own way.

Especially the younger participants were hard to deal with. They lost attention after a while and wanted to do something else. In every crucial step, there is the doctor explaining what needs to be done. All what had to be done was to listen to the doctor and follow the orders. Just for clarification, the output from the doctor is both audio and visual in a form of text. There were a few children that could not read. When the doctor showed up with a new instruction, they did not care about it too much. They did not look at the text and were looking around and not listening to it carefully. There were instances when the children often asked their parents what to do next. At first, we told the parents not to interact with the game or with the child. However, we were afraid that the child would lose all the interest and quit the game. So eventually we let the parents help them occasionally.

When assembling a measuring pen, there is a hint pointing at a cap of the pen. Right next to it there are needles. In some cases, the participants did not understand the principle. They tried to put it on without taking the cap off first. Again, their first thought was that it is not working correctly. They even asked us why it cannot be put on. After the needles are put on, the pen needs to be activated. Even though there is a hint point-

ing at the top of the pen, some children were immediately pressing a button in the middle of the pen (the button releases the needle and makes a jab). On the second try, they remembered the procedure and did the measurement faster. In the game, the player cannot move further without the right steps. The hints are well placed and indicate what should be done. The question is whether a small child could figure it out by himself/herself on the first try.

The second problematic part was applying insulin. As I mentioned earlier, many of the children have an insulin pump. Some of them even had it from birth and never seen a pen before. After selecting an area of the jab, the pen needs to be assembled. The first hint indicates to the removal of a protective cover of a component with a needle. Some children wanted to place it onto the pen right away. Even though there is a message saying that the cover must be removed, they kept going with the same moves. Again, there had to be a hint from us to move further. Right after the component is placed in the pen, there are two more covers that must be removed. An outer cover and an inner cover protecting the needle. There are no hints this time and it was obvious that children with a pump had no idea what to do. There is a button with a question mark in the lower corner. There is the whole procedure written up, however, nobody clicked on it. The last part before applying itself is selecting a dosage of insulin. The instructions are written only (as for how much should be selected) and smaller children couldn't read it.

After taking a shower, there is an instruction about rewinding time forward. A button in the top right corner starts to flicker and the player must press it. Up to this part, everything is alright. The rewinding stops by itself when the time of dinner comes. It happened at least twice that the player stopped the time by himself/herself and wanted to have dinner. At that point, he/she was unable to do anything since it was not the right time for that. In all cases, we had to help the children to rewind the time a bit more. The second time of rewinding they all knew that they must wait until something happens.

In the beginning, there was a mistake in the tutorial that led to a point when the player could not do anything. This was caused by an unexpected state during eating the second dinner. The problem occurred twice and in both cases, we had to reset the game and skip the tutorial (there is a hidden button at the very beginning that lets the player skip it). The mistake was immediately fixed afterwards.

When the tutorial finished, the normal game started. The game starts at 6 am with breakfast. The doctor advises the player that he/she should eat something for breakfast and all the participants did that. They all even follow the order of measuring, applying insulin and then eating. There were only two cases when the player washed hands before measuring.

I don't know if the children realised that they can do whatever they want at this point. Some of them rewound the game to the next meal and then repeated the procedure. One participant wanted to apply insulin before snack but changed its mind when there were 0 insulin units recommended in the hint. Most of the players were discovering new buttons in the rooms and tried some of them. Roughly half of them went into a town shopping for new clothes and furniture. The other half found minigames and started playing.

After that, we stopped the participants and showed them crucial parts that were newly implemented (6) (7). It is namely a new system of tasks and a book containing lots of information about diabetes in various forms.

4.2 Finite automaton for tutorial

In the tutorial, the analytics had a purpose of measuring time spent in each individual part. The whole tutorial is divided into 13 sections entitled from 1 to 13 as seen in Table 2. Each section has a description of what is included. The column "My time" represents time spent in each section. These values I obtained by going through the tutorial on my device. During the walkthrough, I did not stop at any moment and wanted to make it as fast as possible. I listened to the instructions from the doctor and immediately went for it. The next column "Average users' time" is the time obtained by the participants. Every value up to section 8 is an average of 6 children. As I mentioned before, there was a problem with the tutorial and 2 participants were not able to finish it. The sections from 9 to 13 are an average time from 4 participants. To compare the two columns, I added one more called "Time difference". This column says how much more time was spent by the children compared to me. For example, the first row means that the participants spent about 3/5 more time in the first section than me.

Table 2: Comparison of the time spent in the tutorial

Order No.	Name of the action in the tutorial	My time [s]	Average users' time [s]	Time difference [%]
1	Initial instructions, washings hands	74,9	120,2	60,5
2	Measurement	32,3	93,1	188,5
3	Insulin application	46,1	126,3	173,7
4	Eating first dinner	21,9	59,5	171,0
5	Going to toilet	12,7	21,8	72,6
6	Doing sport	10,9	49,1	349,2
7	Taking a shower, time rewinding	44,2	85,6	93,7
8	Eating second dinner	19,0	36,2	90,8
9	Washing hands	29,7	41,2	38,5
10	Measurement	25,3	54,7	116,3
11	Insulin application	35,0	69,0	97,0
12	Brushing teeth	22,6	27,7	22,5
13	Sleeping, time rewinding	44,3	46,8	5,8
Total time		418,9	831,2	98,4

The very first section took me the longest as there is a long introduction to the game. In the tutorial, the doctor cannot be closed (in the normal game there is a close button to hide it) and everyone must listen to it all. My initial idea was to tell the player that he/she should have dinner. And only after clicking on the food button, remind him of measurement and then of washing hands (the button with hands appears at this moment). However, a new dubbing was added right before the testing and there the instruction says "go wash your hands first". Therefore, the children were confused at first

as there were not yet any other buttons that the food and the measurement one. The washing hands itself did not take that long, even though there were some participants that were thorough. There was only one case when the child was impatient and closed the scene with an exit button instead of waiting for the reward. This caused the instruction to be repeated and the participant was forced to wash hands once more. The solution is very straightforward; the beginning of the automaton must be remade. There should be two buttons in the kitchen with the food and the measurement and then the hand's button in the bathroom that flickers. This will tell the players that there are other buttons in different rooms.

After having their hands clean, it usually took the children a while to realise that the measurement needs to be done in a different room. The scene of the measurement was discussed earlier in 4.1. There was a small bug that was discovered by the first participant. After the specific order of moves, the hint arrows started to point to a wrong place. This was fixed before the other participants were testing it, but it still altered the average time. Once the pen was assembled and activated, the children knew what to do. It did not take long to insert a strip into glucometer and place a drop of blood onto it.

The insulin application is also discussed in 4.1. There are only two arrows pointing at the cover of the component with a needle. Once the cover is taken down, there are no more instructions. I think at least for the first try there should be other arrows as a hint. Even one participant using an insulin pen wanted to select a dosage after putting the needle on and had no idea that there are two more covers. Also, some of the participants had problems with the size of buttons. There are colliders detecting the click and are often the sizes of the physical buttons in the game. By increasing the size of the colliders, the time spent in this scene could decrease.

Comparing time in the eating scene is misleading. The instruction from the doctor says that he/she should eat 4 bread units. The participants who could read often spent a lot of time in the foodstuff's list looking up the meals. There are 5 foodstuffs from which one contains about 6 bread units and cannot be eaten. From the rest of the foodstuffs, there are possible combinations all resulting in the desired 4 bread units. However, there is a warning from the doctor, which foodstuffs must be on a dining tray. Maybe the message from the doctor could be altered so that it does not name all foodstuffs needed but only the sum of bread units. Yet this is not that huge issue.

After the meal, there are no instructions for the next step. There is yet one notable change compared to the previous state. The bathroom bar in the lower part of the screen turned orange indicating a need for an action in there. I was quite impressed by the reaction time of the participants. Once they entered the bathroom, there was a toilet button flickering.

The sports chapter in the tutorial is also a bit strange. The avatar is supposed to run for 30 minutes, yet it is not possible to rewind the time. Nobody wants to wait for that period, especially us when we were sitting there with them. The participants went to look around in other rooms but were unable to perform any action. The message from the doctor says that the sport can be interrupted at any moment with a button. More convenient would be a statement saying that the sport is important for the avatar nevertheless during the tutorial the player should press the stop button.

In the shower scene, there are two bottles, one with a shower gel and the other with a shampoo. Again, as with washing hands, some of the participants were thorough. They rinsed the avatar with water first and then applied both the shower gel and shampoo. Some of them even tried to wash the body with a finger (as it is done with washing hands). After rinsing the body from the bubbles and accepting a reward, the time rewinding is also part of this section. I did not want to divide this into two parts. There is no information from the showering. Even though the instruction from the doctor says rewind the time and wait until the second dinner, some participants did not wait long enough as described in 4.1.

The second dinner is eaten right away. There was a participant who washed hands before. Some wanted to measure the glycemia level before but were not let into the scene. For the second dinner 1 bread unit is recommended. There are two foodstuffs, an apple and a plate with something very sweet. Two children looked into the foodstuff's list to check whether an apple has exactly 1 bread unit.

Every repetition cut the time spent almost in half. Washing hands, measuring and insulin application was suddenly a routine. This confirms my thought that the hints in measuring and insulin application are enough to be displayed only once. There was only one case when the participant did not pay much attention to the game and kept asking what should be done next even in the situations that already happened.

Brushing teeth took in average very short time. If there were some participants precise in washing hands and showering, nobody wanted to brush the teeth more than was necessary.

The time difference under 6 per cent in the last section is speaking for itself. When rewinding the time for the second time, everybody knew that they should wait. There was one instance when the player woke up the avatar in the middle of the night. Luckily there were parents present with a remark "Don't wake her up now!"

I talked about it in 4.1 but it is notable to be present here as well. The end of the tutorial is somehow blank and does not inform the player about it. I think there could be a panel with a text saying "Congratulations, you've just completed the tutorial!" Or at least give the player information what is new in the normal game.

4.3 Minigame Balloon

Another area I focused on was the score in the game Balloon. I created a table depicting this situation.

Table 3: High scores of the children in the game Balloon

Participant No.	Number of tries	High score
1	X	X
2	2	57
3	0	0
4	4	9
5	3	210
6	11	192

In the questionnaire after one week of game play, I asked a question regarding the control of the Balloon game. The answers do correspond to the results in

Table 3.

Participant No. 1 told us that he liked this game the most and played it a lot. However, something went wrong with the analytics and we do not have any data from him. We did ask him about the high score at least, but there was a problem with the minigame and could not retrieve it.

Participant No. 2 did not like this game, as it was not educative. Participants No. 3 and No. 4, respectively, did not play it or played it only a bit. From the number of tries of the fourth child, it is clear, that she did not find out how to play the game. She tried a couple of times but gave up eventually. Participant No. 5 just tried it but did not like very much.

There was an interesting development of playing the game with Participant No. 6, which is not shown in

Table 3. The first day, after we left, she played the Balloon 9 times with a minimal score. After the ninth try, she put it away for a while since she was unable to find out, how the game is played. Two days later, she tried it once more and finally could crack it.

Unfortunately, there is not much data from the participants to jump to conclusions. I wanted to find out how intuitive the game is and how difficult it is to play it. As for the intuitiveness part, a half of the participants knew right away the principles. The game Balloon should maybe contain initial information how it is played. Some sort of a text that would appear only with the first start of the game.

As I mentioned earlier in 3.4, the game Balloon contains several constants defining a difficulty of playing. I was tuning them up so that I could reach the highest score,

which is 249. My experiences differ from the children's. I played the game way often than they did. However, I wanted the game to be challenging and a bit hard. At least the results imply that I succeeded in this part.

There was, however, one answer in the questionnaire regarding a bug in the game Balloon. They said that it did not stop after they lost but kept going on and on. After hours of playing, I did not encounter such a mistake and have no idea what might be the problem. I did a small fix in the game, but unfortunately, I don't know how to test it.

4.4 Gamification

The last aspect I was trying to test was the influence of the game. The game is educational and teaches children about diabetes. In the questionnaire, we asked questions concerning knowledge about diabetes. Then after one week, we asked similar questions. Comparing the two versions help us decide, whether the children learnt something new. In this section, I want to first compare each individual participant before and after week before I make any assumptions.

4.4.1 Comparison of knowledge about diabetes

4.4.1.1 Participant No. 1

The first participant did not tell us much in the first seating. I don't know if he was shy with us present or just wasn't in a mood. The first thing he knew was from which area is the insulin absorbed the fastest. To this question, there are several possible answers and arm is one of them. He also knew the procedure of measuring the glycemia level. He said that he does that 6 to 7 times a day just by himself. Questions about bread units remained unanswered. The difference between hypoglycemia and hyperglycemia was explained well enough. He even told us the symptoms or the hypoglycemia, which are shaky hands.

After one week, he could tell us that people with diabetes have a diseased pancreas. The order of actions executed during a day corresponds to the scenario in the game. He wakes up, measures glycemia, applies insulin and has breakfast. In the school, he measures glycemia before snack and eats it. The measurement is just in case of high or low glycemia. Before lunch, he measures glycemia again, applies insulin and eats lunch. The same procedure is performed before afternoon snack as in the case of the morning snack. Then he measures glycemia before dinner, applies insulin and eats it. He applies insulin after the second dinner before going to bed. Bread units were explained as grammes of sugar in food. The correct answer should be 10-12 grammes of carbohydrates, but this is still good enough for a young child. He even knew how many bread units are in foodstuffs we asked about. He does not alter his insulin dosage before doing sport. He told us that he plays football and I think he just does not pay attention to it or

maybe just did not tell us about a snack before the sport. The difference between insulin types was answered correctly. In the end, he told us that he already knew everything about diabetes and did not learn anything new in the game. This information is hard to grasp as there is clear evidence in the answers.

4.4.1.2 Participant No. 2

The second participant was very talkative and well educated as she was the oldest one from our research. According to her, diabetes means a problem with the pancreas. It does not produce insulin at all or produces only a little. The area of the fastest absorption is belly. Her day looks as follows: she measures glycemia level, applies insulin and eats. This procedure is repeated 6 times a day. She has an insulin pump and adds insulin even before snacks. Glycemia level can be affected by movement, food, the glycemic index in food and by stress. When she measures the glycemia, she first washes her hands, cleans the area of a jab with a tampon. Then jabs herself into a finger and places the second drop of blood onto a strip in the glucometer. The first drop of blood is wiped away. She does not apply insulin anymore with a pen but remembers the procedure. First, she disinfects the spot and then applies it.

Bread units were described as 12 grammes of carbohydrates, she as well knew how many bread units are contained in some foodstuffs we asked about. When she has hypoglycemia her body is shaking, is sick and weak and feels like eating. With her, it is caused by applying too much insulin, by eating little food or by a long-lasting activity. Her symptoms are the same by hyperglycemia as they are by hypoglycemia. Only the reason of happening is different and such it happens with overeating, not applying insulin or with dysfunctional canella. The applied insulin is measurable after at least half an hour. Before exercising she lowers her insulin dosage. Her wish is to be more educated about food.

After a week, the question about diabetes was improved a bit, as she explained to us that insulin is needed for a body to absorb carbohydrates. The answers to other questions were the same or similar enough not to talk about it. Short-term insulin works within 1 hour and is applied before every meal but the second dinner. The long-term is used for the night and works within 4 hours. She thinks she found out much new information in the game, especially about food and bread units.

4.4.1.3 Participant No. 3

The third participant was the youngest, however, was still able to answer many questions just by her. From a fairytale, she told us that there are insulin spoons carrying insulin to the body cells and that the body does not produce them so she must apply it by herself. She knows that insulin is absorbed the fastest from the belly. Every day she wakes up, measures glycemia, eats and applies insulin. Then measures glycemia again before lunch and by the result, she applies insulin. She said that glycemia changes if

you eat something bad or if you don't eat anything at all. She is very self-contained in measuring as she does that only by herself. She jabs herself in a finger, presses the finger, removes the first drop of blood and then places the second one onto a strip in the glucometer. She has a pump and does not know the procedure behind the application of insulin. She cannot read and has no idea about bread units, her mother prepares food for her at home and has an assistant in her kindergarten. She can read numbers and told us that hypoglycemia is small numbers on the glucometer and hyperglycemia high numbers. She does gymnastics and before training, she eats a biscuit. She knows she should learn more about diabetes but her mother does not want her to know everything at this stage of life.

After a week, she added one more activity in the morning and such peeing on a strip. She could tell us that bread units tell us how much sugar is in food, concretely one unit is 10 grammes of sugar. Since she has a pump she does not know the difference between short-term and long-term insulin. She does not know what new she learned but was watching a lot of videos in the game about diabetes.

4.4.1.4 Participant No. 4

The fourth participant was a bit shy at the beginning but then opened up. She said that diabetes means that something happens to the pancreas and it stops producing insulin. The insulin is absorbed the fastest from the belly. As for her daily routine, she wakes up, measures glycemia, applies insulin and eats. This is repeated throughout the day with an exception of not measuring glycemia before snacks. Glycemia level is altered by food and insulin, in rare cases when her canella is bent or when she is shoe shopping. She measures glycemia the way she jabs herself in a finger and places the second drop of blood onto a strip in the glucometer. Even though she has a pump she still knows how to apply insulin via an insulin pen. She chooses 2 units of insulin, presses the pen to check the needle and then applies the correct dosage of insulin under the skin. Bread units are the amount of sugar in food and she eats roughly 15 bread units a day. She knew well how many bread units are in the foodstuffs we asked about. With hypoglycemia her hands are shaking, she is lightheaded and must take grape sugar. With hyperglycemia, she has pain in her stomach, drinks a lot and goes to the toilet a lot. She needs to apply insulin in that state. The insulin is present in the measurement after half an hour. Even though she does aerobic she does not change her insulin dosage before it. She thinks she knows a lot but still is missing some information.

After a week, her answers about diabetes and bread units did not change as she knew that already at the beginning. But she admitted that before sport she lowers her dosage of insulin. Also, knew the difference between short-term and long-term insulin. She said that the game did not bring anything new.

4.4.1.5 Participant No. 5

The fifth participant was a pleasant young lady who seemed to know a lot. To question about diabetes, she said that white blood cells attack beta cells and then they cannot produce insulin. The belly was also an answer for the area of the fastest insulin absorption. In the morning when she wakes up she measures glycemia, applies insulin and eats breakfast. The same is repeated during the day. When she doesn't feel right she measures glycemia before snacks and does not have the second dinner. She thinks that glycemia is altered by shoe shopping and by swimming. When she measures glycemia, she jabs herself in a finger and places the second drop of blood onto a strip in the glucometer. She is using an insulin pump now but still could tell the procedure of applying insulin. First, she selects 2 units of insulin to test the needle and then applies the correct dosage. Bread units are 12 grammes of carbohydrates and she eats around 20 bread units a day. She orientates herself in a number of bread units in various foodstuffs. With low glycemia she is cold and sweaty a takes grape sugar. With high glycemia, she is hot and has pains in her stomach. She said that the insulin is present in a measurement after half an hour. She does not change the dosage of insulin before sport as she doesn't do any sport. She knows a lot and takes care of everything herself. But still admits there always something new to be learned.

Since she knew the answers before playing the game, there was no way she suddenly forgot it. Yet we asked and got the same answers. The interesting answer came with a question about altering the dosage of insulin before sport. Both her and participant No. 4 told us at the beginning that they do not change the dosage of insulin before doing sports. Yet both changed their answers after the week. She also told us that before sport she lowers her dosage of insulin. Short-term insulin is used during the day and long-term one works over the night. She feels like the game did not increase her knowledge about diabetes and that she knew everything that was in the game.

4.4.1.6 Participant No. 6

The last participant very excited to be part of the research. She told us that the effect of diabetes is that glycemia does not lower itself, must be measured, insulin needs to be applied and must eat regularly. The insulin is absorbed from the belly the fastest. After waking up she measures glycemia, applies insulin and eats. She applies insulin after snacks only by the result of the measurement. She measures glycemia the way that she jabs herself, places the second drop of blood onto a strip in the glucometer a reads the value. Application of the insulin is easy; she selects the dosage and presses the pen after jabbing herself in the skin. She told us that bread units are how much food we eat. She can tell which food contains sugar and which doesn't, but cannot count them at this moment. With hypoglycemia, she has pain in her stomach, is sweating, has shaky hands, feels weird and should eat grape sugar. With hyperglycemia, she just feels weird and

applies insulin. She thinks that the insulin is present after 20 or 30 minutes in the measurement. Before doing sports, she does not change the dosage of insulin but eats some more. She is quite satisfied with her current level of knowledge.

After a week, she gave us the same answer about diabetes but added a comment that she does not have beta cells. Also, her answer about bread units changed. She said that roll has 2 bread units and she should eat a meal with a specific amount of them. She also knew a number of bread units in four of five foodstuffs. Before sport, she said that she eats something and now she added that sometimes she lowers her insulin dosage. The fast insulin is applied during the day and the slow one for the night. Even though she told us after how long is the insulin present in the measurement, now she could not remember. At the end, she told us that she knew everything yet she did not know anything about bread units in foodstuffs before.

4.5 Results of the testing

The selected group of participants was very special in a way. We posted a message in several groups on Facebook. The groups are designated for parents of children with the diabetes disease. In there, there are thousands of threads with advice and ideas. We spoke to the parents and then they asked their children whether they want to take part. In other words, we came in touch only with parents, who are active online. They want to get more information about the disease so that they are more educated. They care about their children and teach them as much as possible.

I am mentioning this because the children were well educated and knew lots of information. The children have a stable environment at home, means to educate themselves and parents who tell them what to do. I am sure that these conditions are the reason for the participants to answer correctly most of the questions.

Comparing the two states, at the beginning, and after a week is challenging. The longest period in which the participants are suffering from the disease is six years. In other words, there is one child that has diabetes 6 years already. On the other end, the shortest period is two years. Two years with caring parents is already long enough to learn what is necessary.

The attitude of the children towards the testing was wonderful. They all cooperated and wanted to be part of it. They even did not mind being recorded. This, of course, was agreed upon with their parents and with them beforehand. That helped us write down all the answers we missed during the interview. The audio records served this and this only purpose and are nowhere to find online, we did not distribute that anywhere. The records may serve the later research and might not be destroyed yet. We asked the first parents we were at, whether we may record the gameplay on a video. They did not want their child to be in the video and since we were at their place at home, they did

not want any footage of their apartment. We did not realize that and did not even ask the remaining participants.

The first noticeable aspect is the age of the participants. We wanted it to be independent on the age. However, the inability to read is a huge limitation. There are so many instructions or just hints in only text form. The main resource of knowledge in the game is the book. There are two text versions of information about diabetes. One is a thorough description of what diabetes is, how to take care of self and other useful advices. The other one is a fairy tale about diabetes describing what is happening. There is yet one version for smaller children, and that is a video on Youtube. However, one should be able to read to get to the video. There is yet a possibility, that their parents could help them with that. There is one participant that is not able to read yet. She knew about the disease enough so that she can take care of herself in a limited way. Nevertheless, the answers did not differ much after a week. She told us that somehow she got to the educational video but did not remember much from it. I am afraid, that children who are young enough and don't have the ability to read are not suitable for this kind of game. It might be enjoyable for them for a while, but the added value of the game is not considered.

In the research, there were five girls and one boy. From the gender point of view, there are no limitations, both boys and girls can play it. We wanted to have more boys for the testing purpose so that we could make assumptions. Unfortunately, there weren't enough candidates to choose from. The game consists of two parts, an educational and an entertaining. The educational part is represented by all the actions connected with diabetes. It is up to each child, how well they want to take care of the avatar in the game. There is no difference, whether the child is a boy or a girl. The entertaining part consists of several sections. There are minigames, then there is a town with shops and then there are tasks. By completing tasks, the avatar advances to new levels and new items are being unlocked. The items relate to shopping (new clothes and furniture). It was obvious from the research that girls were completing the tasks to unlock new items. They wanted to buy new clothes and furnish the household. Paradoxically, it was the boy who reached the highest level in the game. His motivation was not to buy new stuff, but just to complete the tasks and play the game. The minigames were played by both gender groups. The research does not show any difference between the genders according to playing the game. There aren't, however, many minigames (there are three now). I believe that the game is focused more on the girls as they are mentally more advanced and appreciate the possibility to buy new clothes and furniture.

At the beginning, we asked how often the children play video games. Even though there were answers indicating that some of them don't play often, all the children played it often enough. Some of them said that they felt responsibility for the avatar to take care of it. Others said that they played it for fun and entertainment. The game should not

cause addiction to it. On the other hand, we want the children to play it as often as possible to develop certain habits. Maybe there could be a bonus in the game in a form of game money for logging in at least once a day. Some children had a negative balance after the week of playing and with this, they would play it more often to earn some money and could buy new stuff.

We were testing the game on children suffering from type I diabetes. After all, it is designed to help them learn about the disease and how to take care of it. Some of the children have siblings who were watching them play or even tried it themselves. I see a huge motivation for them to understand the disease. They want to be able to help their diseased brothers or sisters. The game is based on taking care of an avatar and the fun part is more of a bonus. I don't know if children that are healthy and don't have any relatives with type I diabetes would want to play it. They would not understand the routine of measurement and application of the insulin in a way of why should they do it. The tasks, the shops and the minigames might not be enough in this case.

The last section of the research I want to focus on is the duration of the gameplay. How long does it take for a child to be still entertained in the game? Now, the game does not take any kind of end into account. The player simply plays the game over and over and when nothing new happens, he/she stops playing it. There were even few remarks from the participants that after a while the game is boring. Some of them had problems with the money in the game. After they got themselves into a negative balance, they couldn't afford to buy new items from the shops. The main source of income are the tasks and maybe they just didn't know that or didn't want to fulfil them. One participant had a bug in the game after which the game was not playable anymore. The bug was noted and will be hopefully repaired by the next release. There was an idea from one of the participants to simulate ageing in the game. The avatar should start in the current form. There could be an extension to send the avatar to kindergarten or to school. Then it would change its appearance, got older and had to find an employment. After some time, the avatar would retire and eventually died. This way the player would look forward to the next stage of life and would want to keep playing it. There also was an idea to add illnesses into the game. The avatar would develop a disease if the player did not take care of it properly. Yet I am not sure whether this should be the reason to play the game longer. Now, the only variegation in the game are the tasks. I am not sure how long it takes to complete all of them, no participant could reach the end of it after one week. The tasks are getting more and more difficult throughout the time, but are still repeating themselves. The game is not complex enough to have non-repeating tasks. We would like the game to be entertaining for at least three months. That should be a period in which there are demonstrable results of an acquisition of knowledge about diabetes. To accomplish that, there should be another extension and a lot of additional work.

Hopefully, the project will continue in evolving and the noted shortages will be corrected.

5 Conclusion

In this work, I extended the game MyDiabetic with several parts with the idea to improve its playability. That having in mind I created a scene, where a player chooses his/her avatar at the very beginning of the game. Then I added a state machine for the sport to control its logical flow.

The main part of the thesis was to implement a finite automaton for a tutorial. The tutorial guides the player through all important parts of the game. All instructions in the tutorial are both audio and visual. After completing the tutorial, the player should understand the main principles of the game and should be able to take care of the avatar in the game.

I also made a minigame Balloon that was added to the game. The Balloon is a type of never ending game in which the player tries to reach the highest score. By tilting a phone or a tablet the player avoids obstacles and flies with a balloon as high as possible. The minigame serves only the entertaining purpose. It was added in the MyDiabetic to increase its fun part.

The concept of extensions was thoroughly discussed with the supervisor as well as with the team. Only the minigame Balloon was created by my initiative.

The game was tested for a period of one week by 6 children. The idea was to conduct a qualitative research to get to know the children better and to understand the disease. We met with all of them in person, gave them our questionnaire and observed their gameplay for about 15 minutes. After the week, we had a call with them asking another set of questions. We focused on two sections. First, we wanted to know their opinion about the game and the gameplay to improve it. Second, we were observing an acquisition of the game for the children. We wanted to find out whether there was a positive effect only after one week.

Using the answers from the questionnaire I studied an influence of the game MyDiabetic on the children. Even though there were only 6 participants, the results were sufficient enough. The game is suitable for any child that can interact with a phone or a tablet. The only noticeable limitation is the ability to read. Without it the acquisition of the game is irrelevant. From the research, there is no difference between the genders, even though girls might enjoy it more. The current length of the gameplay is about one week. After that period the game became monotonous and the children were losing interest. There were fine ideas from the participants as for how to extend the game. The gained knowledge about diabetes was not that high as I first expected. That was caused by the fact that they were well educated at the beginning and there was small room for improvement. The children learnt a lot about foodstuffs and their bread units. Some of them came across the insulin pen for the first time and understood its usage.

The game should aim at children who were diabetes recently diagnosed, as they are not yet aware of all the principles and routines.

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8 Appendix A

Appendix A contains questions and answers from the screener

1) How old are you?

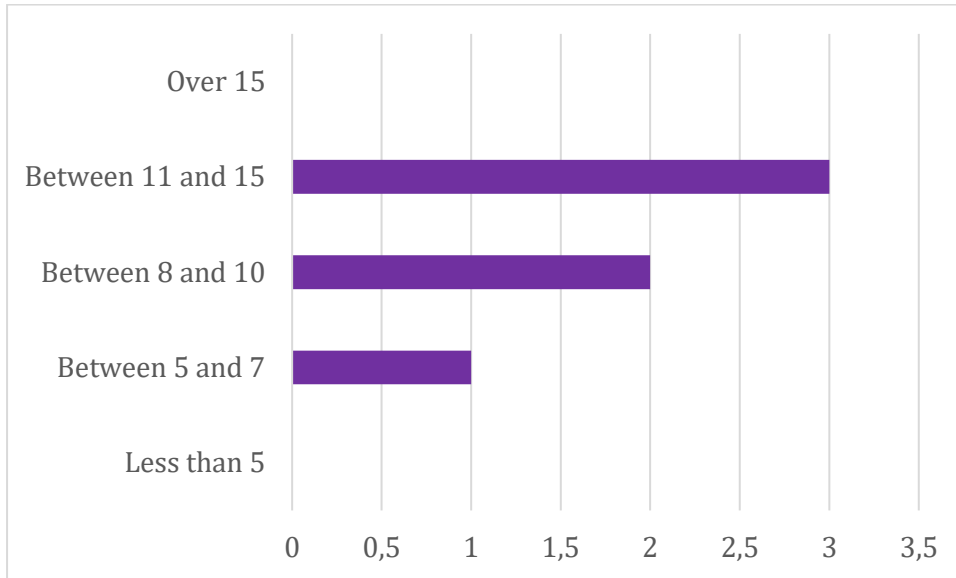


Figure 12: Results of the question about age

2) Are you a girl or a boy?

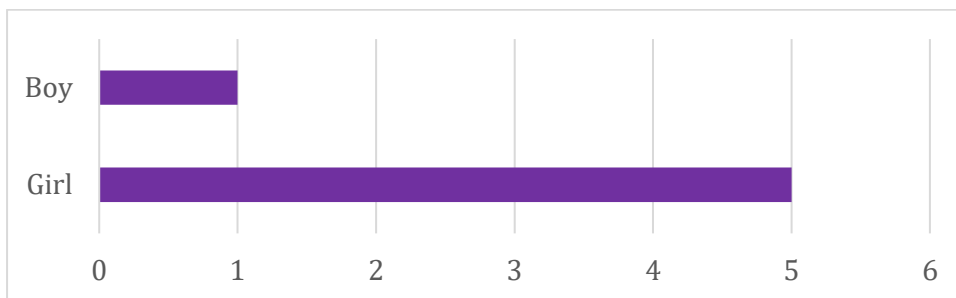


Figure 13: Results of the question about sex

3) Do you have diabetes?

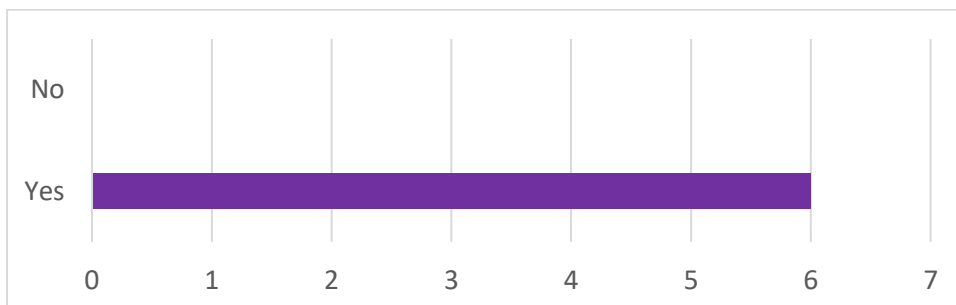


Figure 14: Results of the question about diabetes

4) What type of diabetes do you have?

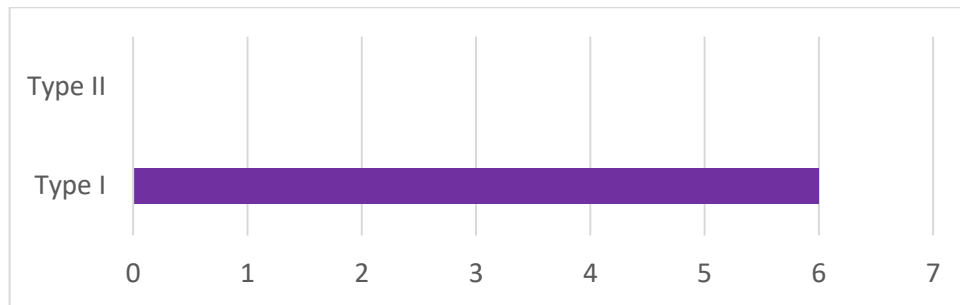


Figure 15: Result of the question about diabetes type

5) How often do you play games?

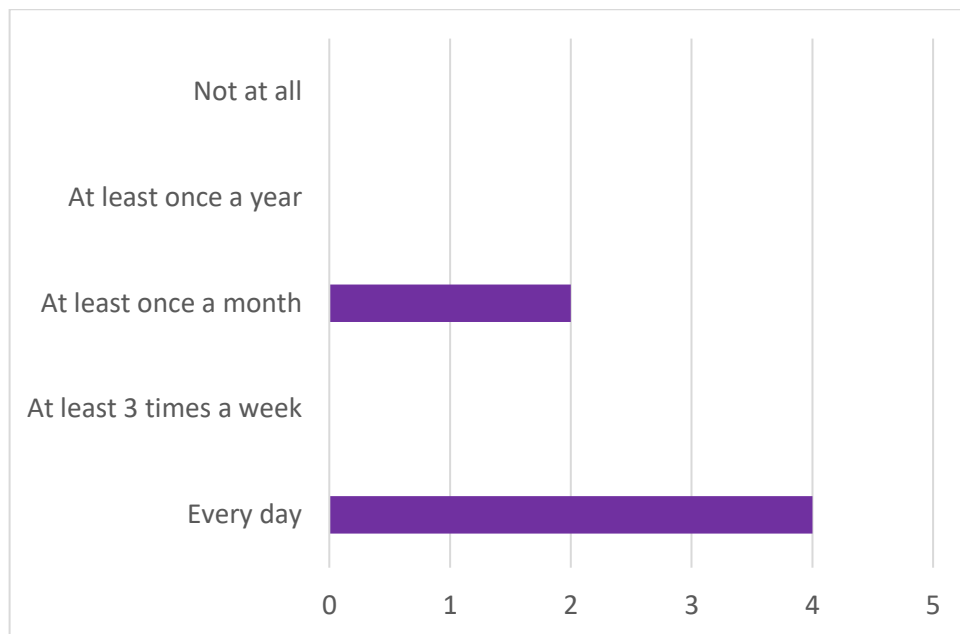


Figure 16: Result of the question about frequency of playing games

6) Where do play the games?

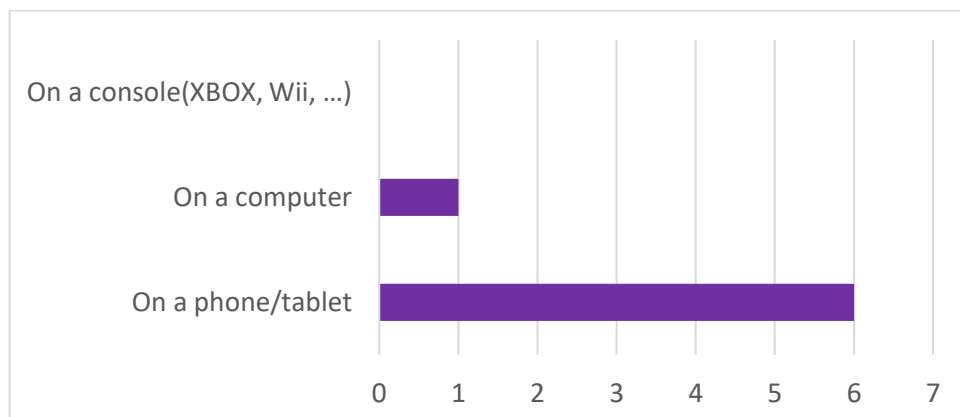


Figure 17: Result of the question about a playing device

7) Do you have your own phone or tablet?

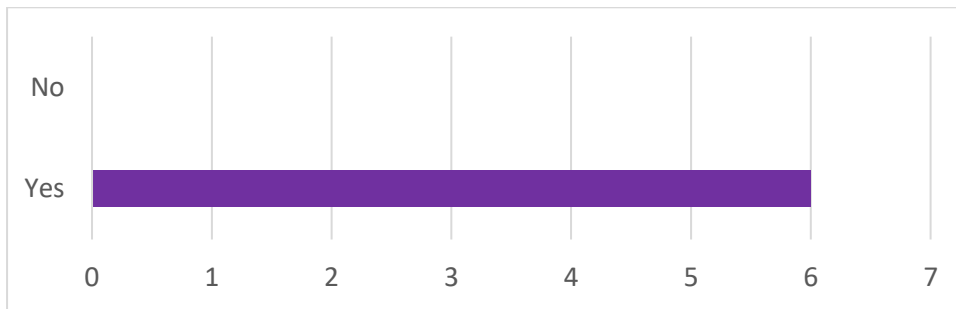


Figure 18: Result of the question about having a phone/ a tablet

8) When did you get your first phone?

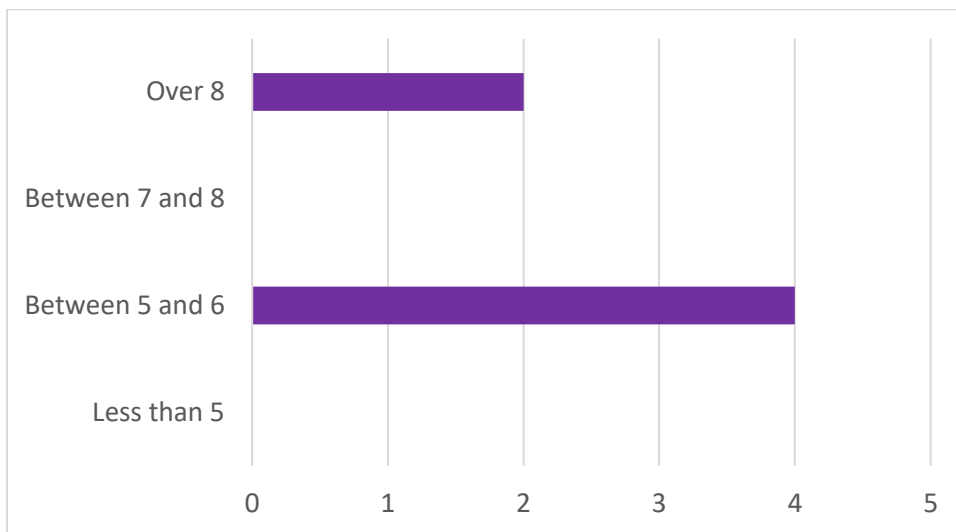


Figure 19: Result of the question about getting the first phone

9) What operational system does it have?

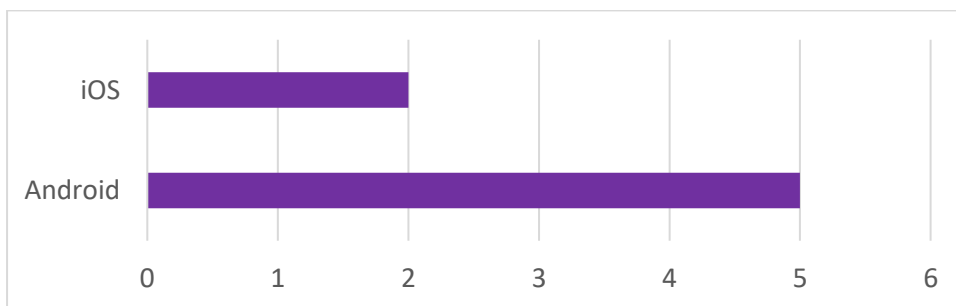


Figure 20: Result of the question about the operational system

9 Appendix B

Appendix B contains questions and answers from all 6 participants. Answers are marked in italics.

9.1 Participant No. 1

9.1.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?
 - i. *At home*
 - b. How do you get information about new games?
 - i. *Father downloads games*
 - c. When did you start playing games?
 - i. *Does not know*
 - d. On what device, do you play?
 - i. *His own phone*
 - e. What is your parents' opinion about your playing?
2. Favourite games
 - a. What is your favourite game?
 - i. *Puppet soccer*
 - b. What do you like/dislike about it?
 - i. *Resemblance with football*
 - c. How long did you play it?
 - i. *No idea*
 - d. Do you still play it?
 - i. *Yes*
3. Tutorial in the games
 - a. Do you know what a tutorial is?
 - i. *No*
 - b. Have you played any game with a tutorial?
 - c. Did you finish it?

9.1.2 Part 2 - Diabetes

1. First years with diabetes
 - a. When was, diabetes diagnosed?
 - i. *In 11 months*
 - b. Where did you get the initial information?
 - i. *From Motol hospital*
 - c. Did you keep forgetting about glucometer measurements?
 - i. *No idea*
 - d. Do you know any other kids with diabetes?
 - i. *No*
 - e. Do you remember your first symptoms?

i. No

2. Diabetes today

a. How does your ordinary day look like?

i. How many times a day do you eat?

1. 6 to 7 times

ii. What kind of sports do you do?

1. Football

iii. How many times a day do you measure glycemia?

1. 6 to 7 times

iv. Do you forget about measuring?

1. Never

v. Do you change the area of a job?

1. Yes

vi. How often do you have extreme levels of glycemia?

1. Sometimes during the night

vii. Do you have a diabetic diary?

1. Parents write it a then rewrite it into excel and send it to the doctor. They are afraid of using applications.

b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?

i. Too young for that

c. How does diabetes limit you? Is there anything you cannot do?

i. Does not know any limitations

9.1.3 Part 3 – Knowledge about diabetes

1. What is diabetes? Can you describe it?

a. No idea

2. From which area is the insulin absorbed the fastest?

a. Arm

3. Describe the order of actions that needs to be done during the day

4. What can alter the glycemia?

5. What is the procedure for measuring the glycemia?

a. Activate, jab, place blood onto the strip

6. What is the procedure in insulin application?

7. Do you know what a bread unit is?

a. No

8. How many do you eat a day?

9. How many bread units do the following foodstuffs have?

a. Apple (1)

b. Roll (2)

c. Spaghetti with sauce (4)

d. Egg (0)

10. What is hypoglycemia and what are the symptoms? What do you do when you have it?
 - a. *Low glycemia level, has shaky hands*
11. What is hyperglycemia and what are the symptoms? What do you do when you have it?
 - a. *High glycemia level*
12. How long does it take for insulin to be present in measurement?
 - a. *No idea*
13. How do you alter the dosage of insulin before doing sports?
14. How do you appreciate your knowledge about the disease? Do you know everything necessary?

9.1.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?
 - a. *He liked everything*
2. What did you like/dislike?

9.1.5 Part 5 – Questionnaire for parents

1. Did you get used to the situation?
 - a. *Transition to school was the hardest part, now it is a part of their life*
2. How does your child react to it? Does he/she feel different?
 - a. *Got used to it*
3. Is your child precise?
 - a. *Extra precise*
4. What is your opinion about playing educational games?
 - a. *They are fine*
5. Where do you gather information about diabetes?
 - a. *From doctors, Facebook*

9.1.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?
 - a. *Adam*
2. How often did you play?
 - a. *Half an hour a day*
3. Did you have the music on?
 - a. *Yes*
4. Has it occurred, that your avatar had an extreme glycemia? How did you react?
 - a. *With hypo gave fast sugars, with hyper applied insulin*
5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?
 - a. *Yes, because he did not play it often*
6. Did you have a look at the settings?
 - a. Did you change anything?
 - i. *Yes, weight*

- b. Did you reset the game?
i. *No*
7. Did you visit the town? What did you do there?
a. *Bought new shoes, bought a lot of furniture*
8. Which game did you like the most?
a. *Balloon*
9. What was your high score in the game balloon? Did you have a problem with controlling?
a. *It was intuitive*
10. Did you notice a mistake in the game?
a. *There was a bug with the balloon, jab could be done outside of the finger*
11. Was there a situation when you did not know what to do?
a. *No*
12. Did you like the doctor? Did you read the instructions or did you close it?
a. *It was bothering him, he kept closing it*
13. What exactly did you like?
a. *Probably everything*
14. What exactly did you dislike?
a. *Doctor kept talking*
15. Did you enjoy the game the whole time?
a. *At the beginning, it was better*
16. What is diabetes? Can you explain it?
a. *Diseased pancreas*
17. Can you name the order of actions that are needed during the day?
a. *Wake up, measure, apply insulin, eat, then school, snack in the school (measures before it), measure before lunch, apply insulin, lunch, snack (same as the one in the morning), measure before dinner, apply insulin, dinner, measure before the second dinner, the second dinner, apply insulin*
18. Do you know what bread units are?
a. *Grammes of sugar in food*
19. How many bread units do the following foodstuffs have?
a. Banana (2)
i. *1,5*
b. Broccoli (0)
i. *0*
c. Bread (2)
i. *2*
d. Chips (3)
i. *2,5*
e. Hot dog (2,5)
i. *2*
20. How do you alter the dosage of insulin before doing sports?

- a. *Does not*
- 21. What is the difference between the short-term and the long-term insulin?
 - a. *Short acts faster and shorter period, longer acts after longer time but lasts longer*
- 22. How does the glycemia change after sport?
- 23. How does the glycemia change after food?
- 24. After what time is the insulin present in a measurement?
 - a. *No idea*
- 25. How do you value your knowledge about diabetes now? Did you learn anything new?
 - a. *Already knew everything*

9.2 Participant No. 2

9.2.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?
 - i. *At home or in a car*
 - b. How do you get information about new games?
 - i. *From friends*
 - c. When did you start playing games?
 - i. *Since she was 5*
 - d. On what device, do you play?
 - i. *On a phone or a computer*
 - e. What is your parents' opinion about your playing?
 - i. *Not happy about it, but she does not play that much*
2. Favourite games
 - a. What is your favourite game?
 - i. *The Sims*
 - b. What do you like/dislike about it?
 - i. *Design in the game, learns English*
 - c. How long did you play it?
 - i. *For 3 years' now*
 - d. Do you still play it?
 - i. *Yes*
3. Tutorial in the games
 - a. Do you know what a tutorial is?
 - i. *It explains how the game is supposed to be played*
 - b. Have you played any game with a tutorial?
 - i. *Yes, but does not remember*
 - c. Did you finish it?

i. *No, there was an option to close it*

9.2.2 Part 2 - Diabetes

1. First years with diabetes

- a. When was, diabetes diagnosed?
 - i. *In 6 years*
- b. Where did you get the initial information?
 - i. *From mum and Vinohrady hospital*
- c. Did you keep forgetting about glucometer measurements?
 - i. *Yes, very often*
- d. Do you know any other kids with diabetes?
 - i. *No, knows about 5 people from the hospital*
- e. Do you remember your first symptoms?
 - i. *Did not have, was found by an accident*

2. Diabetes today

- a. How does your ordinary day look like?
 - i. How many times a day do you eat?
 - 1. *5 to 6 times*
 - ii. What kind of sports do you do?
 - 1. *Tennis, walking the dog*
 - iii. How many times a day do you measure glycemia?
 - 1. *In the morning and in the evening to calibrate the sensor*
 - iv. Do you forget about measuring?
 - 1. *Sometimes forgets about insulin*
 - v. Do you change the area of a job?
 - 1. *Has a pump*
 - vi. How often do you have an extreme level of glycemia?
 - 1. *Not often*
 - vii. Do you have a diabetic diary?
 - 1. *No, she has a sensor*
- b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?
 - i. *Yes, but would like to improve knowledge about food intake and its composition*
- c. How does diabetes limit you? Is there anything you cannot do?
 - i. *Does not, parents helped with adaptation. Eats by herself*

9.2.3 Part 3 – Knowledge about diabetes

- 1. What is diabetes? Can you describe it?
 - a. *Problem with pancreas, which does not produce insulin or just a little*

2. From which area is the insulin absorbed the fastest?
 - a. *Belly*
3. Describe the order of actions that needs to be done during the day
 - a. *Measure, apply insulin, eat – the same during the day (applies insulin before every meal)*
4. What can alter the glycemia?
 - a. *Movement, food, glycemic index, stress*
5. What is the procedure for measuring the glycemia?
 - a. *Wash hands, clean them with a tampon, jab, place the second drop of blood onto the strip in glucometer*
6. What is the procedure in insulin application?
 - a. *Disinfection of the spot, jab*
7. Do you know what a bread unit is?
 - a. *12 carbohydrates*
8. How many do you eat a day?
9. How many bread units do following foodstuffs have?
 - a. Apple (1)
 - i. *over 1*
 - b. Roll (2)
 - i. *2*
 - c. Spaghetti with sauce (4)
 - i. *3.5*
 - d. Egg (0)
 - i. *almost nothing*
10. What is hypoglycemia and what are the symptoms? What do you do when you have it?
 - a. *Low glycemia level, is shaking, sick and weak, feels like eating. Happens with lot o insulin, a little food, too much activity*
11. What is hyperglycemia and what are the symptoms? What do you do when you have it?
 - a. *High glycemia level, same symptoms as with hypoglycemia. Happens with overeating, not applying insulin, dysfunctional cannula*
12. How long does it take for insulin to be present in measurement?
 - a. *After half an hour or an hour*
13. How do you alter the dosage of insulin before doing sports?
 - a. *Lowers the insulin income*
14. How do you appreciate your knowledge about the disease? Do you know everything necessary?
 - a. *Knows a lot, wants to know more about food*

9.2.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?
 - a. *It's cool. Is, however, used to apply insulin even before snacks. Would appreciate having it at the beginning*

2. What did you like/dislike?

9.2.5 Part 5 – Questionnaire for parents

1. Did you get used to the situation?
 - a. *We had to*
2. How does your child react to it? Does he/she feel different?
 - a. *Difficult at first, she hated insulin application, it's normal now*
3. Is your child precise?
 - a. *She is, sometimes forgot that she was not supposed to eat it*
4. What is your opinion about playing educational games?
 - a. *They are great*
5. Where do you gather information about diabetes?
 - a. *They don't trust the internet, read books, Facebook*

9.2.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?
 - a. *First Emma, then Adam*
2. How often did you play?
 - a. *Almost every day*
3. Did you have the music on?
 - a. *Indoor, outside not*
4. Has it occurred, that your avatar had an extreme glycemia? How did you react?
 - a. *Quite often, had to apply insulin or eat some food*
5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?
 - a. *Yes, for the reason she did not take care of it properly*
6. Did you have a look at the settings?
 - a. Did you change anything?
 - i. *She changed the values according to herself*
 - b. Did you reset the game?
 - i. *Yes, wanted to try something new*
7. Did you visit the town? What did you do there?
 - a. *She bought a lot of furniture*
8. Which game did you like the most?
 - a. *Sorting food*
9. What was your high score in the game balloon? Did you have a problem with controlling?
 - a. *Problem at the beginning*
10. Did you notice a mistake in the game?
 - a. *Sometimes the avatar ran just one second a then stopped*
11. Was there a situation when you did not know what to do?
 - a. *No*
12. Did you like the doctor? Did you read the instructions or did you close it?
 - a. *Did not mind*
13. What exactly did you like?

- a. Personalisation with the player, book with information about diabetes, list of foodstuff with bread units*
14. What exactly did you dislike?
a. Not sure
15. Did you enjoy the game the whole time?
a. Something could change after a while, but she liked it
16. What is diabetes? Can you explain it?
a. Pancreas does not produce insulin which is needed to absorb carbohydrates
17. Can you name the order of actions that are needed during the day?
a. Wake up, wash hands, measure, apply insulin, eat and repeat
18. Do you know what bread units are?
a. Yes
19. How many bread units do the following foodstuffs have?
- a. Banana (2)
 - i. 2*
 - b. Broccoli (0)
 - i. 0*
 - c. Bread (2)
 - i. 2*
 - d. Chips (3)
 - i. 1,5*
 - e. Hot dog (2,5)
 - i. over 2*
20. How do you alter the dosage of insulin before doing sports?
a. Lowers the dosage or adds food
21. What is the difference between the short-term and the long-term insulin?
a. Short works within 1 hour, is applied before every meal apart from the second dinner and is applied with high glycemia level. Long works within 4 hours, is used for night
22. How does the glycemia change after sport?
a. Goes down
23. How does the glycemia change after food?
a. Goes up
24. After what time is the insulin present in a measurement?
a. After 1 hour at most
25. How do you value your knowledge about diabetes now? Did you learn anything new?
a. She learned new things, knows more about food

9.3 Participant No. 3

9.3.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?

- i. *At home*
 - b. How do you get information about new games?
 - i. *From friends*
 - c. When did you start playing games?
 - i. *About half a year ago*
 - d. On what device, do you play?
 - i. *On a tablet*
 - e. What is your parents' opinion about your playing?
 - i. *They don't mind*
- 2. Favourite games
 - a. What is your favourite game?
 - i. *„Tiger“*
 - b. What do you like/dislike about it?
 - i. *You earn points and buy new things for that*
 - c. How long did you play it?
 - i. *Half a year*
 - d. Do you still play it?
 - i. *Yes*
- 3. Tutorial in the games
 - a. Do you know what a tutorial is?
 - i. *No*
 - b. Have you played any game with a tutorial?
 - c. Did you finish it?

9.3.2 Part 2 - Diabetes

- 1. First years with diabetes
 - a. When was, diabetes diagnosed?
 - i. *In 3 years*
 - b. Where did you get the initial information?
 - i. *From Motol hospital, then from a spa*
 - c. Did you keep forgetting about glucometer measurements?
 - i. *No, mother keeps reminding her*
 - d. Do you know any other kids with diabetes?
 - i. *Has many friends, her mother is active online*
 - e. Do you remember your first symptoms?
 - i. *Was sick, pain in the stomach, vomited*
- 2. Diabetes today
 - a. How does your ordinary day look like?
 - i. How many times a day do you eat?
 - 1. *6 times a day*
 - ii. What kind of sports do you do?
 - 1. *Gymnastics*
 - iii. How many times a day do you measure glycemia?
 - 1. *3 to 4 times a day*

- iv. Do you forget about measuring?
 - 1. No
- v. Do you change the area of a jab?
 - 1. Has a pump
- vi. How often do you have an extreme level of glycemia?
 - 1. Has hypoglycemia often during
the night
- vii. Do you have a diabetic diary?
 - 1. Used to have, now the data is being sent via the pump
- b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?
 - i. Yes, she thinks she handles everything well
- c. How does diabetes limit you? Is there anything you cannot do?
 - i. No, she even goes to a sweet-shop

9.3.3 Part 3 – Knowledge about diabetes

1. What is diabetes? Can you describe it?
 - a. From a fairy tale, children can eat, if there are insulin spoons bringing insulin to the cells
2. From which area is the insulin absorbed the fastest?
 - a. Belly
3. Describe the order of actions that needs to be done during the day
 - a. Wake up, measure, eat and apply insulin before going to kindergarten. Measures before lunch and by the result apply insulin and go eating.
4. What can alter the glycemia?
 - a. If you eat something bad and don't ask mommy before or if you don't eat anything.
5. What is the procedure for measuring the glycemia?
 - a. Jab into a finger, presses the finger, removes the first drop of blood and then places the second one onto a strip in the glucometer.
6. What is the procedure in insulin application?
 - a. Does not know, has a pump
7. Do you know what a bread unit is?
 - a. Does not know, her mother prepares the food at home and in the kindergarten, she has an assistant helping her.
8. How many do you eat a day?
9. How many bread units do following foodstuffs have?
 - a. Apple (1)
 - b. Roll (2)
 - c. Spaghetti with sauce (4)
 - d. Egg (0)

10. What is hypoglycemia and what are the symptoms? What do you do when you have it?

a. Small numbers on a glucometer

11. What is hyperglycemia and what are the symptoms? What do you do when you have it?

a. Big numbers on a glucometer

12. How long does it take for insulin to be present in measurement?

a. No idea

13. How do you alter the dosage of insulin before doing sports?

a. Eats a biscuit before

14. How do you appreciate your knowledge about the disease? Do you know everything necessary?

a. Knows she must learn more

9.3.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?

a. She was amazed, liked everything

2. What did you like/dislike?

a. She liked the actions connected with diabetes, that it resembles her of her disease.

9.3.5 Part 5 – Questionnaire for parents

1. Did you get used to the situation?

a. It was a shock; they did not see that coming. They try a lot so that her child has a normal life

2. How does your child react to it? Does he/she feel different?

a. She does not feel any different.

3. Is your child precise?

a. She is still very young; they remind her of everything

4. What is your opinion about playing educational games?

a. They like it a lot. Think, that information from the games are easier absorbed than from the parents

5. Where do you gather information about diabetes?

a. From other mothers, from books

9.3.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?

a. Emma

2. How often did you play?

a. First two days a lot, then not at all

3. Did you have the music on?

a. Yes

4. Has it occurred that your avatar had an extreme glycemia? How did you react?

a. Yes, but was unable to find appropriate treatment

5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?
 - a. *No*
6. Did you have a look at the settings?
 - a. Did you change anything?
 - i. *No*
 - b. Did you reset the game?
 - i. *No*
7. Did you visit the town? What did you do there?
 - a. *Yes, she bought a new chair*
8. Which game did you like the most?
 - a. *Did not try any*
9. What was your high score in the game balloon? Did you have a problem with controlling?
 - a. *Did not play it*
10. Did you notice a mistake in the game?
 - a. *Applying half a unit of insulin is not possible, missing orange juice*
11. Was there a situation when you did not know what to do?
 - a. *Could not treat hypoglycemia*
12. Did you like the doctor? Did you read the instructions or did you close it?
 - a. *Yes, she listened to all the doctor's instructions*
13. What exactly did you like?
 - a. *She liked how she can take care of a person with diabetes*
14. What exactly did you dislike?
 - a. *No idea*
15. Did you enjoy the game the whole time?
 - a. *Stopped playing after 3 days*
16. What is diabetes? Can you explain it?
 - a. *From a fairy tale, children can eat, if there are insulin spoons bringing insulin to the cells. She has to jab in a finger to know how much to apply.*
17. Can you name the order of actions that are needed during the day?
 - a. *In the morning pee on a strip, measure, apply insulin.*
18. Do you know what bread units are?
 - a. *How much sugar is in food, one unit is 10 grammes of sugar*
19. How many bread units do the following foodstuffs have?
 - a. Banana (2)
 - b. Broccoli (0)
 - c. Bread (2)
 - d. Chips (3)
 - e. Hot dog (2,5)
20. How do you alter the dosage of insulin before doing sports?
 - a. *Eats a biscuit before*

21. What is the difference between the short-term and the long-term insulin?
 - a. *Does not know, has a pump*
22. How does the glycemia change after sport?
 - a. *Goes down*
23. How does the glycemia change after food?
 - a. *Goes up*
24. After what time is the insulin present in a measurement?
 - a. *No idea*
25. How do you value your knowledge about diabetes now? Did you learn anything new?
 - a. *Does not know what she learned. She knows she does not have vast knowledge*

9.4 Participant No. 4

9.4.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?
 - i. *Does not play much, mostly at home*
 - b. How do you get information about new games?
 - i. *From Google play*
 - c. When did you start playing games?
 - i. *Does not know*
 - d. On what device, do you play?
 - i. *On a phone*
 - e. What is your parents' opinion about your playing?
 - i. *They don't control it*
2. Favourite games
 - a. What is your favourite game?
 - i. *„Crocodile“*
 - b. What do you like/dislike about it?
 - i. *It's fun*
3. Tutorial in the games
 - a. Do you know what a tutorial is?
 - i. *No*
 - b. Have you played any game with a tutorial?
 - c. Did you finish it?

9.4.2 Part 2 - Diabetes

1. First years with diabetes
 - a. When was, diabetes diagnosed?
 - i. *In 10 years*
 - b. Where did you get the initial information?
 - i. *From the Motol hospital*
 - c. Did you keep forgetting about glucometer measurements?

- i. *Not at the beginning, does forget now*
 - d. Do you know any other kids with diabetes?
 - i. *She got to know other kids in the hospital, takes part in diabetical camps*
 - e. Do you remember your first symptoms?
 - i. *She drank a lot and used to go to the toilet a lot*
- 2. Diabetes today
 - a. How does your ordinary day look like?
 - i. How many times a day do you eat?
 - 1. *5 times a day*
 - ii. What kind of sports do you do?
 - 1. *Aerobic*
 - iii. How many times a day do you measure glycemia?
 - 1. *4 times a day*
 - iv. Do you forget about measuring?
 - 1. *Does forget occasionally*
 - v. Do you change the area of a jab?
 - 1. *Has a pump*
 - vi. How often do you have an extreme level of glycemia?
 - 1. *Just sometimes*
 - vii. Do you have a diabetic diary?
 - 1. *Doesn't have, information is being sent from the pump*
 - b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?
 - i. *Is quite satisfied, she could improve meals. Snacks are being prepared by mother, she eats by herself at home.*
 - c. How does diabetes limit you?
 - i. *Not aware of anything, maybe difficult beginnings from the perspective of other children*

9.4.3 Part 3 – Knowledge about diabetes

1. What is diabetes? Can you describe it?
 - a. *Something happens with pancreas and it stops producing insulin*
2. From which area is the insulin absorbed the fastest?
 - a. *Belly*
3. Describe the order of actions that needs to be done during the day
 - a. *Wake up, measure, apply insulin, eat, then snack, lunch, snack and dinner. Does not measure before snacks.*
4. What can alter the glycemia?
 - a. *Low glycemia level by shoe shopping, high level when the cannula from the pump is bent. Food and insulin alter glycemia level.*
5. What is the procedure for measuring the glycemia?

- a. *Jab in a finger, places the second drop of blood onto a strip in the glucometer.*
6. What is the procedure in insulin application?
a. *Chooses 2 units of insulin, presses the pen, chooses the correct dosage and jabs into the skin.*
7. Do you know what a bread unit is?
a. *Amount of sugar in food*
8. How many do you eat a day?
a. *About 15*
9. How many bread units do following foodstuffs have?
a. Apple (1)
i. *1,5*
b. Roll (2)
i. *2*
c. Spaghetti with sauce (4)
i. *4*
d. Egg (0)
i. *0*
10. What is hypoglycemia and what are the symptoms? What do you do when you have it?
a. *Her hands are shaking, lightheaded. Eats*
11. What is hyperglycemia and what are the symptoms? What do you do when you have it?
a. *Pain in the stomach, drinks a lot and goes to the toilet a lot. Applies insulin*
12. How long does it take for insulin to be present in measurement?
a. *After half an hour*
13. How do you alter the dosage of insulin before doing sports?
a. *Does not alter it*
14. How do you appreciate your knowledge about the disease? Do you know everything necessary?
a. *She knows a lot, but there are still gaps in the knowledge*

9.4.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?
a. *She was positively surprised.*
2. What did you like/dislike?
a. *Thinks it can help a lot to smaller children with diabetes, especially at the beginning. Does not see anything bad at the moment*

9.4.5 Part 5 – Questionnaire for parents

1. Did you get used to the situation?
a. *It was hard at the beginning, the whole family had to get used to it. It is better with an insulin pump. Still, prepares snacks.*
2. How does your child react to it? Does he/she feel different?

- a. *Was embarrassed at first, but got used to it. Has 4 friends with diabetes at school.*
- 3. Is your child precise?
 - a. *Has to ask her whether she applied insulin, sometimes lies about it.*
- 4. What is your opinion about playing educational games?
 - a. *She likes it.*
- 5. Where do you gather information about diabetes?
 - a. *From magazines, books*

9.4.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?
 - a. *Emma*
2. How often did you play?
 - a. *Once in two days*
3. Did you have the music on?
 - a. *Yes*
4. Has it occurred, that your avatar had an extreme glycemia? How did you react?
 - a. *Once had hypo, applied fast sugars*
5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?
 - a. *Did not happen*
6. Did you have a look at the settings?
 - a. Did you change anything?
 - i. *Did not*
 - b. Did you reset the game?
 - i. *No*
7. Did you visit the town? What did you do there?
 - a. *She was, but shopping is not her thing*
8. Which game did you like the most?
 - a. *Balloon*
9. What was your high score in the game balloon? Did you have a problem with controlling?
 - a. *It was alright*
10. Did you notice a mistake in the game?
 - a. *Every loading took too long*
11. Was there a situation when you did not know what to do?
 - a. *Not really*
12. Did you like the doctor? Did you read the instructions or did you close it?
 - a. *Was closing it*
13. What exactly did you like?
14. What exactly did you dislike?
 - a. *The game is slow and that you can measure glycemia from the thumb.*

15. Did you enjoy the game the whole time?
 - a. *She liked it kind of*
16. What is diabetes? Can you explain it?
 - a. *Pancreas is unhealthy, does not produce insulin*
17. Can you name the order of actions that are needed during the day?
 - a. *Wake up, measure, apply insulin and so on*
18. Do you know what bread units are?
 - a. *Amount of food*
19. How many bread units do the following foodstuffs have?
 - a. Banana (2)
 - i. 2
 - b. Broccoli (0)
 - i. 0
 - c. Bread (2)
 - i. 2
 - d. Chips (3)
 - i. 3
 - e. Hot dog (2,5)
 - i. 1,5
20. How do you alter the dosage of insulin before doing sports?
 - a. *Lowers the dosage*
21. What is the difference between the short-term and the long-term insulin?
 - a. *Short during the day, long for the night*
22. How does the glycemia change after sport?
 - a. *Goes down*
23. How does the glycemia change after food?
 - a. *Goes up*
24. After what time is the insulin present in a measurement?
 - a. *After half an hour*
25. How do you value your knowledge about diabetes now? Did you learn anything new?
 - a. *The game did not bring anything new*

9.5 Participant No. 5

9.5.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?
 - i. *At home*
 - b. How do you get information about new games?
 - i. *From google play*
 - c. When did you start playing games?
 - i. *Does not know*
 - d. On what device, do you play?
 - i. *On a tablet*

- e. What is your parents' opinion about your playing?
 - i. *They don't control it*
- 2. Favourite games
 - a. What is your favourite game?
 - i. *Does not have one*
- 3. Tutorial in the games
 - a. Do you know what a tutorial is?
 - i. *Yes, it's at the beginning*
 - b. Have you played any game with a tutorial?
 - c. Did you finish it?
 - i. *Yes*

9.5.2 Part 2 - Diabetes

- 1. First years with diabetes
 - a. When was, diabetes diagnosed?
 - i. *In 11 years*
 - b. Where did you get the initial information?
 - i. *In Motol hospital*
 - c. Did you keep forgetting about glucometer measurements?
 - i. *No, never*
 - d. Do you know any other kids with diabetes?
 - i. *From hospital, she visits diabetical camps*
 - e. Do you remember your first symptoms?
 - i. *Tired, lost 12 kilogrammes*
- 2. Diabetes today
 - a. How does your ordinary day look like?
 - i. How many times a day do you eat?
 - 1. *6 times a day*
 - ii. What kind of sports do you do?
 - 1. *None*
 - iii. How many times a day do you measure glycemia?
 - 1. *4 times a day*
 - iv. Do you forget about measuring?
 - 1. *No*
 - v. Do you change the area of a jab?
 - 1. *Has a pump*
 - vi. How often do you have an extreme level of glycemia?
 - 1. *Not that often*
 - vii. Do you have a diabetic diary?
 - 1. *No*
 - b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?
 - i. *She prepares meals for herself, would like to do more sports.*

- c. How does diabetes limit you? Is there anything you cannot do?
i. *She got used to it, does not know any limitations.*

9.5.3 Part 3 – Knowledge about diabetes

1. What is diabetes? Can you describe it?
a. *White blood cells attack beta cells and they cannot produce insulin*
2. From which area is the insulin absorbed the fastest?
a. *Belly*
3. Describe the order of actions that needs to be done during the day
a. *Measure, apply, meal and so on, sometimes measures before snacks, does not have the second dinner*
4. What can alter the glycemia?
a. *Shoe shopping, swimming*
5. What is the procedure for measuring the glycemia?
a. *Jab into a finger, placing the second drop of blood onto the strip in a glucometer*
6. What is the procedure in insulin application?
a. *Knows it, but uses pump*
7. Do you know what a bread unit is?
a. *12 grammes of carbohydrates*
8. How many do you eat a day?
a. *Around 20*
9. How many bread units do following foodstuffs have?
 - a. Apple (1)
 - i. *1*
 - b. Roll (2)
 - i. *2*
 - c. Spaghetti with sauce (4)
 - i. *3,5*
 - d. Egg (0)
 - i. *0*
10. What is hypoglycemia and what are the symptoms? What do you do when you have it?
a. *Low glycemia level, is cold and sweaty, takes grape sugar*
11. What is hyperglycemia and what are the symptoms? What do you do when you have it?
a. *High glycemia level, is hot and has pain in a stomach*
12. How long does it take for insulin to be present in measurement?
a. *After half an hour to an hour*
13. How do you alter the dosage of insulin before doing sports?
a. *Does not*

14. How do you appreciate your knowledge about the disease? Do you know everything necessary?

a. There is always something to be taught, handles everything herself for the moment

9.5.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?

a. It could be useful for children to learn something

2. What did you like/dislike?

a. Some foodstuffs were not recognisable

9.5.5 Part 5 – Questionnaire for parents

Parents of Kristyna were not present during the interview

9.5.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?

a. Emma

2. How often did you play?

a. Once in two days

3. Did you have the music on?

a. Yes, but low volume

4. Has it occurred, that your avatar had an extreme glycemia? How did you react?

a. With hypoglycemia, she gave the avatar fast sugars

5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?

a. Never occurred

6. Did you have a look at the settings?

a. Did you change anything?

i. No

b. Did you reset the game?

i. No

7. Did you visit the town? What did you do there?

a. Yes, she bought new clothes

8. Which game did you like the most?

a. Sorting food

9. What was your high score in the game balloon? Did you have a problem with controlling?

10. Did you notice a mistake in the game?

a. She had some problems and reinstalled the game

11. Was there a situation when you did not know what to do?

a. No

12. Did you like the doctor? Did you read the instructions or did you close it?

a. Sometimes closed, sometimes not

13. What exactly did you like?

a. It is informative, especially for less educated children

14. What exactly did you dislike?

- a. *Is too old for that*
- 15. Did you enjoy the game the whole time?
 - a. *Kind of*
- 16. What is diabetes? Can you explain it?
 - a. *White blood cells attack the beta cells*
- 17. Can you name the order of actions that are needed during the day?
 - a. *Wake up, measure, apply insulin, eat*
- 18. Do you know what bread units are?
 - a. *Amount of carbohydrates to be eaten*
- 19. How many bread units do the following foodstuffs have?
 - a. Banana (2)
 - i. 2
 - b. Broccoli (0)
 - i. 0
 - c. Bread (2)
 - i. 2
 - d. Chips (3)
 - i. 3,5
 - e. Hot dog (2,5)
 - i. 2
- 20. How do you alter the dosage of insulin before doing sports?
 - a. *Lowers insulin before sport*
- 21. What is the difference between the short-term and the long-term insulin?
 - a. *Short during the day, long over the night*
- 22. How does the glycemia change after sport?
 - a. *Goes down*
- 23. How does the glycemia change after food?
 - a. *Goes up*
- 24. After what time is the insulin present in a measurement?
 - a. *After half an hour*
- 25. How do you value your knowledge about diabetes now? Did you learn anything new?
 - a. *Knew everything*

9.6 Participant No. 6

9.6.1 Part 1 – About playing games

1. Factors of gaming
 - a. When do you play? At school, at home, in a car?
 - i. *At home*
 - b. How do you get information about new games?
 - i. *From google play*
 - c. When did you start playing games?
 - i. *Since she was 5*
 - d. On what device, do you play?

- i. *On a tablet*
- e. What is your parents' opinion about your playing?
i. *She plays at most 1,5 hours a day*
2. Favourite games
- a. What is your favourite game?
i. *Minecraft*
- b. What do you like/dislike about it?
i. *Real simulator, can create houses*
- c. How long did you play it?
i. *2 years' now*
- d. Do you still play it?
i. *Yes*
3. Tutorial in the games
- a. Do you know what a tutorial is?
i. *Cannot explain it*
- b. Have you played any game with a tutorial?
i. *Yes*
- c. Did you finish it?
i. *No, always skip*

9.6.2 Part 2 - Diabetes

1. First years with diabetes
- a. When was, diabetes diagnosed?
i. *In 2 years*
- b. Where did you get the initial information?
i. *Internet, books*
- c. Did you keep forgetting about glucometer measurements?
i. *Never*
- d. Do you know any other kids with diabetes?
i. *Meet other kids through facebook, events, has a classmate with diabetes*
- e. Do you remember your first symptoms?
i. *Drank too much*
2. Diabetes today
- a. How does your ordinary day look like?
- i. How many times a day do you eat?
1. *6 times*
- ii. What kind of sports do you do?
1. *Judo*
- iii. How many times a day do you measure glycemia?
1. *8 times, but only since she is in a research group*
- iv. Do you forget about measuring?
1. *No*

- v. Do you change the area of a jab?
 - vi. How often do you have an extreme level of glycemia?
 - vii. Do you have a diabetic diary?
- b. Are you satisfied with the way how you handle diabetes? Are you able of taking care of everything?
 - c. How does diabetes limit you? Is there anything you cannot do?

9.6.3 Part 3 – Knowledge about diabetes

1. What is diabetes? Can you describe it?
 - a. *Glycemia does not lower itself, must measure, apply insulin and eat regularly*
2. From which area is the insulin absorbed the fastest?
 - a. *Belly*
3. Describe the order of actions that needs to be done during the day
 - a. *Wake up, measure, apply insulin, eat, applies insulin after snack only by the result of measurement*
4. What can alter the glycemia?
5. What is the procedure for measuring the glycemia?
 - a. *Jab, place the second drop of blood onto the strip in glucometer*
6. What is the procedure in insulin application?
 - a. *Sets the dosage, jabs and presses the pen*
7. Do you know what a bread unit is?
 - a. *How much food we eat. Knows which food has sugar, but cannot count it*
8. How many do you eat a day?
9. How many bread units do following foodstuffs have?
 - a. Apple (1)
 - b. Roll (2)
 - c. Spaghetti with sauce (4)
 - d. Egg (0)
10. What is hypoglycemia and what are the symptoms? What do you do when you have it?
 - a. *Low glycemia, pain in the stomach, sweating, shaky hands, feels weird, eats grape sugar*
11. What is hyperglycemia and what are the symptoms? What do you do when you have it?
 - a. *High glycemia, feels weird, must apply insulin*
12. How long does it take for insulin to be present in measurement?
 - a. *After 20 minutes, 30 minutes*
13. How do you alter the dosage of insulin before doing sports?
 - a. *Does not change insulin, eats more*
14. How do you appreciate your knowledge about the disease? Do you know everything necessary?
 - a. *Is satisfied with herself*

9.6.4 Part 4 – First reaction after the gameplay

1. What is your first reaction?
 - a. *Likes it a lot*
2. What did you like/dislike?

9.6.5 Part 5 – Questionnaire for parents

1. Did you get used to the situation?
 - a. *Adapted themselves to the disease*
2. How does your child react to it? Does he/she feel different?
 - a. *Sometimes feels like eating something, her classmate supports her a lot*
3. Is your child precise?
 - a. *Very precise, does not cheat*
4. What is your opinion about playing educational games?
 - a. *They are fine, small children can learn a lot about diabetes from these games*
5. Where do you gather information about diabetes?
 - a. *From the internet, various diabetical groups*

9.6.6 Part 6 – Questionnaire after a week

1. Which avatar did you choose? Emma or Adam?
 - a. *Emma*
2. How often did you play?
 - a. *Every day during the week, about 15 minutes a day*
3. Did you have the music on?
 - a. *Just sometimes*
4. Has it occurred, that your avatar had an extreme glycemia? How did you react?
 - a. *It did, applied insulin with hyper, eat something with hypo*
5. Has it occurred, that the avatar was hospitalised? Can you describe why that happened?
 - a. *Never*
6. Did you have a look at the settings?
 - a. Did you change anything?
 - i. *Not sure*
 - b. Did you reset the game?
 - i. *No*
7. Did you visit the town? What did you do there?
 - a. *Bought new blanket, shoes, trousers, and table. Enjoyed it a lot*
8. Which game did you like the most?
 - a. *Played all*
9. What was your high score in the game balloon? Did you have a problem with controlling?
 - a. *It was alright*
10. Did you notice a mistake in the game?

- a. Bad instructions from the doctor, jab can be done outside of a finger, bought food did not appear in the inventory*
11. Was there a situation when you did not know what to do?
- a. No*
12. Did you like the doctor? Did you read the instructions or did you close it?
- a. She liked it, read it thoroughly*
13. What exactly did you like?
- a. Liked it a lot, came up with an idea of adding a backpack with basic supplies for a person with diabetes*
14. What exactly did you dislike?
- a. Does not know*
15. Did you enjoy the game the whole time?
- a. Yes*
16. What is diabetes? Can you explain it?
- a. You must measure, apply insulin and eat regularly. She does not have beta cells*
17. Can you name the order of actions that are needed during the day?
- a. The measure, apply insulin, eat and so on. Does everything before every meal*
18. Do you know what bread units are?
- a. Roll has 2 and you should eat a meal with specific amount*
19. How many bread units do the following foodstuffs have?
- a. Banana (2)*
- i. 2*
- b. Broccoli (0)*
- i. Nothing*
- c. Bread (2)*
- i. 2*
- d. Chips (3)*
- i. Does not know*
- e. Hot dog (2,5)*
- i. 2*
20. How do you alter the dosage of insulin before doing sports?
- a. Lowers the insulin dosage or eats something*
21. What is the difference between the short-term and the long-term insulin?
- a. Slow is applied for the night and the fast one during the day*
22. How does the glycemia change after sport?
- a. Goes down*
23. How does the glycemia change after food?
- a. Goes up*
24. After what time is the insulin present in a measurement?
- a. Does not know*
25. How do you value your knowledge about diabetes now? Did you learn anything new?
- a. She thinks she already knew everything*