

Bachelor Project



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Design of story line for serious educational game

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Declaration

I hereby declare that I have written this bachelor thesis independently and quoted all the sources of information in accordance with Methodical instructions about ethical principles for writing academic theses.

In Prague, 24. May 2024

Abstract

This thesis explores the design of a story line for a serious educational game targeted at children with diabetes. The game takes inspiration from popular mobile games such as Tamagotchi and Talking Tom and is developed using the Unity game engine and C# programming language. The objective of the game is to help children with diabetes become accustomed to using insulin and managing their condition effectively. This thesis investigates the significance of storytelling in serious educational games and proposes a compelling narrative that engages and educates the target audience. The design process involves extensive research on diabetes management and the application of game design principles to create an immersive and educational gaming experience. The resulting story line integrates educational content with interactive gameplay, aiming to empower children with diabetes and facilitate their understanding of insulin usage.

Keywords: MyDiabetic, Android, iOS, Diabetes mellitus, Unity, serious game

Supervisor: doc. Ing. Daniel Novák, Ph.D.

Abstrakt

Tato práce zkoumá návrh dějové linie vážné vzdělávací hry zaměřené na děti s diabetem. Hra čerpá inspiraci z populárních mobilních her, jako jsou Tamagotchi a Talking Tom, a je vyvíjena pomocí herního enginu Unity a programovacího jazyka C#. Cílem hry je pomoci dětem s diabetem se seznámit s užíváním inzulínu a efektivním řízením svého stavu. Tato práce zkoumá význam vyprávění příběhu ve vážných vzdělávacích hrách a navrhuje poutavý příběh, který zapojuje a vzdělává cílovou skupinu. Návrhový proces zahrnuje rozsáhlý výzkum správy diabetu a aplikaci principů herního designu pro vytvoření poutavého a vzdělávacího herního zážitku. Výsledná dějová linie integruje vzdělávací obsah s interaktivním hraním, s cílem posílit schopnosti dětí s diabetem a usnadnit jim porozumění užívání inzulínu.

Klíčová slova: MyDiabetic, Android, iOS, Diabetes mellitus, Unity, seriózní hra

Překlad názvu: Vytvoření příběhového modulu pro seriózní hru

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Chapter 1

Introduction

1.1 Background and Rationale

Serious educational games have gained significant attention in recent years due to their potential to engage and educate players in various domains. These games combine the elements of entertainment and learning to create interactive experiences that can effectively convey educational content [2]. As a result, serious educational games have been utilized in diverse fields such as health education, environmental awareness, and cultural heritage preservation [3].

One area where serious educational games hold great promise is in the management of chronic health conditions among children. Chronic diseases, such as diabetes, pose significant challenges to children's well-being and require them to learn complex self-management skills. Diabetes, in particular, necessitates continuous monitoring of blood glucose levels, insulin administration, and adherence to dietary and lifestyle changes [4].

Mobile games have become increasingly popular among children, offering a convenient and engaging platform for delivering educational content. Games like Tamagotchi and Talking Tom have demonstrated the potential to captivate and entertain young audiences [5]. By leveraging the success of these games, there is an opportunity to develop a serious educational game that can help children with diabetes become familiar with insulin usage and empower them to manage their condition effectively.

1.2 Research Objectives

The primary objective of this research is to design a compelling story line for a serious educational game aimed at children with diabetes. The specific research objectives are as follows:

1. To investigate the role of storytelling in serious educational games and its impact on player engagement and learning outcomes.
2. To explore the potential of mobile game platforms, such as Unity and C#, for creating an immersive and interactive gaming experience.

Chapter 2

Understanding Diabetes

This chapter provides an overview of diabetes, a chronic metabolic disorder that affects millions of people worldwide. Understanding the basics of diabetes is essential for developing a serious educational game targeted at children with diabetes. This chapter aims to explain the key aspects of diabetes, its types, causes, symptoms, complications, and management strategies, drawing on relevant research and expert opinions.

2.1 Diabetes Mellitus

Diabetes mellitus is a chronic illness that affects the lives of many people, including children. Not only in the Czech Republic but in the whole world, diabetes mellitus is one of the most common illnesses that children are diagnosed with, and the number is only rising. Proper treatment and management of diabetes is key to improving the quality of life of patients, especially for children who are dealing with this disease.

Year	Number of People
2021	813 871
2020	792 338
2019	782 967
2018	760 372
2017	744 454
2016	728 413
2015	706 149

Table 2.1: Number of people with diabetes under treatment in Czechia from 2015 to 2021.[1]

2.2 Types of Diabetes

Diabetes is characterized by the body's inability to regulate blood glucose levels effectively. There are several types of diabetes, including:

1. **Type 1 Diabetes:** Also known as insulin-dependent diabetes, type 1 diabetes is an autoimmune disease where the body's immune system mistakenly attacks and destroys the insulin-producing cells in the pancreas. As a result, individuals with type 1 diabetes require insulin injections or the use of an insulin pump to manage their blood glucose levels [6].
2. **Type 2 Diabetes:** Type 2 diabetes is a metabolic disorder characterized by insulin resistance, where the body's cells become resistant to the effects of insulin. It is often associated with lifestyle factors such as obesity, physical inactivity, and poor dietary choices. Type 2 diabetes can be managed through lifestyle modifications, oral medications, or insulin therapy if necessary [6].
3. **Gestational Diabetes:** Gestational diabetes occurs during pregnancy and usually resolves after childbirth. It is characterized by high blood glucose levels that develop due to hormonal changes during pregnancy. Women with gestational diabetes have an increased risk of developing type 2 diabetes later in life [6].

2.3 Causes and Risk Factors

The exact causes of diabetes vary depending on the type, but there are common factors that contribute to its development. For type 1 diabetes, genetic predisposition and autoimmune factors play a significant role. Type 2 diabetes, on the other hand, is influenced by a combination of genetic and environmental factors, such as obesity, sedentary lifestyle, and unhealthy eating habits [7].

Certain risk factors increase the likelihood of developing diabetes, including family history, ethnicity (e.g., African, Hispanic, Asian), age, and a history of gestational diabetes. Understanding these risk factors can help identify individuals who may be at higher risk and require targeted interventions and education [6].

2.4 Symptoms, Complications, and Worsening

Diabetes can lead to various complications if not properly managed. High blood glucose levels over time can damage organs and systems in the body. Common complications of diabetes include cardiovascular disease, kidney disease, nerve damage, eye problems, and foot complications [6].

Furthermore, poor blood glucose control can result in hyperglycemia, where blood glucose levels are consistently high. Hyperglycemia can cause symptoms such as increased thirst, frequent urination, fatigue, and blurred vision. Inadequate management of diabetes can also lead to hypoglycemia, characterized by low blood glucose levels, which can cause dizziness, sweating, confusion, and, in severe cases, loss of consciousness.

It is important for individuals with diabetes to work closely with healthcare professionals to develop a personalized diabetes management plan and to regularly monitor their blood glucose levels to prevent both hyperglycemia and hypoglycemia [6].

The symptoms of diabetes can vary depending on the type and severity of the condition. Common symptoms include frequent urination, excessive thirst, unexplained weight loss, fatigue, and blurred vision [6]. If left untreated or poorly managed, diabetes can lead to various complications, including:

- **Cardiovascular Disease:** High blood glucose levels and other risk factors associated with diabetes can increase the risk of developing cardiovascular diseases such as heart disease, stroke, and peripheral artery disease. Cardiovascular disease is a major concern for individuals with diabetes, as the elevated blood glucose levels can damage blood vessels and lead to the buildup of fatty deposits, narrowing the arteries and impeding blood flow [6]. It is essential for individuals with diabetes to manage their blood glucose levels, blood pressure, and cholesterol to reduce the risk of cardiovascular complications.
- **Kidney Disease:** Diabetes is one of the leading causes of kidney disease, known as diabetic nephropathy. Elevated blood glucose levels can damage the small blood vessels in the kidneys, impairing their ability to filter waste products effectively. Over time, this can lead to kidney damage and eventually kidney failure. Individuals with diabetes should undergo regular screenings to detect any signs of kidney disease and take steps to manage their blood glucose levels and blood pressure to protect kidney function [6].
- **Nerve Damage:** Elevated blood glucose levels over time can cause nerve damage, known as diabetic neuropathy. This condition can affect various nerves in the body, leading to complications such as numbness, tingling, pain, and problems with digestion, urination, and sexual function. Diabetic neuropathy most commonly affects the nerves in the feet and legs, causing peripheral neuropathy. Proper blood glucose control, along with regular foot care and check-ups, can help prevent or manage nerve damage in individuals with diabetes [6].
- **Eye Problems:** Diabetes can affect the blood vessels in the eyes, leading to diabetic retinopathy, which is a leading cause of blindness in adults. Elevated blood glucose levels can damage the small blood vessels in the retina, the light-sensitive tissue at the back of the eye. Over time, this can lead to vision problems and, if left untreated, severe vision loss or blindness. Regular eye examinations and early detection of diabetic retinopathy are crucial for preserving vision in individuals with diabetes. Maintaining proper blood glucose control and blood pressure management can help reduce the risk of eye complications [6].
- **Foot Complications:** Poor blood circulation and nerve damage can lead to foot ulcers and infections in individuals with diabetes. Elevated

blood glucose levels can impair blood flow to the feet and cause damage to the nerves, leading to decreased sensation and increased vulnerability to injuries. Foot ulcers, if left untreated, can develop into serious infections and, in severe cases, may necessitate amputation. Proper foot care, including regular foot inspections, appropriate footwear, and prompt treatment of any foot issues, is essential for preventing foot complications in individuals with diabetes [6].

2.5 Diabetes Management

Proper diabetes management is crucial for maintaining optimal blood glucose control and preventing complications. The management strategies include:

1. **Blood Glucose Monitoring:** Regular monitoring of blood glucose levels using glucose meters or continuous glucose monitoring (CGM) systems helps individuals with diabetes track their levels and make appropriate adjustments to their treatment plan.
2. **Insulin Therapy:** Individuals with type 1 diabetes or advanced type 2 diabetes may require insulin therapy to regulate their blood glucose levels effectively. Insulin can be administered through injections or insulin pumps.
3. **Lifestyle Modifications:** Adopting a healthy lifestyle plays a vital role in diabetes management. This includes engaging in regular physical activity, following a balanced diet, maintaining a healthy weight, and avoiding tobacco and excessive alcohol consumption.
4. **Medication:** In addition to insulin, oral medications and other injectable medications may be prescribed to manage blood glucose levels in individuals with type 2 diabetes.
5. **Education and Support:** Diabetes self-management education and support programs provide individuals with the knowledge and skills to effectively manage their condition. This includes understanding carbohydrate counting, meal planning, medication management, and problem-solving strategies [6].

2.6 Ketone Bodies and Measurement

In certain situations, such as during periods of prolonged fasting or when blood glucose levels are consistently high, the body may start producing ketone bodies as an alternative source of energy. Ketone bodies, including beta-hydroxybutyrate, acetoacetate, and acetone, are produced by the liver through the breakdown of fatty acids [8].

When insulin levels are low, such as in individuals with uncontrolled diabetes, the body's cells cannot effectively utilize glucose for energy. As a

result, the liver increases the production of ketone bodies, which can be used by the brain and other organs as an energy source. This process is known as ketogenesis [9].

However, excessive production of ketone bodies can lead to a condition called diabetic ketoacidosis (DKA). DKA is a serious and potentially life-threatening complication of diabetes, particularly in individuals with type 1 diabetes. It can occur when there is a combination of insulin deficiency, elevated blood glucose levels, and increased ketone production [10].

Measuring ketone bodies can help detect and monitor the risk of DKA in individuals with diabetes. There are several methods for measuring ketone bodies:

1. **Urine Ketone Testing:** This method involves using ketone test strips to measure the presence and concentration of ketone bodies in the urine. It is a simple and inexpensive method, but it has some limitations. Urine ketone testing only provides a rough estimate and may not accurately reflect the current ketone levels. Additionally, the concentration of ketones in the urine may vary depending on hydration status and the individual's kidney function [11].
2. **Blood Ketone Testing:** Blood ketone meters can be used to measure the concentration of beta-hydroxybutyrate in the blood. This method provides a more accurate measurement of ketone levels. Blood ketone testing is commonly used in clinical settings, especially for individuals with diabetes at risk of DKA or those who require close monitoring of their ketone levels. It is more precise and provides real-time results, allowing for immediate intervention if necessary [11].
3. **Breath Ketone Testing:** Breath ketone analyzers are devices that measure acetone levels in the breath. This method is non-invasive and provides an alternative option for monitoring ketone levels. It works by detecting the acetone exhaled in the breath, which is a byproduct of ketone metabolism. Breath ketone testing offers convenience and ease of use, although its accuracy may vary among different devices [12].

Regular monitoring of ketone bodies is essential for individuals with diabetes, especially during periods of illness, elevated blood glucose levels, or when experiencing symptoms such as nausea, vomiting, abdominal pain, or difficulty breathing. Elevated ketone levels may indicate a risk of DKA and the need for immediate medical attention [11].

It is important for individuals with diabetes to be educated on the significance of ketone bodies and how to monitor them effectively. Healthcare professionals can provide guidance on the proper use of ketone testing methods and interpretation of results [11].

By incorporating information about ketone bodies and their measurement into the serious educational game, children with diabetes can gain a better understanding of the importance of monitoring ketone levels and how it relates to their overall diabetes management.

Chapter 3

Literature Review

This chapter presents a comprehensive review of the relevant literature on serious educational games, the role of storytelling in games, mobile games and child health education, and design considerations for games targeted at children with diabetes. The review aims to provide a theoretical foundation for the design of the story line for a serious educational game targeting children with diabetes.

3.1 Serious Educational Games

Serious educational games have emerged as a powerful tool for engaging and educating players in various domains. These games combine elements of entertainment and learning to create interactive experiences that effectively convey educational content [2]. Serious games have been used in diverse fields such as health education, environmental awareness, and cultural heritage preservation [3]. They have the potential to enhance learning outcomes by providing an immersive and interactive environment where players can actively participate in educational activities and acquire knowledge and skills in an engaging manner.

In the context of health education, serious games have been developed to address various health issues, including chronic diseases. These games aim to educate and empower individuals to manage their health effectively. For instance, in a study by Baranowski et al. [13], a serious game was developed to promote healthy eating habits and physical activity among children. The results showed that the game was effective in improving children's dietary knowledge and influencing their food choices. Similarly, serious games have been developed for disease management, such as asthma [14] and HIV/AIDS [15], to educate individuals about the condition and its management strategies.

3.2 Role of Storytelling in Games

Storytelling plays a crucial role in the design of games, including serious educational games. Stories provide a narrative structure that engages players emotionally, immerses them in the game world, and enhances their learning

children to take an active role in managing their condition by providing them with opportunities to make decisions, solve problems, and experience the consequences of their actions. Furthermore, the game should be enjoyable and entertaining to motivate long-term engagement and foster positive attitudes towards diabetes self-management.

In addition to these considerations, it is important to ensure that the game is user-friendly and accessible to children with varying levels of technological proficiency. The user interface should be intuitive, with clear instructions and visual cues. The game should also provide support and feedback to guide children through the gameplay and reinforce their learning [20].

■ 3.5 Conclusion

This literature review has explored the role of serious educational games, storytelling in games, mobile games and child health education, and design considerations for games targeted at children with diabetes. The findings highlight the potential of serious games to engage and educate players, the importance of storytelling in enhancing learning outcomes, the benefits of mobile games in child health education, and the key considerations for designing games for children with diabetes.

Building upon this foundation, the subsequent chapters of this thesis will focus on the design and development of a compelling story line for a serious educational game targeting children with diabetes.

Chapter 4

Game Development Tools and Technologies

In the development of a serious educational game, choosing the right tools and technologies is crucial to ensure efficient development, cross-platform compatibility, and a robust user experience. This chapter provides an overview of various game development tools and technologies, with a focus on Unity and C# as the chosen platform for developing the game. Additionally, alternative options will be discussed to highlight the rationale behind the selection.

4.1 Unity and C#

Unity is a widely used game development engine that provides a comprehensive set of features and tools for creating games across different platforms. It offers a user-friendly interface, a powerful scripting language, and extensive documentation and community support [21]. Unity's cross-platform capabilities allow developers to build games for various operating systems, including iOS and Android, making it an ideal choice for a mobile game aimed at children with diabetes.

C# (pronounced "C sharp") is the primary programming language used in Unity for scripting game logic and behavior. It is a versatile and modern programming language with a syntax similar to other C-style languages. C# provides a wide range of libraries and frameworks that facilitate game development, including Unity-specific APIs that allow seamless integration with the Unity engine [22]. By using C# in conjunction with Unity, developers can create interactive and engaging gameplay mechanics while leveraging the performance and flexibility of the Unity engine.

4.2 Alternative Options

While Unity and C# are the chosen tools for this project, it's worth noting that other game development tools and technologies exist. Some popular alternatives include:

- **Unreal Engine:** Unreal Engine is another powerful game development engine that offers advanced graphics capabilities and a visual scripting

system called Blueprints. Unreal Engine uses C++ as its primary programming language, providing low-level control and performance optimizations [23]. However, for the scope of this project, Unity's ease of use and the familiarity of C# were considered more suitable.

- **HTML5 and JavaScript:** HTML5 and JavaScript provide a platform-independent approach to game development, allowing games to run in web browsers on various devices. This approach offers advantages in terms of accessibility and distribution [24, 25]. However, the limitations of web-based technologies for mobile games, such as performance and access to device-specific features, led to the decision to utilize Unity and C# for a more immersive and tailored experience.
- **Native Mobile Development:** Developing the game natively for specific mobile platforms (e.g., using Java for Android or Swift for iOS) would provide maximum control and performance optimization [26, 27]. However, this approach would require separate development efforts for each platform, increasing development time and resources. Unity's cross-platform capabilities, combined with the familiarity of C#, allow for efficient development and deployment across multiple platforms.

Considering the specific requirements of the project, including cross-platform compatibility, ease of development, and access to advanced game development features, Unity and C# were determined to be the most suitable tools for creating the serious educational game for children with diabetes.

4.3 Blender and 3D Modeling Software

In addition to the game development tools, the creation of 3D assets plays a crucial role in developing an immersive and visually appealing game. Blender, an open-source 3D modeling software, is a popular choice for creating 3D models, animations, and visual effects in the game development industry.

Blender offers a comprehensive set of tools and features that enable artists and designers to create stunning 3D assets. It supports various modeling techniques, including polygonal modeling, sculpting, and procedural modeling, allowing for versatile and creative design possibilities. Furthermore, Blender provides powerful animation tools, physics simulation capabilities, and a node-based material editor, facilitating the creation of dynamic and visually captivating game assets [28, 29].

Compared to other commercial 3D modeling software, such as Autodesk Maya or 3ds Max, Blender stands out for its open-source nature and accessibility. It provides a cost-effective solution for indie developers or small teams who may have budget constraints. Additionally, Blender's active community contributes to its continuous development and offers extensive online resources, tutorials, and forums for support and learning.

While Blender is the chosen 3D modeling software for this project, it's important to acknowledge the existence of alternative options. Commercial

software like Maya and 3ds Max offer powerful features, industry-standard workflows, and integration with other professional tools. However, their higher costs and licensing restrictions may limit their accessibility for certain projects.

In the next chapters, we will delve into the design and implementation of the game using Unity and C#, leveraging their strengths to create an engaging and effective educational experience.

Chapter 5

Designing the Game Story Line

The design of the game story line is a crucial aspect of developing a serious educational game for children with diabetes. A well-crafted and engaging story line can enhance player motivation, immersion, and learning outcomes. This chapter focuses on the process of designing the game story line, including defining the target audience, identifying learning objectives, incorporating game mechanics and interactivity, integrating diabetes education within the narrative, and leveraging gamification techniques.

5.1 Defining the Target Audience

Designing a game for children with diabetes requires a deep understanding of their needs, preferences, and challenges. The target audience for this game includes children between the ages of 6 and 12 who have been diagnosed with diabetes. It is important to consider their cognitive abilities, emotional maturity, and level of diabetes self-management skills when designing the game. By tailoring the game to their specific characteristics and needs, we can ensure that it effectively engages and educates them about diabetes management [3].

5.2 Identifying Learning Objectives

The learning objectives of the game are essential in guiding the design process and ensuring that educational content is effectively delivered. The primary learning objective is to help children with diabetes become familiar with insulin usage and develop the necessary skills for self-administration. Secondary objectives include promoting healthy lifestyle choices, understanding the importance of blood glucose monitoring, and managing diabetes-related challenges in daily life. By clearly defining these objectives, we can align the game mechanics and content to support the desired learning outcomes [2].

healthcare professionals, we can identify areas for improvement and make iterative design changes to enhance the game’s educational value and overall experience. This continuous evaluation and iteration process ensures that the game remains relevant, effective, and enjoyable for children with diabetes [2, 17].

Data analysis was conducted to assess player retention rate, game completion rates, and player progress throughout the game. The collected data provided insights into player engagement and the effectiveness of the game in retaining players over time. It also allowed for the identification of potential areas of improvement in terms of game difficulty, pacing, and progression.

The analysis revealed that, as of now, the user retention rate is incredibly low, with less than 10% of players continuing to play the game on the second day.

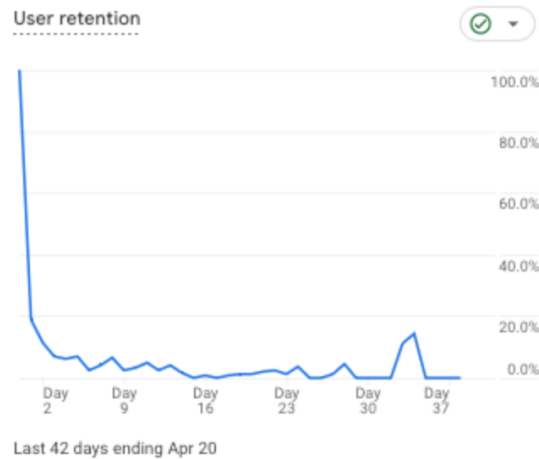


Figure 5.1: Data analysis of user retention

This finding indicates that there is room for improvement in terms of player excitement and motivation to continue playing the game over an extended period. The analysis of the data suggests that additional efforts are needed to enhance the game’s features, content, and overall appeal to increase user retention rates.

5.7 Conclusion

Designing the game story line involves understanding the target audience, defining learning objectives, incorporating game mechanics and interactivity, integrating diabetes education within the narrative, and leveraging gamification techniques. By focusing on these aspects and continuously evaluating the design through user feedback, a compelling and educational game can be developed for children with diabetes.

In the next chapter, we will discuss the implementation of the game mechanics and user interface design within the Unity game engine using C#.

Chapter 6

Background and Basis for the Thesis

6.1 Introduction

This chapter provides a comprehensive overview of the existing game titled 'My Diabetic' and elaborates on the foundation upon which this thesis is built. It meticulously details the core mechanics and features of the game, specifies the particular focus and contributions of this thesis, and justifies the choice of using 'My Diabetic' as the basis for this academic work. By establishing this context, the chapter sets the stage for the subsequent sections, which delve into the methodology, design process, and anticipated impact of the new storyline developed as an integral part of this thesis. This approach ensures that readers are well-informed about the background and relevance of the existing game, thereby appreciating the enhancements and contributions made through this research.

6.2 Introduction to the Existing Game

The game titled *My Diabetic* is specifically designed to assist children with diabetes in managing their condition through interactive and engaging gameplay. The game involves players taking care of an avatar diagnosed with diabetes, guiding it through various daily activities such as eating, exercising, sleeping, and managing insulin levels. By engaging in these activities, children are able to learn about the crucial aspects of diabetes management in an educational yet entertaining manner. This innovative approach helps in making the learning process enjoyable and relatable for children, thereby enhancing their understanding and retention of essential diabetes management practices.

6.3 Base for Implementation

To provide a visual context for the game, a screenshot from *My Diabetic* is presented below. This image illustrates the user interface and some of the interactive elements that players engage with during gameplay.



Figure 6.1: Screenshot from the game My Diabetic

6.4 Existing Game Mechanics and Features

In *My Diabetic*, players must ensure that their avatar adheres to a healthy lifestyle by eating balanced meals, participating in regular physical activity, monitoring blood sugar levels, and following a proper sleep schedule. These activities are intricately designed to mimic real-life diabetes management tasks, providing players with a practical and realistic understanding of their condition. The game's mechanics are strategically developed to educate children on the importance of maintaining a healthy lifestyle while managing diabetes, thereby empowering them with knowledge and skills that are crucial for their well-being.

6.5 Your Focus and Contributions

This thesis concentrates on the development and implementation of a new, enriched storyline for *My Diabetic*, aiming to significantly enhance the educational experience and engagement of players. The newly developed storyline introduces a series of novel scenarios and challenges that are intricately related to diabetes management. These scenarios encourage players to make informed decisions and understand the consequences of their actions within a safe, virtual environment. The primary goal of this contribution is to provide a more immersive and comprehensive learning experience, thereby augmenting the educational value of the game and making it more engaging for the players.

6.6 Justification for Using the Existing Game

The decision to base this thesis on *My Diabetic* is motivated by the game's established popularity and its proven efficacy in educating children about diabetes management. By building upon an already successful platform, this thesis aims to leverage the strengths of the existing game while addressing identified gaps, such as the need for more engaging and educational storylines. This approach ensures that the enhancements made through this research are directly applicable and beneficial to the existing user base, thereby maximizing the impact and relevance of the contributions. Furthermore, this strategy allows for a more efficient development process, as it builds upon a well-established foundation rather than starting from scratch.

6.7 Summary and Transition

In summary, this thesis builds upon the robust foundation laid by *My Diabetic* to create an enriched gaming experience that further aids children in understanding and managing their diabetes. The following chapters will provide a detailed account of the methodology employed in developing the new storyline, the design considerations taken into account, and the anticipated impact on the target audience. By elaborating on these aspects, the thesis aims to offer a comprehensive insight into the development process and the educational benefits of the new storyline, thereby contributing to the overall objective of enhancing diabetes management education for children through interactive gameplay.

Chapter 7

Development and Implementation of the New Storyline

7.1 Introduction

This chapter details the creation and integration of a new storyline into the existing game *My Diabetic*. The new storyline is designed to enhance user engagement and retention by providing a captivating and immersive experience that complements the main educational objectives of the game. By offering an engaging bonus storyline, the aim is to keep players motivated and invested in the game, thereby indirectly supporting the primary goal of educating children about diabetes management.

7.2 Storyline Overview

The new storyline centers around a character who finds themselves stranded on an uninhabited island after their ship crashes. The character must explore the island, gather various resources, and build a camp to survive and eventually escape. This survival scenario introduces a dynamic and engaging narrative that motivates players to make strategic decisions and manage resources, adding an element of adventure and challenge to the game.

7.3 Plot and Objectives

The storyline begins with the protagonist waking up on the shore of an uninhabited island, disoriented and equipped with only a mysterious phone. This phone has the unique ability to materialize items through the completion of various minigames. The primary objectives for the player include:

- **Exploring the Island:** Players must navigate different terrains, discover hidden areas, and uncover the island's secrets. Exploration is key to finding resources necessary for survival.
- **Gathering Resources:** Essential resources such as food, water, wood, and materials for shelter must be gathered. These resources are obtained

by playing minigames on the phone, which simulate real-life activities and challenges.

- **Building a Camp:** Players use gathered resources to construct and upgrade their camp, ensuring it provides adequate shelter, safety, and comfort.
- **Surviving and Thriving:** The player must maintain the character's health, energy, and well-being by managing resources wisely and completing daily tasks.
- **Planning an Escape:** Ultimately, the goal is to find a way off the island, which involves solving puzzles, crafting necessary items, and making strategic decisions.

Screenshot of the island that the player has to explore:



Figure 7.1: Screenshot of the game Island

7.4 Engagement Through Minigames

The phone that the protagonist wakes up with serves as a central gameplay mechanic, enabling the materialization of items through the completion of various minigames. These minigames are designed to be fun and challenging, providing players with a sense of accomplishment and progress. Examples of minigames include:

- **Resource Collection:** Players gather food, water, and materials by completing tasks that require quick thinking and coordination.
- **Construction:** Building and upgrading the camp involves puzzle-solving and strategic placement of resources.
- **Exploration Challenges:** Navigating new areas of the island involves overcoming obstacles and discovering hidden items.

7.4.1 Minigame 1: Tetris

Tetris, a timeless classic, is a puzzle game that challenges players to arrange falling blocks to create complete rows. The objective is to strategically move and rotate the blocks as they descend, aiming to fill entire rows. When a row is completely filled, it clears from the screen, allowing the player to earn points and create more space for upcoming blocks. The game tests the player's agility and problem-solving skills.

The screenshot below showcases a captivating moment of the Tetris minigame, where the player successfully aligns the falling blocks to clear multiple rows:



Figure 7.2: Screenshot of the Tetris minigame

7.4.2 Minigame 2: Fruit Collection

In this minigame, players engage in a fruit collection activity where they must strategically drop fruits into a container. When two fruits of the same type collide, they merge to form a larger fruit. By achieving a high enough score, players can earn fruits for use on the island.

The screenshot below captures a moment from the Fruit Collection minigame:

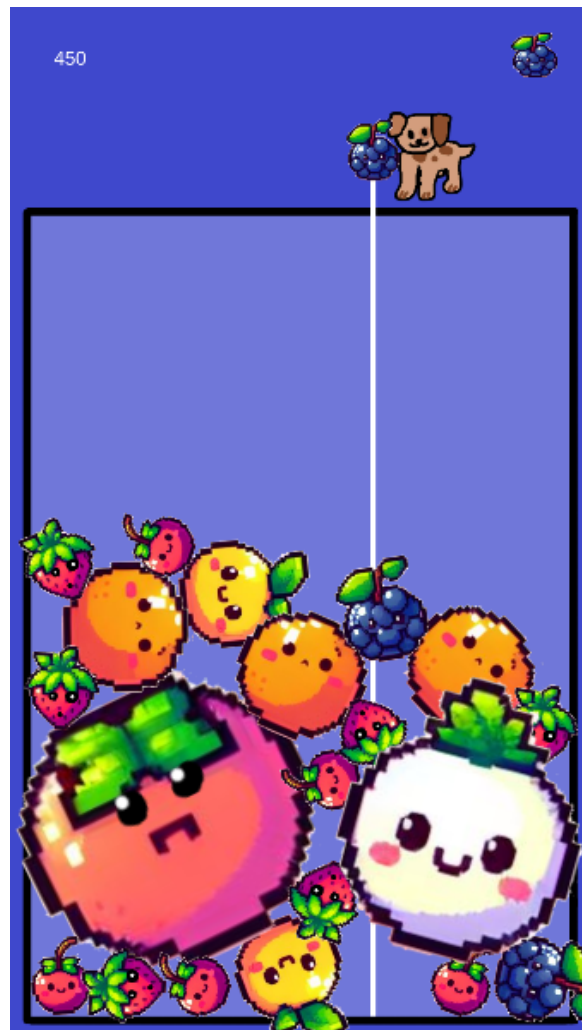


Figure 7.3: Screenshot of the Fruit Collection minigame

7.4.3 Minigame 3: Maze Escape

Maze Escape is an adventure-based minigame that takes players on a thrilling journey through a maze to find resources for their camp. They can collect pieces of wood to later start a bonfire in their camp to keep the character warm. What makes this minigame even more exciting is that the maze is procedurally generated, offering a unique experience with each playthrough. Procedural generation involves using algorithms and randomization to create dynamic and diverse content, ensuring that players never encounter the same maze layout twice.

To create the procedurally generated maze for Maze Escape, various maze generation algorithms were extensively researched. One valuable resource that it was consulted with is the website by Jamis Buck, an expert in maze algorithms and author of "Mazes for Programmers." Buck's website, located at <http://www.jamisbuck.org/mazes/>, provides a comprehensive collection of maze generation algorithms along with visual representations.

After careful analysis and experimentation, the reverse backtracking algorithm was selected for generating the mazes in Maze Escape. This algorithm is known for producing challenging and intricate mazes with a single solution. It operates by starting with a grid of cells and recursively traversing the grid to carve out passages and create walls. The reverse backtracking algorithm utilizes a stack to track the path taken, making it easier to backtrack and explore alternate routes when encountering dead ends.

The algorithm works as follows:

1. Start with a grid of cells, with each cell representing a part of the maze.
2. Choose a random starting cell and mark it as visited.
3. Repeat the following steps until all cells have been visited:
 - a. Choose a random neighbor of the current cell that has not been visited.
 - b. Remove the wall between the current cell and the chosen neighbor.
 - c. Push the current cell onto a stack.
 - d. Make the chosen neighbor the current cell and mark it as visited.
4. If a cell has no unvisited neighbors, pop a cell from the stack and make it the current cell.
5. Continue this process until all cells have been visited.

Here's how it looks in the code:

```
public void CarvePassagesFrom
(int currentX, int currentY, int[,] grid)
{
    var directions = new List<Directions>
    {
        Directions.N,
        Directions.S,
        Directions.E,
        Directions.W
    };
    Shuffle(directions);

    foreach (var direction in directions)
    {
        var nextX = currentX + DirectionX[direction];
        var nextY = currentY + DirectionY[direction];

        if (IsOutOfBounds(nextX, nextY, grid))
            continue;
    }
}
```

```
        if (grid[nextY, nextX] != 0) // has been visited
            continue;

        grid[currentY, currentX] |= (int)direction;
        grid[nextY, nextX] |= (int)Opposite[direction];

        CarvePassagesFrom(nextX, nextY, grid);
    }
}
```

By employing the reverse backtracking algorithm, Maze Escape ensures that players will face challenging mazes that require careful exploration and decision-making. The dynamically generated mazes, combined with the objective of finding the lost dog, create an immersive and engaging experience for players.

As players progress through Maze Escape, they will encounter visually captivating maze layouts, constantly stimulating their problem-solving skills and sense of adventure. The screenshot below showcases a moment in the game as the player explores the procedurally generated maze, searching for the key to unlock the exit:

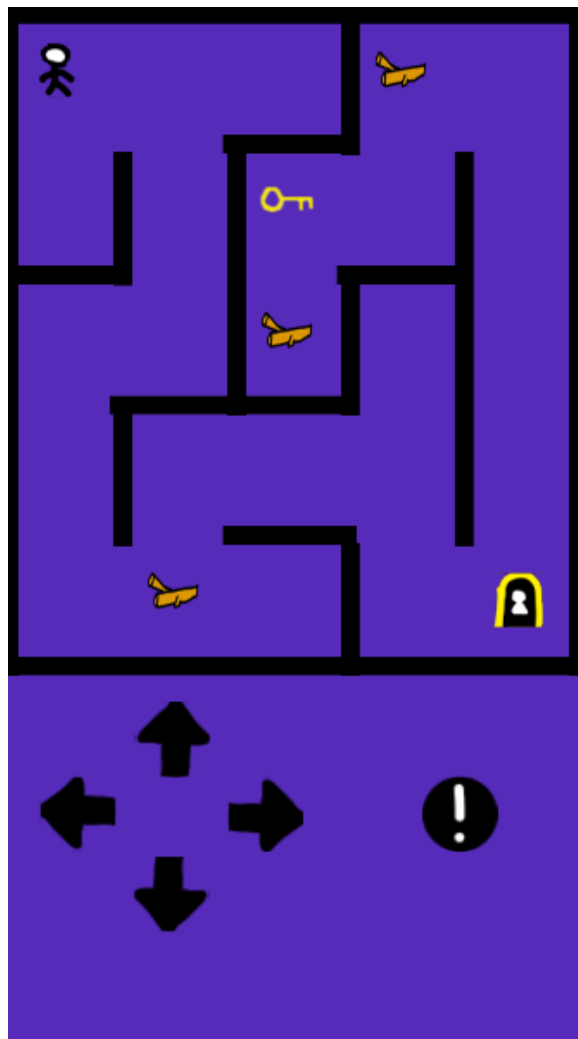


Figure 7.4: Screenshot of the procedurally generated maze in Maze Escape

The combination of procedural generation, the reverse backtracking algorithm, and the objective of finding pieces of wood ensures that Maze Escape provides a challenging and captivating experience for any children. By successfully navigating through the maze, players not only enjoy an exciting adventure but also reinforce their problem-solving skills.

■ 7.4.4 Minigame 4: Fishing

Fishing, a relaxing and visually appealing activity, is brought to life in our serious educational game through a captivating minigame. Players are invited to engage in a virtual fishing experience, where they cast their fishing rod, reel in fish, and collect points.

By engaging in the Fishing minigame, players can catch fish to later use in the game.

The screenshot below depicts a tranquil moment in the Fishing minigame

as the player patiently waits for a fish to bite:



Figure 7.5: Screenshot of the Fishing minigame

■ 7.4.5 Minigame 5: Bird

In this minigame, the player takes control of a small bird flying through pipes. A little twist to the game is that you can collect stones, which you can later use on your island.

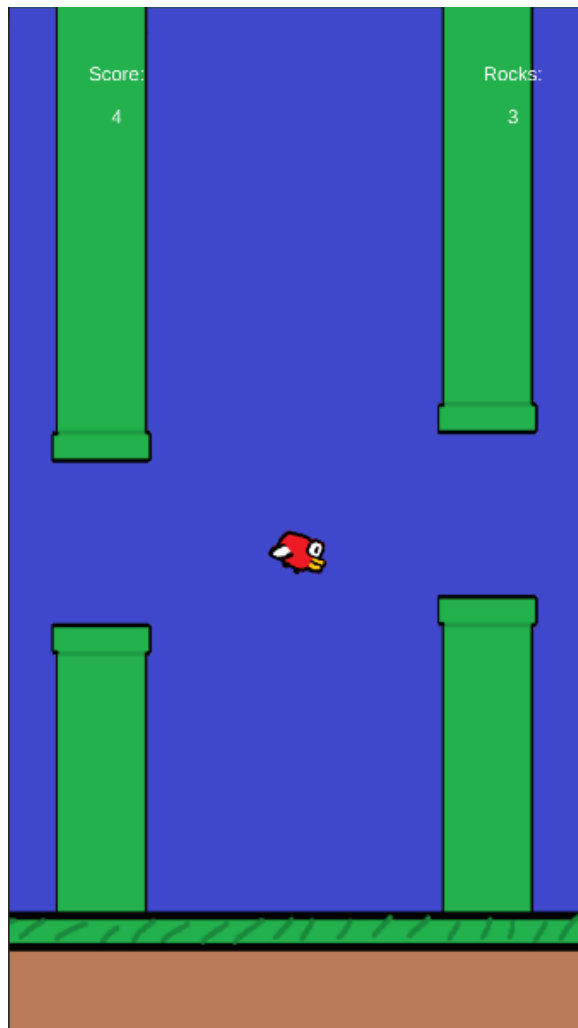


Figure 7.6: Screenshot of the Bird minigame

7.4.6 Minigame 6: Racing

This minigame is featured in the concluding sequence of the game. The player uses their phone to materialize a car, which they then use to reach a volcano that is about to erupt. The objective is to prevent the eruption and uncover the mystery of how the player ended up on the island.

The player must skillfully navigate the car, avoiding flipping it over while traversing various hills and terrains.

The level in this minigame is procedurally generated using the Perlin Noise method. This method helps create a natural-looking environment, which is a significant improvement over the typical random generation methods.

The following code snippet demonstrates the method used to create the level:

```
private void OnValidate()  
{
```



```

_spriteShapeController.spline.Clear();

for (int i = 0; i < _levelLength; i++)
{
    _lastPos = transform.position + new Vector3
(i * _xMultiplier, Mathf.PerlinNoise(0, i * _noiseStep) * _yMultiplier);
    _spriteShapeController.spline.InsertPointAt(i, _lastPos);
    if (i != 0 && i != _levelLength - 1)
    {
        _spriteShapeController.spline.SetTangentMode
(i, ShapeTangentMode.Continuous);
        _spriteShapeController.spline.SetLeftTangent
(i, Vector3.left * _xMultiplier * _curveSmoothness);
        _spriteShapeController.spline.SetRightTangent
(i, Vector3.right * _xMultiplier * _curveSmoothness);
    }
}

_spriteShapeController.spline.InsertPointAt
(_levelLength, new Vector3(_lastPos.x, transform.position.y - _bottom));
_spriteShapeController.spline.InsertPointAt
(_levelLength + 1, new Vector3
(transform.position.x, transform.position.y - _bottom));
}

```

Here's the screenshot from the minigame:

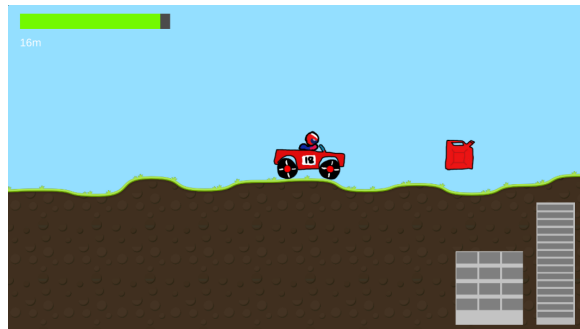


Figure 7.7: Screenshot of the Racing minigame

7.4.7 Minigame 7: Picross

Picross, also known as nonogram, is a puzzle game that engages players in solving number-based grid puzzles to reveal hidden pictures. The gameplay involves analyzing numeric clues provided for each row and column of the grid to deduce which cells should be filled and which should remain empty. By skillfully completing the puzzles, players uncover delightful pictures and experience the satisfaction of problem-solving.

The minigame happens during the peak emotional point of the story. The minigame is a cipher for a passcode that stops the vulcano from erupting. Only the player character can decode it and save the day.

The screenshot below showcases an intriguing moment of the Picross minigame as the player unravels the hidden picture by skillfully filling in the grid cells:

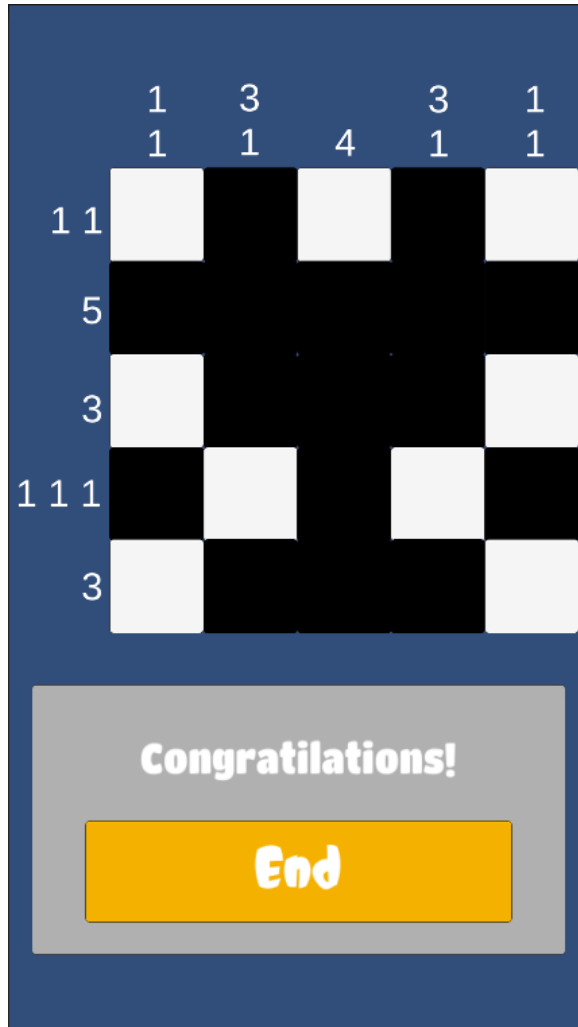


Figure 7.8: Screenshot of the Picross minigame

7.5 Narrative Development

The storyline is divided into chapters, each with specific goals and milestones. This structure ensures a gradual progression of difficulty and complexity, keeping players engaged and providing a sense of achievement. Key narrative elements include:

- **Initial Survival:** The first chapter focuses on immediate survival needs, such as finding food and water.

- **Establishing a Base:** Subsequent chapters involve building and fortifying a camp, introducing more complex minigames and resource management tasks.
- **Exploration and Discovery:** As players progress, they unlock new areas of the island, each with unique resources and challenges.
- **Secret Reveal:** The final chapters focus on gathering resources and solving puzzles necessary to help the character to reveal the secret of the island.

7.6 Retention Strategy and User Engagement

The primary purpose of the new storyline is to serve as a retention strategy, keeping players engaged with the game over a longer period. By offering a compelling and interactive narrative, the game aims to maintain user interest and encourage regular play. This approach helps to reinforce the educational content of the main game by ensuring that players remain invested in the overall gaming experience.

7.7 Summary and Transition

In summary, the new storyline for *My Diabetic* provides an engaging and immersive experience that complements the main game's educational objectives. By integrating a survival adventure narrative, the game not only entertains but also enhances user retention and engagement.

The following chapter will delve into the testing phase of the game. We will examine the methodologies used for game testing, the feedback received from players, and the adjustments made based on this feedback. This analysis will provide insights into the effectiveness of the new storyline in achieving its intended goals and its impact on the overall user experience.

Chapter 8

User Testing

8.1 Introduction

User testing is a critical phase in the development of any game, providing valuable insights into its usability, effectiveness, and overall user experience. This chapter focuses on the user testing conducted for *My Diabetic*, specifically targeting individuals aged 12 to 18 who are diagnosed with Type 1 diabetes. The testing aimed to gather feedback on various aspects of the game, including gameplay mechanics, storyline integration, educational content, and overall satisfaction. By analyzing the feedback from participants, we can identify areas for improvement and ensure that the game effectively meets the needs of its target audience.

8.2 Methodology

The user testing phase involved recruiting 5 participants diagnosed with Type 1 diabetes, aged between 12 and 18 years old. Participants were selected based on their familiarity with gaming and their willingness to provide constructive feedback. The testing sessions were conducted individually to ensure focused attention and minimize external influences.

Each participant was asked to play *My Diabetic* for a predetermined duration, during which they were encouraged to interact with various game features and provide feedback in real-time. After completing the gameplay session, participants were interviewed to gather additional insights into their experiences, preferences, and suggestions for improvement.

8.3 Key Findings

The user testing yielded several key findings regarding the gameplay experience and educational effectiveness of *My Diabetic*:

- **Engagement and Immersion:** Participants expressed high levels of engagement with the game, particularly enjoying the immersive storyline and interactive gameplay mechanics.

- **Educational Value:** The educational content embedded within the game was well-received, with participants acknowledging its effectiveness in teaching diabetes management principles in a fun and engaging manner.
- **Usability and Accessibility:** While most participants found the game easy to navigate and understand, some suggested improvements to certain user interface elements to enhance accessibility for players with varying levels of gaming experience.
- **Storyline Integration:** The new storyline introduced in the game received positive feedback for its entertainment value, but some participants suggested further integration of diabetes management themes to reinforce the educational aspect.
- **Feedback and Suggestions:** Participants provided valuable feedback and suggestions for improvement, including additional features, mini-games, and storyline expansions to enhance replay value and overall enjoyment.

8.4 Discussion and Implications

The findings from the user testing phase highlight the strengths and areas for improvement of *My Diabetic*. Overall, the game was well-received by participants, demonstrating its potential to effectively engage and educate individuals with Type 1 diabetes. However, there are opportunities for refinement, particularly in enhancing usability, storyline integration, and replay value.

The feedback gathered from participants will inform future iterations of the game, guiding the development team in implementing enhancements to address identified issues and further optimize the user experience. By iteratively refining the game based on user feedback, *My Diabetic* can continue to serve as an effective educational tool and source of entertainment for individuals managing diabetes.

8.5 Conclusion

User testing plays a crucial role in ensuring the effectiveness and usability of *My Diabetic* as an educational game for individuals with Type 1 diabetes. The feedback gathered from participants provides valuable insights into the game's strengths and areas for improvement, guiding the development process and ensuring that the game meets the needs and preferences of its target audience. Through ongoing testing and refinement, *My Diabetic* can continue to evolve as a valuable resource for diabetes management education and support.

■ 8.6 Appendices

Two appendices are provided for further reference:

- **Appendix A:** Questionnaire administered before the user testing.
- **Appendix B:** Detailed reports on each user testing session, including information on the tester, how the testing was conducted, and the tester's rating of the game.



Chapter 9

Conclusion

In conclusion, the development and implementation of *My Diabetic* as an educational game for children with diabetes have been a significant endeavor aimed at addressing the unique needs of this target audience. Through an iterative design process, incorporating feedback from medical professionals, educators, and potential users, the game has evolved into a comprehensive tool for diabetes management education and support.

The integration of engaging gameplay mechanics, immersive storytelling, and relevant educational content has proven to be effective in capturing the attention and interest of players. By simulating real-life scenarios and challenges associated with diabetes management, *My Diabetic* provides players with valuable insights and practical skills to better manage their condition in everyday life.

The user testing phase has played a crucial role in validating the effectiveness and usability of the game, allowing for the identification of strengths and areas for improvement. Feedback from participants has been instrumental in refining the gameplay experience, enhancing accessibility features, and ensuring that the educational content remains informative and engaging.

Moving forward, the development team will continue to iterate on *My Diabetic* based on the insights gained from user testing and ongoing feedback from the community. Plans for future updates include the addition of new features, expansion of storyline content, and further optimization to accommodate the diverse needs of players.

Ultimately, *My Diabetic* represents more than just a game—it is a tool for empowerment, education, and support for children living with diabetes. By leveraging the power of gaming technology, we can make meaningful strides in improving health outcomes and quality of life for individuals managing chronic conditions.

As we continue on this journey, our commitment remains steadfast—to provide a compelling and effective resource for diabetes management education, while fostering a sense of community and empowerment among players. Together, we can make a positive impact on the lives of children with diabetes and contribute to a brighter, healthier future for all.



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Appendices

Appendix A: Questionnaire Before User Testing

1. Age?
2. Gender?
 - a. Female
 - b. Male
 - c. Prefer not to say
3. Do you have diabetes?
 - a. Yes, Type I
 - b. Yes, Type II
 - c. No
4. If yes, at what age were you diagnosed with diabetes?
5. Do you have a smartphone?
 - a. Yes
 - b. No
6. Do you play games on your mobile phone?
7. Which platform do you prefer for playing games?
 - a. Mobile phone
 - b. PC
 - c. Game console - PlayStation, Xbox, etc.
 - d. I don't play video games
8. How often do you play games on your mobile phone?
 - a. Never

- b. 1-3 times a month
 - c. 1-3 times a week
 - d. Every day or almost every day
9. Have you ever played a game related to diabetes or with this theme?
- a. Yes
 - b. No
10. What type of game do you like to play? (You can select multiple options)
- a. Adventure
 - b. Action games
 - c. Platformers
 - d. Puzzle
 - e. Simulators
 - f. Sports games
 - g. Other (Specify)

Appendix B: Detailed Reports on User Testing Sessions

1. Information on Tester 1
- Age: 14
 - Gender: Male
 - Diagnosis: Type I diabetes at age 10
 - Smartphone: Yes
 - Gaming Experience: Plays games on mobile phone 1-3 times a week
 - Previous Experience with Diabetes-related Games: No
 - Preferred Game Genre: Action games, Adventure
 - User Testing Process:
 - a. Tester played the game for 30 minutes.
 - b. Tester interacted with various game features and completed multiple levels.
 - c. Tester provided feedback on gameplay mechanics, storyline integration, and educational content during a post-game interview.
 - Rating of the Game: 4 out of 5 stars
 - Tester enjoyed the immersive storyline and interactive gameplay mechanics.

- Tester suggested minor improvements to certain user interface elements for better accessibility.

2. Information on Tester 2

- Age: 16
- Gender: Female
- Diagnosis: Type I diabetes at age 8
- Smartphone: Yes
- Gaming Experience: Plays games on mobile phone every day
- Previous Experience with Diabetes-related Games: Yes
- Preferred Game Genre: Puzzle, Simulators
- User Testing Process:
 - Tester played the game for 45 minutes.
 - Tester explored different game modes and completed several missions.
 - Tester provided detailed feedback on user interface design, game controls, and overall experience.
- Rating of the Game: 5 out of 5 stars
 - Tester found the game engaging and informative, particularly praising the educational content related to diabetes management.
 - Tester suggested adding more interactive elements to enhance gameplay diversity.

3. Information on Tester 3

- Age: 18
- Gender: Male
- Diagnosis: Type I diabetes at age 12
- Smartphone: Yes
- Gaming Experience: Plays games on mobile phone 1-3 times a month
- Preferred Game Genre: Sports games, Adventure
- User Testing Process:
 - Tester played the game for 20 minutes.
 - Tester focused on completing main story missions and exploring game environments.
 - Tester provided feedback on game difficulty, pacing, and visual presentation.
- Rating of the Game: 3 out of 5 stars

- Rating of the Game: 5 out of 5 stars
 - Tester thoroughly enjoyed the game's immersive world and engaging gameplay mechanics.
 - Tester suggested adding more customization options for player characters to enhance personalization.