

4 Prototype Design

4.1 Introduction

This chapter describes the serious game – *StoryTimes* – that the participants played before they were interviewed. A brief overview of the development of *StoryTimes* is followed by a discussion of the pedagogical aspects thereof. Lastly, the structure and key interface elements of *StoryTimes* are briefly discussed.

4.2 Development of StoryTimes

For the purposes of this research, a prototype of a serious game called *StoryTimes* was developed for participants to play before being interviewed. The purpose of *StoryTimes* is to make the learning of the multiplication tables more motivating and is especially aimed at young children who are being introduced to the multiplication tables for the first time. *StoryTimes* was developed using Adobe Flash Professional (CS5 and CC) with Adobe AIR and targeted for Android tablets.

4.3 Pedagogical aspects of StoryTimes

StoryTimes is based on principles of memory improvement (Horsley, 2012:9) to help players remember and recall the multiplication tables in a fun and effective way. There are two memory improvement techniques in particular that are incorporated in the design of *StoryTimes*, namely the Shape Peg Method and the Method of Loci (Bower, 1972:496; Horsley, 2012:66).

4.3.1 Shape Peg Method

The Shape Peg Method as presented by Horsley (2012:66) is based on the mnemonic device known as the numeric pegword system (Bower, 1972:500). This device is a technique for memorising lists in a specific order.

The numeric pegword system works by first creating “*numeric pegs*” or cues which entails associating concrete objects with numbers, usually running from 1 to 20, in a one-to-one fashion. These objects are usually chosen so that they rhyme with the number they need to be associated with (Bower, 1972:500). For example, “*one is a swan, two is a shoe, three is a bee*”.

These pegs are stored in long term memory and act as compartments to store new short term information in. For example, suppose the following ordered list of items needs to be remembered when shopping:

1. Bread
2. Milk
3. Cheese

The items on the shopping list can be remembered by attaching them to the developed pegs in the manner explained next. The cue for the number one is a swan. Therefore to remember to buy bread, bread could be pegged to the swan by visualising a scenario involving these two objects. Such a scenario could be to imagine feeding bread crumbs to a swan by a pond. Similarly to remember the milk, it is noted that it is the second item on the shopping list and should therefore be associated with a shoe. Conjuring up the image of dancing gumboots splashing in a pool of milk will peg the milk to the number two. To remember the cheese – the third item on the list – it can be imagined as a block of Swiss cheese with the holes in the form of hexagons like the honey cells in a beehive with a bee in one of them.

The Shape Peg Method (Horsley, 2012:66) is used in the same way as the numeric pegword system except that the cues are objects that are similar in shape to the number they have to be associated with. For example, as illustrated in Figure 4.1, a pencil is used as the cue for the number 1, a duck for the 2 and a camel for the 3.

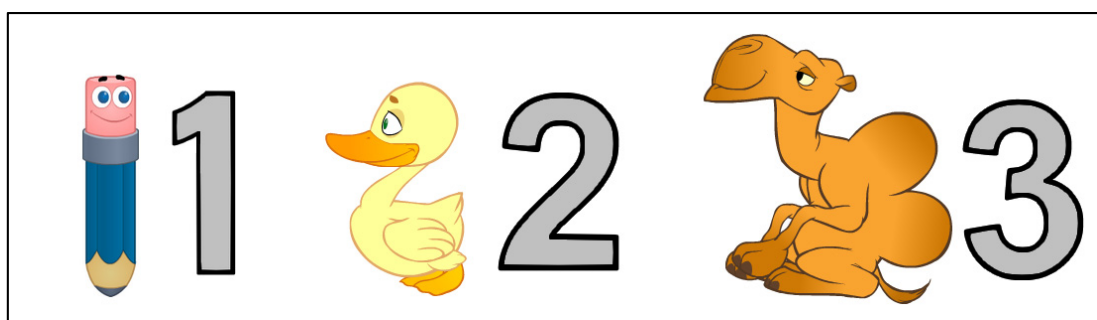


Figure 4.1: Numbers and associated objects have similar shapes.

Using the Shape Peg Method to remember the bread, milk and cheese by using the cues in Figure 4.1 could be done as follows. The number one is associated with the pencil. Therefore to remember to buy bread, a scenario where a slice of bread is being buttered using a pencil could be imagined. Visualising a duck swimming in a pond

filled with milk pegs the milk to the number two. The cheese can be remembered by imagining how the camel, which represents the number three, is pulling a cart with wheels made of cheese.

Although it could be argued that the more elaborate, unusual and strange the images are, the easier it is to remember the items, Bower (1972:6) remarks that making more familiar associations is just as effective.

4.3.2 Method of Loci

Another mnemonic device that shares similarities with the shape system is known as the Journey Method or Method of Loci (MOL) (Godwin-Jones, 2010:6; Horsley, 2012:75). Yates (1966:3) provides the basic steps to implement the Method of Loci as used in ancient Greek times as follows.

Firstly a series of locations needs to be remembered and visualised. This was usually a set of rooms from a known building. Even decorations in each room are noted. Next, the different items to be remembered are placed in each room by mentally visualising walking to each room in a specific order and placing the items in each room. To recall the items in the list, a person takes a stroll or journey in his or her mind's eye through the building and “*looking*” at the items in the same order as the order that was used when the items were placed in the rooms.

Suppose one uses the kitchen with a kitchen sink, the living room with a couch and the foyer with a foyer bench in a house, illustrated in Figure 4.2, as the locations where new information could be stored.

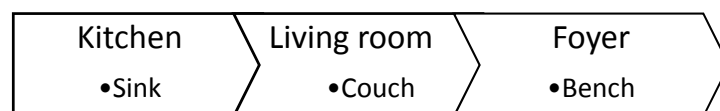


Figure 4.2: Locations in a house to store information.

To remember the bread, milk and cheese from the shopping list discussed previously, people could use the locations of Figure 4.2 in the following manner.

A person could imagine entering the house through the kitchen door and noticing a baker washing the dishes at the kitchen sink using a loaf of bread. Next, the person walks from the kitchen to the living room and sees the milkman passed out on the

couch with milk bottles lying all around him. Lastly, the person moves from the living room to the foyer and places a mouse trap with cheese next to the foyer bench to trap the resident mouse.

Legge *et al.* (2012:389) researched how changes to the MOL mnemonic would affect its efficiency when used to remember items. They concluded that using virtual environments, environments that are unfamiliar and little previous training in the device, did not negatively impact the effectiveness of the device.

4.3.3 Recalling the multiplication tables with StoryTimes

In *StoryTimes*, the Shape Peg Method and Journey Method are combined by providing the player with different locations and events taking place at these locations. The different environments in the game are an adaptation from paper-based posters (Çetin & Flamand, 2013:52) developed and published by Horsley (2012). The paper-based version of a desert scene representing the three times table is shown in Figure 4.3. These posters have been brought to life through a serious game, using animations, sounds and interactivity to make the storing and recalling of the multiplication tables more engaging and fun. A detailed discussion of how the two memory improvement techniques are incorporated into *StoryTimes* is presented in the following sections.

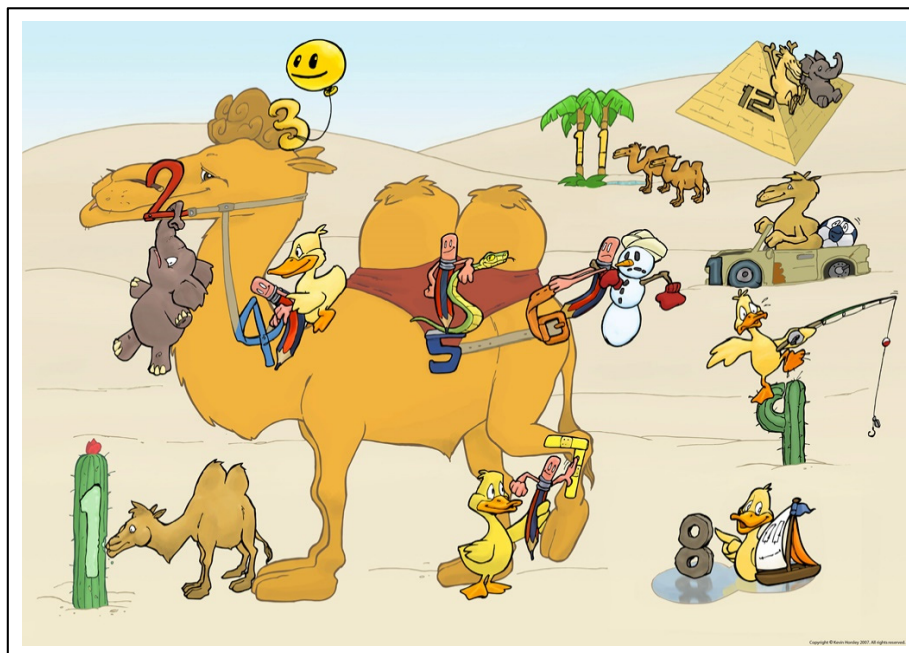


Figure 4.3: Paper-based poster as presented in StoryTimes.

4.4 StoryTimes game structure

The following sub-sections describe the various areas that the player comes across when playing *StoryTimes*. The overall structure of the game and the available levels are shown in Figure 4.4. The game objective of *StoryTimes* is to journey to seven different continents – corresponding to seven levels – and collect seven gemstones by completing the activities in each level. After the completion of each level, the player is awarded with a particular gemstone and the next level becomes available to the player.

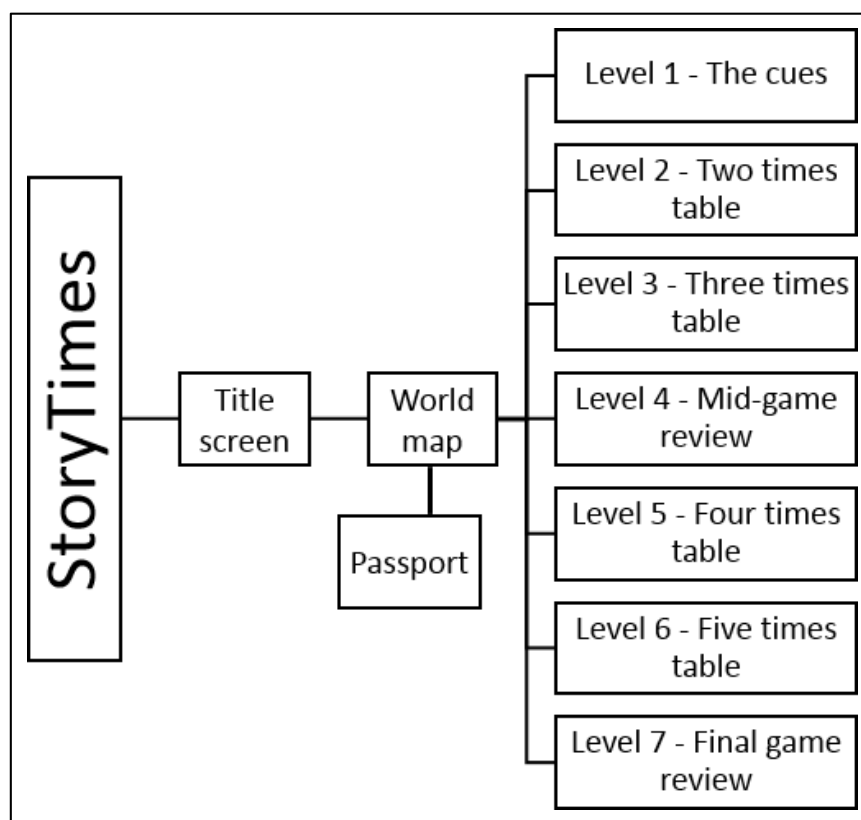


Figure 4.4: Structure of *StoryTimes*.

4.4.1 Title screen

StoryTimes starts with the title screen, shown in Figure 4.5, where a player can choose whether to start a new adventure, load an existing adventure, view credits or exit the game.



Figure 4.5: *StoryTimes* title screen.

4.4.2 World map

After loading or starting a new adventure, a world map is shown to the player and provides the player with an overview of the levels. The prototype version of *StoryTimes* contains seven levels. The world map, illustrated in Figure 4.6, indicates where the levels take place, which levels have been completed, which levels still need to be unlocked, and the next level that can be played. The next level is indicated by an arrow and to start the level, the player clicks on the character that the arrow is pointing to.



Figure 4.6: *The world map screen of StoryTimes.*

4.4.3 Level 1: Introducing the cues

The first level of the game differs from all the other levels in that it offers an introduction to the characters that will feature throughout the rest of the game. These characters represent the cues of the Shape Peg Method discussed in Section 4.3.1. The shape system that is used in *StoryTimes* associates these characters with the digits zero to nine where every character that is associated with a specific digit has a similar shape as that of the digit. In *StoryTimes*, the characters associated with the numbers 0 to 9 are based on those provided by Horsley (2012:72) and are shown in Figure 4.7.



Figure 4.7: The Shape Peg Method adapted from Horsley (2012:72).

This introductory level consists of four sections namely a learning activity and three quizzes.

- Learning activity

In the first activity of level 1, the player is shown the nine characters that represent nine digits, illustrated in Figure 4.8. The game zooms in on each character in turn, starting with the soccer ball representing a zero, and shows the number that the character is associated with. The player must click on the corresponding number on the bottom of the screen to continue to the next character. Figure 4.9 shows a zoomed-in view of the camel, which represents the number 3. This activity is completed once the player reaches the balloon, the character that represents the

number nine. After the initial activity of level 1, the player has to successfully complete three quizzes to unlock the second level.



Figure 4.8: An activity in the first level to get to know the characters.

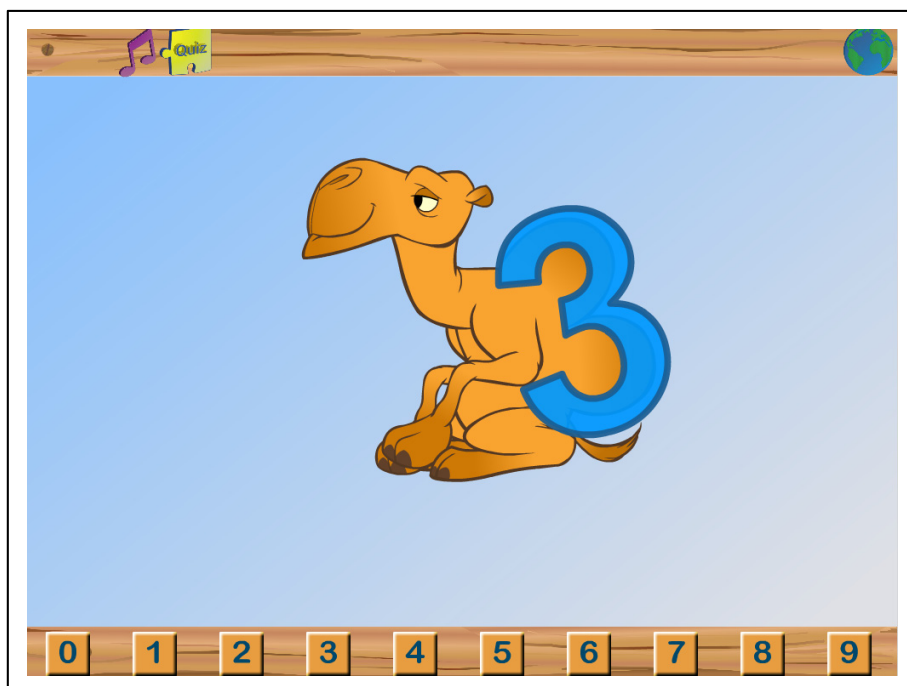


Figure 4.9: Getting to know the third cue.

- Quiz 1

The first quiz asks the player to identify the number with which the displayed character is associated, illustrated in Figure 4.10. After each correct answer, the next random character is shown. This continues until all nine characters have been identified.

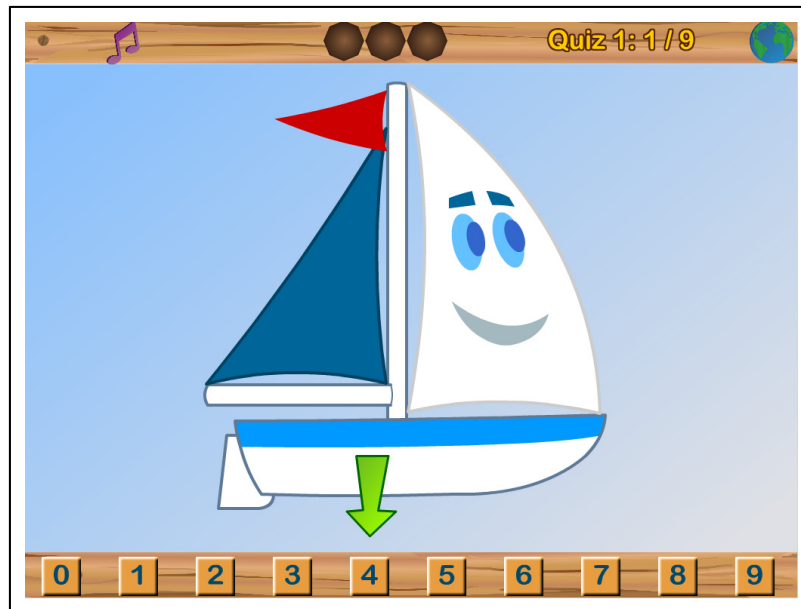


Figure 4.10: The first quiz of level 1.

- Quiz 2

The second quiz ask of the player to identify the character which is associated with the given number in the centre of the screen, as depicted in Figure 4.11. Once the correct answer is given, a new number is displayed. The player must answer nine questions correctly to complete the second quiz.



Figure 4.11: The second quiz of level 1.

- Quiz 3

In the third quiz, players have to identify the numbers associated with the two given characters. The player has to select the numbers in the correct order. The question in Figure 4.12 would therefore require the player to first select the number 4 and then the number 2. Once this final quiz is successfully completed, level 2 becomes unlocked and available to the player.



Figure 4.12: The last quiz of level 1.

4.4.4 Multiplication table levels

The prototype version of *StoryTimes* contains four multiplication table levels where each one level represents the two, three, four or five times tables. Figure 4.13 and Figure 4.14 illustrate the locations for level 2 (two times table) and level 3 (three times table) respectively. Level 5 represents the four times table and level 6 represents the five times table. Taking Figure 4.13 into consideration, the duck is the prominent feature in this setting and is also associated with the number 2 through the use of the shape system mentioned earlier in Section 4.4.3. Thus this pond setting represents the two times table. Similarly, the camel, associated with the number 3, features prominently in level 3 and thus level represents the three times table.

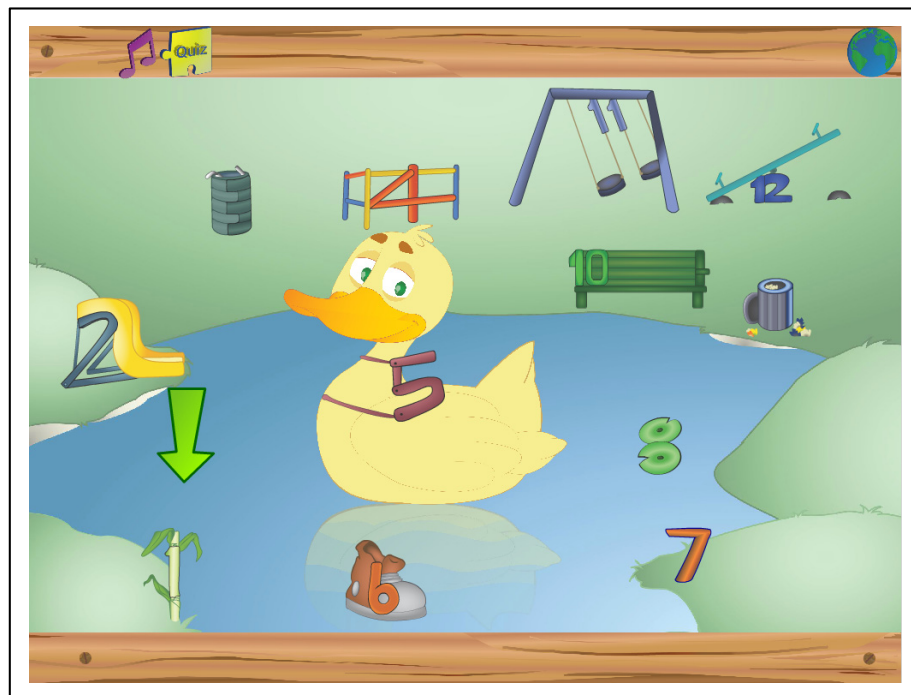


Figure 4.13: The pond setting of level 2.



Figure 4.14: The desert setting of level 3.

Level 5 is set in a harbour with a big yacht tied to a jetty, thus representing the four times table. Level 6 takes place inside a jungle cave featuring a big snake, therefore the cave is the setting of the five times table.

Each of these four levels consist of three learning activities and three quizzes. The three learning activities will be referred to as the journey activity, the placing activity and the focus activity. These activities and quizzes will be explained by using level 3 as an example.

- The journey activity

Each of the four levels starts with a rather empty looking setting with twelve points of interest, illustrated in Figure 4.15. Each of these twelve locations represents a number from 1 to 12. For example, the first location is a cactus tree with a number 1 carved into it. The second location is at the nose of the big camel where the girdle is in the shape of the number 2. The last two locations are the oasis with two palm trees representing eleven and the pyramid with the number 12 written on it.

These twelve locations correspond to the different locations of the Method of Loci memory technique discussed in Section 4.3.2. In the context of the original Method

of Loci technique, the desert setting corresponds to a building and the twelve locations in the desert correspond to twelve rooms located in the building.



Figure 4.15: Starting the journey activity.

As the player clicks on each of the twelve points, guided by the arrow, certain characters from level 1 appear and perform some animated action. For example, as shown in Figure 4.16, when the player clicks on the first location, the cactus tree, a camel appears who walks up to the cactus tree and bumps his nose against it. In relation to the Method of Loci technique, this represents placing or storing an object. In this case, a camel is “stored” at the first location of the desert.

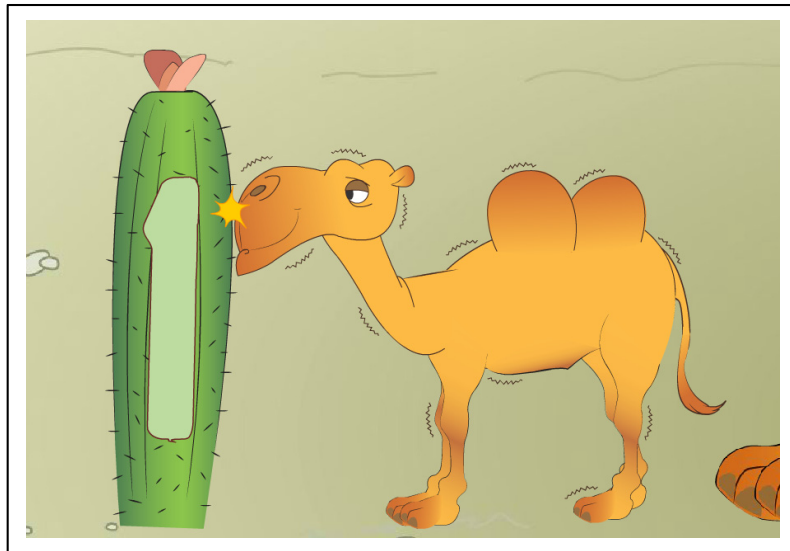


Figure 4.16: The first event of level 3.

After the animation at a location has finished playing, the player is allowed to click on the next location. Figure 4.17 shows the state where the player has reached the seventh location. This location is at the hind leg of the big camel, with a plaster in the shape of a seven stuck to it.



Figure 4.17: The seventh location in the desert.

When the player taps on the plaster, a duck and a pencil are revealed, illustrated in Figure 4.18. The animation shows the duck and the pencil trying to fix the plaster to the camel.

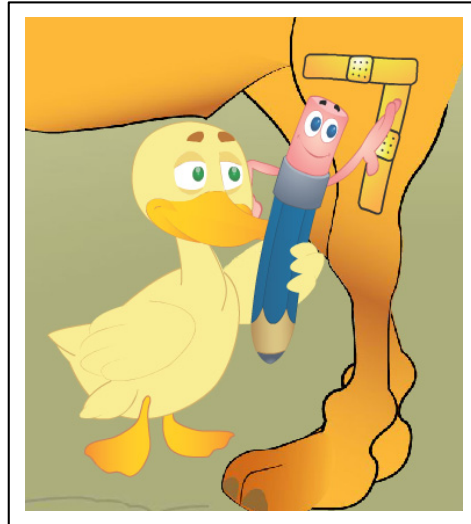


Figure 4.18: The duck and the pencil revealed at the seventh location.

Once the player has tapped on each of the twelve locations and revealed the associated characters, the journey activity is complete and the player can view all of the animations before indicating to continue to the next activity.

Before continuing the discussion of the remaining activities, an explanation of why specific characters are stored at certain locations is warranted. As indicated above, this process is based on the Method of Loci technique to store and recall objects. The desert with the large camel is analogous to the building and the locations to the rooms in the building. The characters stored at these locations are the objects to be recalled, but they themselves are associated with numbers according to the Shape Peg Method in accordance with the discussion in Section 4.4.3.

With reference to Figure 4.15, the setting of level 3 prominently features a camel, which has been associated with the number 3 in level 1. Placing the camel in a desert environment is done to enforce the idea that this level is about the camel and that the number 3 plays a big part in it. Indeed, level 3 represents the three times table. Each of the twelve locations represent the factor with which three will be multiplied. The first location is created to enforce the idea

that this location has to do with the number one. It is the first location visited and consists of a cactus tree with the number 1 carved into it. This location therefore represents the expression 3×1 . Next, the object that will be stored at this location will be the answer of this expression. Therefore, a camel, which is associated with a number 3, will be placed here. To engrain into memory that this location has a camel stored in it, this scene with the camel is animated. In this case, the camel walks up to the cactus, presses his nose against it (for reasons unknown) and gets stung by the cactus needles. This location and how the equation $3 \times 1 = 3$ is stored in memory are depicted in Figure 4.19.

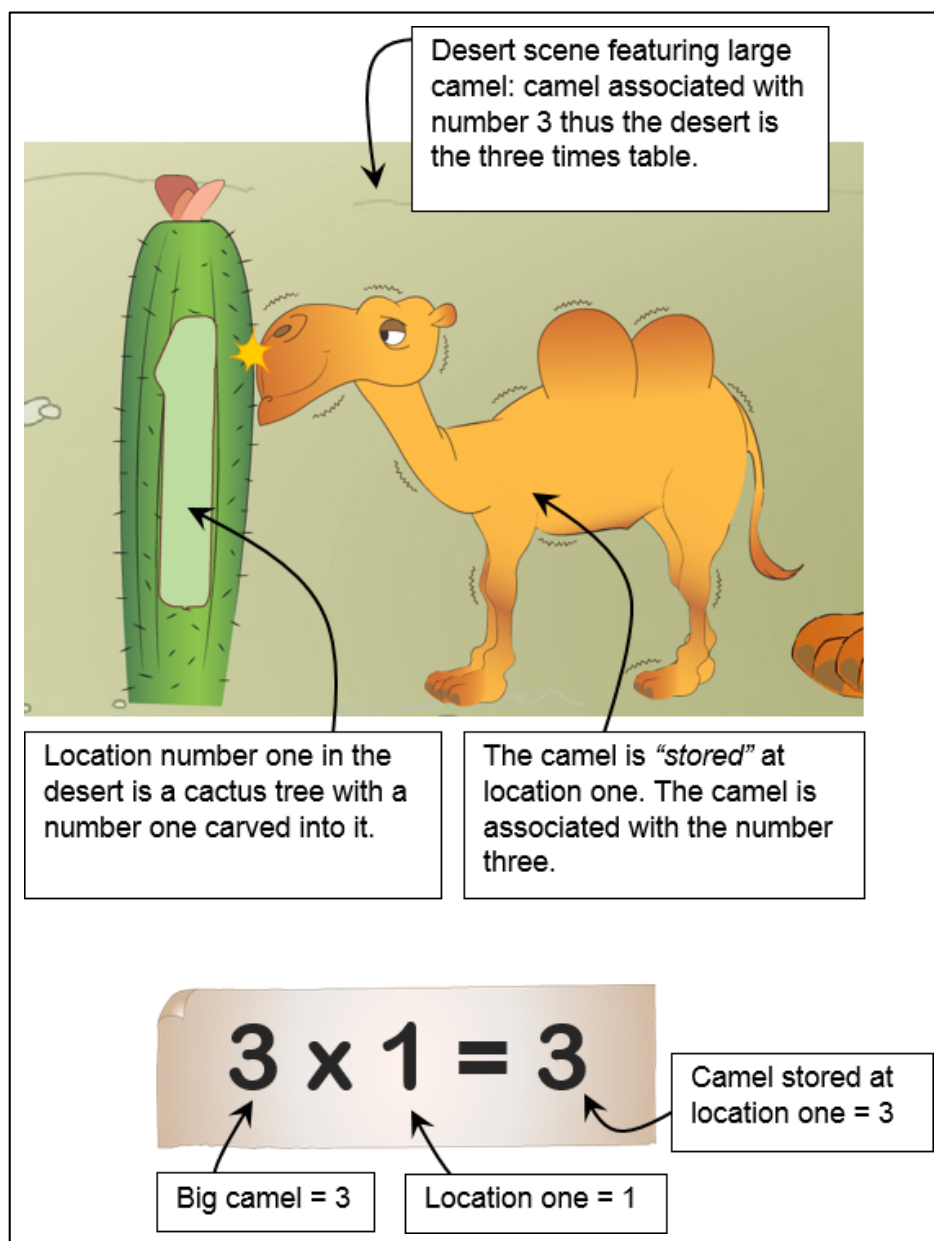


Figure 4.19: How $3 \times 1 = 3$ is stored and recalled from memory.

To illustrate how an expression where the product consists of two digits is stored, the seventh location of the desert setting will be used. As discussed previously, the seventh location is at the hind leg of the camel, and to enforce that this location regards the factor 7, a seven-shaped plaster is fixed to the camel. This location therefore represents 3×7 . When the player clicks on the plaster, the duck and pencil are revealed.

From the third quiz of level 1 (discussed in Section 4.4.3) the player is taught that two characters next to each other represent two numbers, but that these numbers must be given in the order in which the characters appear. For example, as per Figure 4.12, the yacht to the left and the duck to the right represent 35. This condition is valid for the subsequent levels. Thus, the position of the duck and the pencil relative to one another, shown in Figure 4.20, is significant. Together, and in this order, the duck and pencil represent the number 21.

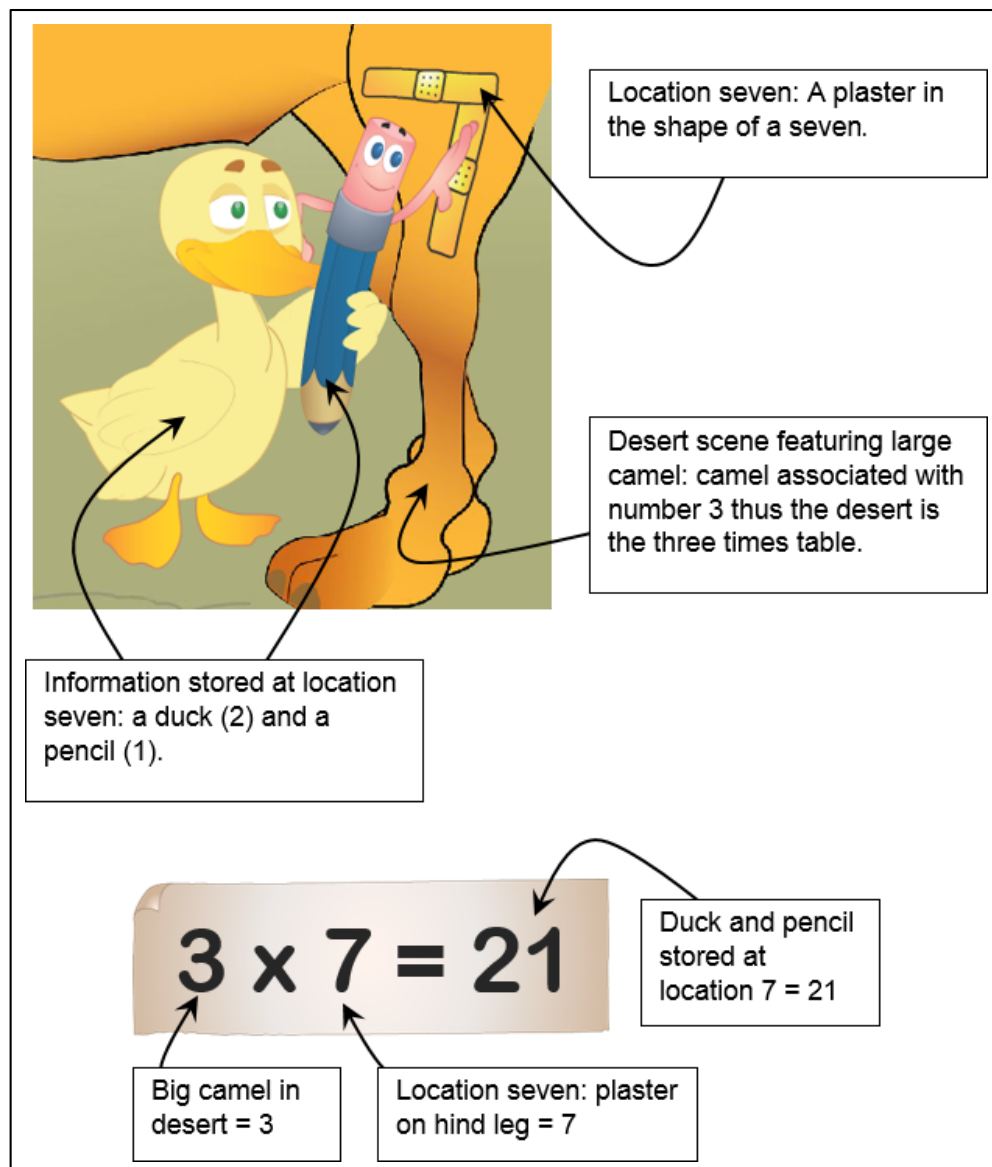


Figure 4.20: How $3 \times 7 = 21$ is stored and recalled.

This combined use of the Journey Method and the Shape Peg Method to remember the answers form the core of *StoryTimes* and are used in each of the four multiplication levels. Expressions such as “ 3×2 ”, “ 3×3 ” and “ 3×4 ” are represented by locations reminiscent of the Journey System. The answers to these expressions are stored at the corresponding locations in the form of cues that are associated with digits according to the Shape Peg Method.

- The placing activity

After journeying through all twelve locations, the player is presented with a card showing the characters of a specific location. The player must select the correct location where the characters on the card were placed during the journey activity. This activity further confirms the connection between the characters and the location they belong to. As illustrated in Figure 4.21, a card with the camel and a soccer ball is shown. These two characters represent the number 30 and should therefore be placed at location ten. This location is at the Jeep, which represents 3×10 . The player can hide the card to select locations underneath it. After all of the cards have been placed at the correct locations, the placing activity is complete.

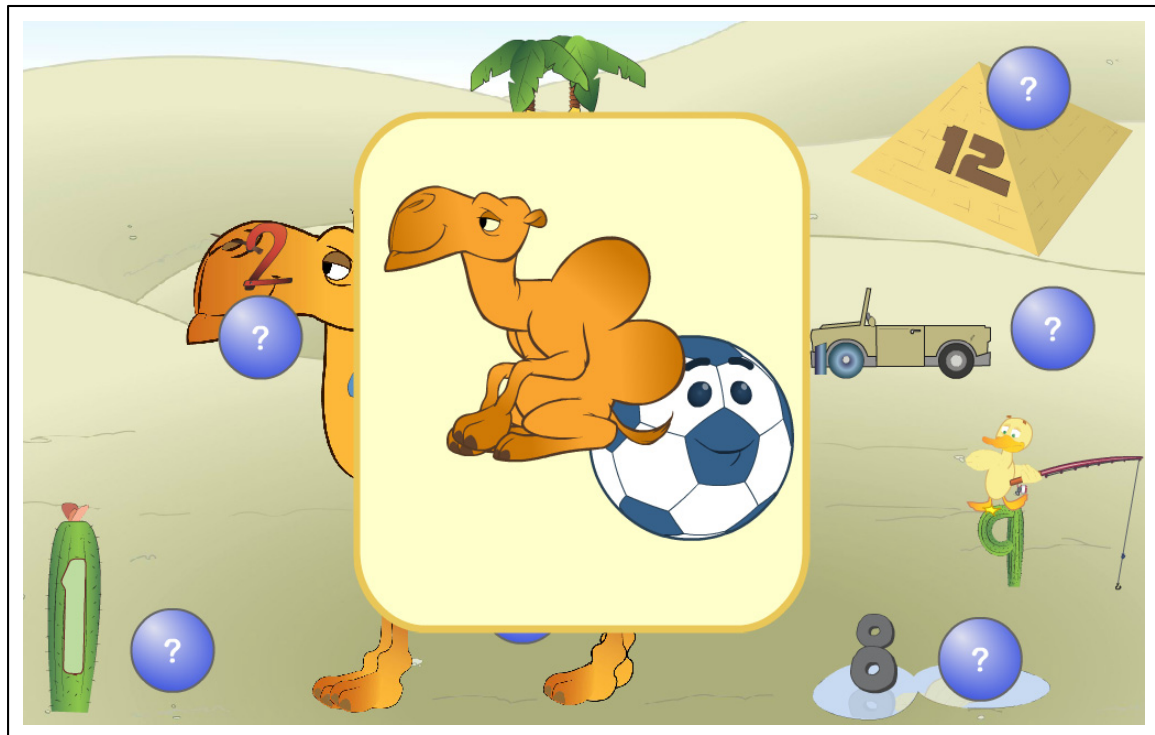


Figure 4.21: The placing activity showing the 30 card.

- The focus activity

The final activity before the quizzes commence, takes the player to each of the twelve locations again, but this time, starting from the first location, zooms in to the location and asks the player to select the numbers that correspond with the characters at the locations. The equation that corresponds with the location and the characters are also shown, including the answer. For example, when the player progresses to location nine, the game zooms in to this location and the duck and fishing rod appear, illustrated in Figure 4.22.

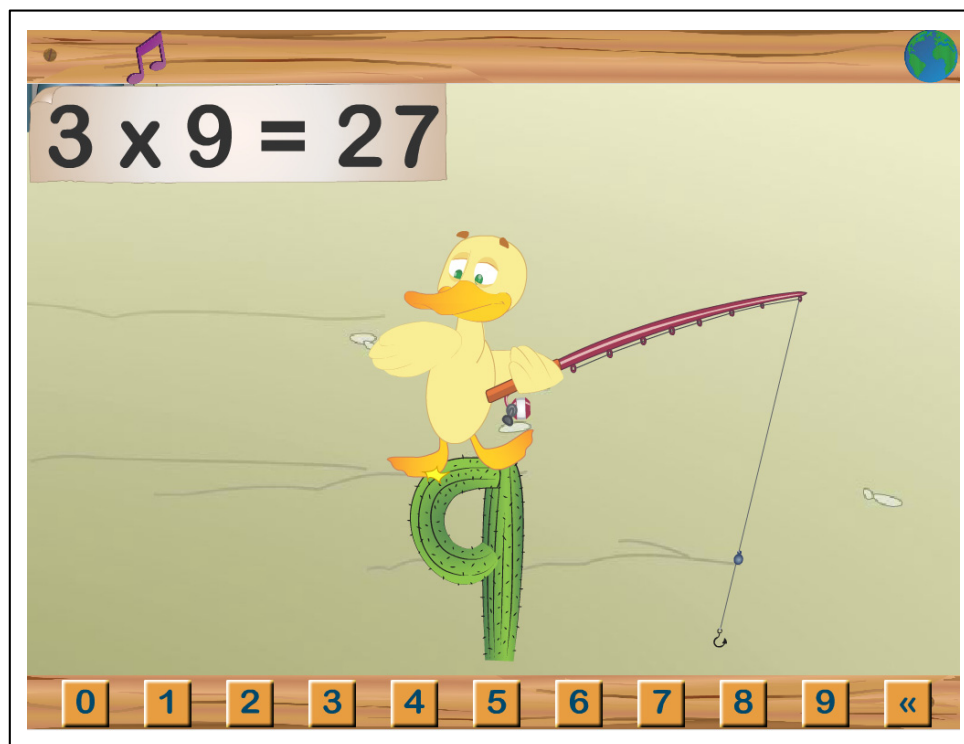


Figure 4.22: Location nine in focus.

The player has to select the number 2 first and then the number 7 on the bottom bar of the screen to continue to the next location. If the player selects the wrong combination of numbers, the game indicates this through alarm-type sound and changing the colour of the number and character of concern to red for a brief moment, as shown in Figure 4.23. This indicates where the player made a mistake. The game will then remove all red colouring and wait for the player to try again.

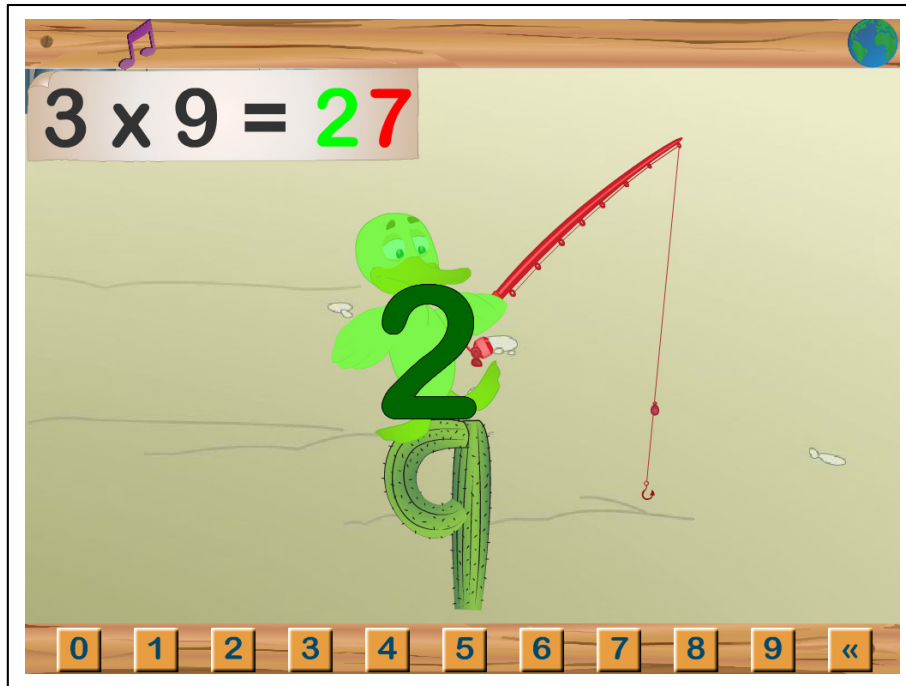


Figure 4.23: An incorrect answer is given at location nine.

If the correct numbers are selected, as is done in Figure 4.24, the numbers are momentarily shown on the corresponding characters while a “magical harp” sound is simultaneously heard before the game moves on to the next location.

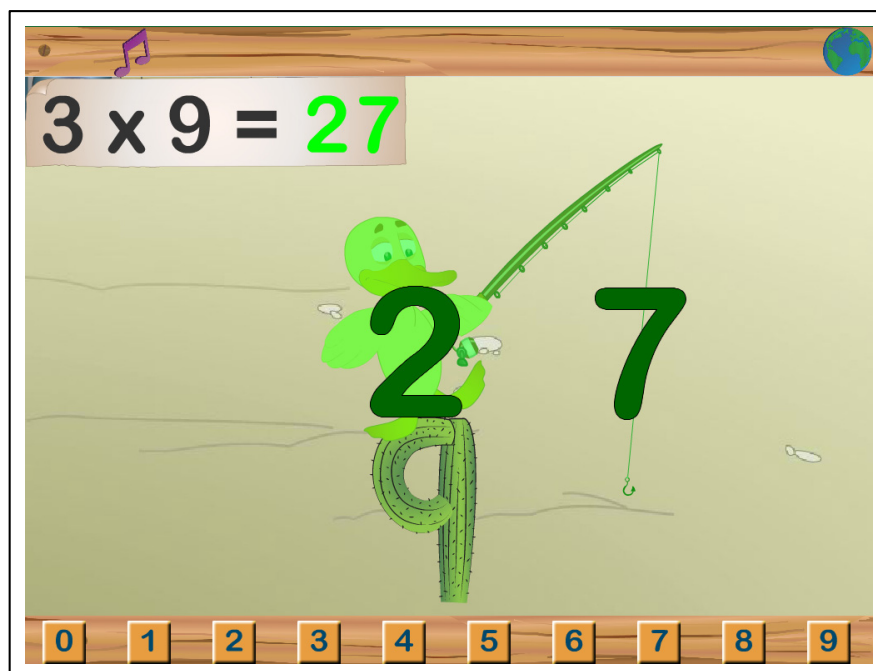


Figure 4.24: The correct numbers are given at location nine.

Once the player gives the correct answer at the last location, the game moves on to the quiz part of the level.

- Quiz 1

The first quiz is similar to the focus activity, but differs in that the game randomly picks a location to zoom to, such as the location shown in Figure 4.25 which was zoomed to first. Also, while the mathematical expression is shown, the answer is omitted and has to be entered by the player by selecting the numbers on the bottom of the screen. The player has to answer the question correctly to move to the next question. Once all twelve questions were answered, the player moves to the second quiz.



Figure 4.25: The first quiz asking the player what 3×12 is.

- Quiz 2

Quiz 2 shares similarities with the placing activity in that random cards with the characters are shown and the player has to select the corresponding location. As illustrated in Figure 4.26, the locations are signified with blue bubbles containing the corresponding expression. After the twelve locations have been correctly identified, the second quiz is completed and is followed by the third and final quiz.



Figure 4.26: In the second quiz the player matches the location to the characters.

- Quiz 3

The final quiz of the level is again similar to the second quiz but instead of characters on the card, the answer is shown in numbers. The card in Figure 4.27 shows the number 9, the product of the expression 3×3 . The player clicks to hide the card and has to select the 3×3 bubble or location to answer the questions correctly. Once the twelve cards have been correctly matched to the locations, the level is finished and the player returns to the world map where the next level will be unlocked.



Figure 4.27: In the last quiz the player matches the expression to the product.

4.4.5 Review levels

The prototype version of *StoryTimes* contains two levels that were created as a means to review the previous levels. Level 4 of *StoryTimes* is a review level of the two times and three times multiplication table levels and level 7 reviews all of the previous levels. These two levels are very short and in essence are drill questions to practice multiplication. Level 7 is portrayed in Figure 4.28 and Figure 4.29, where the player has to answers nine random questions.



Figure 4.28: One of the two review levels.



Figure 4.29: The correct answer is given in the review level.

4.4.6 Passport

The passport provides an overview of levels that the player has completed along with the score that the player obtained for the levels. Each completed level is represented by a stamp in the passport. The passport is stamped at the end of each level and the points that the player collected in the level are tallied.

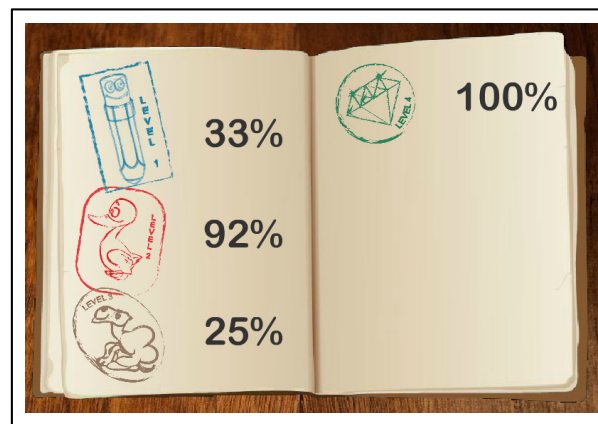


Figure 4.30: The passport with scores.

4.5 Interface elements

The player interacts with the game world by tapping various areas of the interface. The main interface components included in *StoryTimes* are discussed below.

- The menu bar is displayed along the top of the screen and contains various clickable icons, shown in Figure 4.31. The menu bar is contextualised, since some icons may be available and others hidden depending on the screen the player is currently viewing.

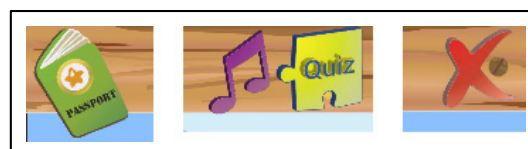


Figure 4.31: The *StoryTimes* menu bar icons.

Clicking on the music note will toggle the audio in the game on and off. This icon is always available to the player. The “quiz” puzzle piece icon is only available when a player has not reached the end of the journey or learning section for a

specific level. This icon allows more experienced players to quickly jump to the quiz section to test their knowledge. The passport icon takes the player to the passport screen to see the scores for completed levels. The exit icon to the far right returns a player to the world map from the current level. If this icon is clicked when the player is on the world map, the game returns the player to the title screen.

Each level has three quizzes that needs to be completed to win the level. During these quizzes, the menu bar shows three gem sockets, and as each quiz is completed, a gem socket gets filled with a gemstone. The menu bar also displays the current quiz and the progression through the quiz, illustrated in Figure 4.32.

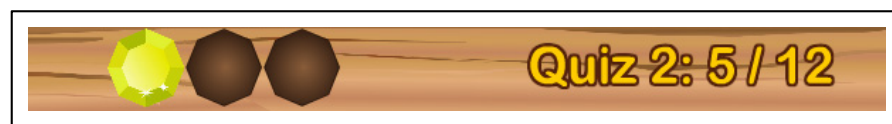


Figure 4.32: The menu bar showing quiz progression.

- The button bar is located at the bottom of the screen. During levels, when stepping through the events in each level, the button bar may display a series of numbered buttons, shown in Figure 4.33. These buttons will become visible as soon as the player needs to provide a numeric response to the events in the level.



Figure 4.33: Button bar with numbered buttons.

On the world map, the button bar displays the collected gems found after completing each level. Empty sockets indicate the amount of levels that still needs to be completed, as illustrated in Figure 4.34.



Figure 4.34: Gems collected shown on the button bar.

- Hints are provided for the player on what to do next by using arrows pointing to objects that can be interacted with. These arrows are illustrated in Figure 4.35. Arrows are also used during the first question of a quiz to show the player how the remaining questions should be answered.

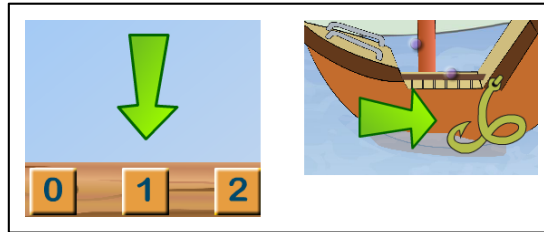


Figure 4.35: Arrows guiding the player.

4.6 Conclusion

This chapter presented the serious game *StoryTimes* and discussed its development, its pedagogical aspects, game structure and key interface elements.

5 Data Analysis and Discussion

5.1 Introduction

This chapter reports on the findings from the empirical part of this research. After a review of the literature was conducted, limitations were identified with regard to the UX evaluation of serious games. The problem statement for this research was formulated as a need by serious game developers for a set of HCI principles to guide the UX evaluation of a serious game.

The purpose of the empirical portion of this research was to characterise suitable HCI principles for the UX evaluation of serious games. This was achieved by interpreting the meanings that participants give to their experiences of a serious game and investigating which aspects of the game are the most influential on the player's experience.

5.2 Research strategy

Due to the constant interactivity inherent in video games and the varied ways in which players experience them, the nature of UX is highly subjective, as discussed in Section 2.10. This is also true of serious games, meaning that individual players each have their own unique experiences when playing these games. Therefore an interpretative phenomenological analysis (IPA) approach was selected for this research since IPA is founded on phenomenology, hermeneutics and idiography (Smith, 2011:9) as discussed in Section 3.4.2. This research explored the aspects of a serious game that matter to the participants and the meanings that the participants gave to these aspects. Through the interpretation of the participants' accounts, a set of HCI principles relevant to the UX evaluation of serious games was characterised.

5.3 Participant selection

IPA studies tend to focus on small groups of participants to explore in depth the meaning that participants give to their experiences. In order to investigate how people experience a serious game, purposive sampling (discussed in Section 3.4.2) was used to select participants. The prototype of the serious game that participants had to play

was developed with pre-school and school-going children in mind as the target audience. As a starting point in investigating player experiences of serious games, it was decided to involve parents of young children in this study, since they would, to the researcher's mind, be able to better articulate their experiences of playing *StoryTimes* while at the same time relating how their own children use technology and video games. Furthermore, since IPA is based on a double hermeneutic process, that is, a process where the researcher attempts to make sense of the participants' interpretation of their experiences, it was decided that participants should share the same home language as the researcher. This was done so that misunderstandings between the researcher and the participants were minimised and that the nuances in the expressions of participants did not go unnoticed. Therefore, individuals who spoke Afrikaans as a home language were eligible for inclusion in the study. In reporting on the findings in Section 5.5, the quotations of the participants are provided as a direct translation from Afrikaans to English to convey the intended meanings of participants as accurately as possible. Appendix D provides the original quotations in Afrikaans along with the English translation.

Considering these requirements and time and budget limitations, a local higher education institution was selected as the sample site from where employees of the institution was approached for selection in the study. The researcher obtained informed consent from each participant, as per the discussion in Section 3.9. Appendix E shows a sample consent form from one of the participants. Interviews took place during July and August 2015, on days and times which the participants considered the most convenient.

After each interview, data analysis was performed, and if data saturation (as defined in Section 3.4.2) was not yet achieved, another interviewee was sought out. This resulted in five participants being interviewed for this research, which is in agreement with the recommendation by Smith *et al.* (1997:57) to use three participants for a first time IPA study.

5.4 Data collection

Qualitative data was collected by conducting semi-structured one-on-one interviews using an interview schedule as guidance (discussed in Section 3.5.2). During each

individual session, participants were first asked to play a section of *StoryTimes* (discussed in Chapter 4). After playing the game, an interview was conducted with the participants. Participants still had access to the game during the interview in order for them to revisit parts of the game under discussion. Each session lasted between 40 minutes to an hour.

As mentioned in Section 1.7.2.2, semi-structured interviews allowed the researcher to explore the subjective experiences of individual participants' experiences regarding serious games in depth. The interview schedule containing the topics of discussion and questions to be used during the interviews was generated based on the findings from the literature review and the experience gained through the development of *StoryTimes*. The interview schedule is presented in Appendix A. The interviews with the five participants were audio-recorded and the relevant sections of the interviews were then transcribed for use in the analysis phase.

5.5 Data analysis

The collected data was analysed according to the four steps discussed in Section 3.6 which are provided as guidelines for IPA research. These steps were applied to this research as follows.

Step 1: Familiarisation with text.

The researcher read through the interview transcript several times while simultaneously listening to the audio recording to become familiar with the participant's accounts. The researcher made annotations and comments where a participant said something interesting or significant. These annotations included descriptions of what the participant was saying as well as the researcher's questions, thoughts, observations and reflections.

Step 2: Initial identification of themes.

The researcher worked through the annotated transcript again and documented emerging themes. To aid with the identification of themes, Atlas.ti computer software was used to organise, keep track of and search through the researcher's notes and annotations. The researcher's interpretation of the interview data resulted in the identification of 35 themes. An excerpt of the interview transcript with annotations and coding is presented in Appendix B, which was guided by examples from Larkin and Thompson (2012:107).

Step 3: Grouping themes together as clusters.

The researcher continually searched for connections between the emerging themes of Step 2 by clustering related themes together. In this step, the researcher continually referred back to the transcripts to compare her own interpretation, sense-making and development of connections against what participants actually said. In the end, the 35 themes were grouped together to form seven clusters. These seven clusters were labelled and became the superordinate or main themes. It was noted that the number of themes appears in line with Saldaña's (2013:24) recommendation of having up to 40 themes grouped into three to seven major themes.

Step 4: Tabulating themes into a summary table.

Using Atlas.ti to facilitate the process, a coherent table was produced which lists the main themes and related sub-themes, along with the number of quotations from the interviews associated with each theme. This table is presented in Appendix C.

These four steps were followed after each interview was conducted and transcribed. After the second interview was transcribed, the four steps were followed by considering the previous interviews and continually re-evaluating previous findings when new information surfaced from the current transcription under analysis. The analysed data was inspected for trustworthiness through participant verification. This entailed providing the participants with their interview transcript and the interpretation of the collected data and allowing them an opportunity to provide corrections or feedback.

5.6 Discussion of the main themes

The seven main themes represent the aspects of serious games that participants felt most strongly about. The identified themes from the interviews are as follows.

T1: Technology use and convenience of mobile devices.

T2: The player's attention.

T3: Player's feelings toward subject content.

T4: Player's feelings toward in-game challenges.

T5: Player's feelings toward the serious game world.

T6: Assistance with the serious game.

T7: Challenges associated with wide target audiences.

In accordance with Smith's (2011:24) guidelines for reporting on IPA research, an indication of the prevalence of themes is presented in Table 5.1. This table summarises the number of times each of the seven themes was mentioned by each participant.

Table 5.1: Themes discussed by participants.

	T1	T2	T3	T4	T5	T6	T7	Total
Participant 1	13	6	7	15	13	3	6	63
Participant 2	8	2	10	7	4	6	1	38
Participant 3	6	3	5	14	6	6	2	42
Participant 4	16	3	9	14	10	8	9	69
Participant 5	7	5	3	13	8	8	2	46
Total	50	19	34	63	41	31	20	258

The following sections discuss the seven main themes in detail and provide evidence for the findings in the form of quotations from the participants. As mentioned in Section 5.3, the semi structured interviews were conducted in Afrikaans and translated directly to English. The schedule guiding these interviews is presented in Appendix A and the Afrikaans quotations with their direct English translation appear in Appendix D.

5.6.1 The use of technology and convenience of mobile devices

An aspect that goes hand in hand with serious games is the hardware platform on which these games are available. Many of the participants compared these platforms with one another. Two participants expressed the view that tablets seem easier to use than desktop computers.

Participant 1: "...with a computer it is more complicated, with a mouse and keys and things, whereas with the tablet it is automatic, it shows you where to press and you press there."

Participant 2: "I think the tablet and touch screen environment is much easier. She cannot work on the computer with a mouse...give her a tablet and look at everything she can accomplish with it."

Participant 1 also considered gaming consoles, such as PlayStation consoles, to take more time to learn than other gaming devices.

Participant 1: "I think one has to get more used to the other consoles first."

All of the participants agreed that today's children are growing up with technology and are very comfortable using it. The participants also expressed amazement at how capable very young children seem to be when using technology, especially tablets.

Participant 4: "...the children start early with computers...They have a computer period... from grade 1 they go once a week."

Participant 4: "...it's wonderful. They like touch screens, they know touch screens. The children are really geared up for these things."

Participant 5: "You know, there are schools that now issue the small children iPads and tablets in grade R already?"

Participant 3: "They now have to learn to write. So where they have to make the pattern eight, where they must connect the dots from one to two, and you know, my three year old does this."

The participants further described the ways in which they use their mobile devices. Many participants indicated that they use tablets to keep themselves or their children

occupied, for example waiting at the doctor's office or during power outages. Participant 1 also mentioned that some games allow for more functionality on a desktop computer, but even so, still plays many games on tablets. The participants also seem to enjoy the mobility that tablets provide. They take it with them and allow their kids to play on it when traveling.

Participant 4: "Especially if we are visiting persons who do not have children or their children are grown up. Then I find it difficult to keep him occupied and then I think that it will be quite good."

Participant 3: "Also when we are travelling on holiday we load games instead of videos on the laptop which also means that they are learning."

Participant 1: "Because what is nice is you can do one adventure and then leave it and then you can do another. Can you stop in the middle of [the game]?"

Conclusion:

There is a strong sense that convenience plays an important role in the use of mobile devices. This corroborates research by Burford and Park (2014:632) in which participants expressed a penchant for the convenience that iPads provide. Furthermore, from the interviews, mobile devices were found to be the preferred platform on which to play serious games when compared with other gaming platforms such as desktop computers and consoles, due to factors such as the ease of switching from one application to another and the mobility that these devices provide. Unlike avid video game players, who play entertainment titles as a hobby and are not affronted by bulky and expensive gaming computers, the serious game player may place higher value on the convenience that mobile platforms provide.

From the above discussion the researcher concluded that players of serious games want convenience.

5.6.2 The player's attention

A prominent aspect that surfaced during the discussions with the participants related to a player's attention while playing video games.

One participant stated that attention might diminish after playing a game for a while.

Participant 2: "There were a few times that I felt it went too slow but then again, what I've seen with myself and other memory games I've played, there comes a stage that your concentration levels just begin to fall, where maybe you don't concentrate as fully as you need to."

The reason this participant gave was that the pacing was too slow. This could indicate that players expect something interesting or something unexpected to happen more often.

Living or growing up in an age where information is constantly being presented or served to individuals, makes it even more difficult to stay focused when playing a game.

Participant 1: "...and then an email 'pops'! PING!... and it detracts your attention... That one can almost say that when you go [into the game] then you are trapped there and you may not leave until you are finished. [LAUGH]. It's maybe not ideal but it would be good to help to focus on it."

It would be beneficial to minimise distractions such as email notifications by possibly allowing players to disable notifications from other applications or even incoming calls to keep their focus on the game. It was also mentioned that not only adults, but children too seem to move from one activity to the next and back again.

Participant 5: "They will lose attention, stand up, do something else, and then come back again."

Contemporary mobile games, such as *Cut the Rope 2* (ZeptoLab, 2014), *Candy Crush Saga* (King, 2012) and *Hay Day* (Supercell, 2012) attempt to draw players back to the game by alerting the player of in-game events or that a secret surprise gift is waiting for the player. Figure 5.1 depicts an example of such a notification.

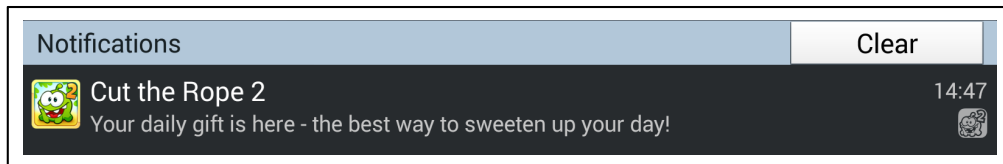


Figure 5.1: A notification to lure players back to Cut the Rope 2 (ZeptoLab, 2013).

Further to keeping the player's attention, the player's attention has to be drawn to specific areas in the game, otherwise the player could miss important information. This is crucial for serious games as the aim is to convey real life knowledge to players.

Participant 3: "...but actually... I didn't read it... that is why I made mistakes here."

Participant 3 additionally suggested "*highlighting*" objects to make them more noticeable.

Conclusion:

It is inevitable that a player's attention will fade, or be seized by other activities. Therefore, the serious game designer has to devise strategies to entice players to return to the game. Once in the game, the player must stay captivated and their attention directed to the relevant areas in the game. The serious game therefore has to enchant players, both when drawing them back to the game and while they are playing the game.

From the above discussion the researcher came to the conclusion that players of serious games want to be enchanted.

5.6.3 The player's feelings toward subject content

A significant aspect of serious games is the subject content they need to convey. Since the subject content of *StoryTimes* focus on the multiplication tables, the participants discussed their experiences of learning using mathematics as a starting point.

Many of the participants related how they experienced mathematics when they were still in school. Most of the participants expressed that they were forced to learn through rote memorisation and were reprimanded if they did not remember their work. As a result, as one participant stated, they rebelled against the “*terrorist of a teacher*”.

Participant 3: “...I mean, if everything just gets forced then that is why the children don’t like mathematics in school.”

Participant 2: “You know, when it is forced upon you then it is not always the same.”

Participant 1: “To this day I still do not know my tables, specifically since [my teacher] hit me because I didn’t know it.”

Participant 4: “Years ago when we were at school, they would hit you until you knew your tables. That doesn’t happen today.”

The participants compared the traditional teaching approaches that they were used to as children to *StoryTimes* and other educational games used today and indicated that playing games is more preferred. Even though the participants did not consider themselves to be avid video game players, they were open to the idea of using serious games as a learning medium.

Participant 5: “It is much more fun to do it like this than just writing out, writing out, writing out.”

Participant 2: “But also if you have the choice to play the game or sit down and do sums for half an hour, you might perhaps elect to play the game.”

The participants felt that learning will take place much more effectively in a relaxed or playful environment. Participant 3 stated that a stress-free environment is key to effective learning and developing a positive attitude toward the subject content.

Participant 3: "...because I know that's how one learns easier, not under stress, where you actually play while you learn, and it sticks, I believe in that."

Participant 3: "It is actually important that children learn by playing because then they enjoy it and then they get a love for the subject."

Serious games are ideal to present these playful, stress free environments in which subject content can be incorporated. An interesting matter relating to embedding subject content into a video game was participants pointing to the use of the game setting to incorporate incidental learning.

Participant 3: "The world, yes, you can even learn here in terms of which country is which number and you can make those associations too. They can even get a little geography out of this, not only mathematics. The nine times table is over there in India."

Participant 2: "...but what one can also do if you wanted to, to maybe link the animals from certain continents with levels that take place in those continents. So if you are in Australia then you do kangaroo's and such things and if you are in South Africa then you do lions and leopards and rhinoceroses."

Incidental learning, as opposed to intentional learning, relates to knowledge that is acquired without it explicitly being taught, but inferred from contextual cues (Rieber, 1991:322; Rosas *et al.*, 2003:77).

Conclusion:

It is up to the serious game developer to interweave the subject content and opportunities for incidental learning carefully into the game world so that the players are not intimidated by the subject content and in a sense forget that they are in fact learning.

The discussion above led the researcher to conclude that players of serious games want to learn effortlessly.

5.6.4 The player's feelings toward in-game challenges

All of the participants expressed how they felt regarding the *StoryTimes*' quizzes after playing the game.

Participant 4 suggested that players must feel motivated when they are attempting the quizzes.

Participant 4: "...but one can sort of motivate him with 'Well done!' Especially if he gets stuck...because he may really not know the answer. That someone maybe just says: 'Oh, try again...' yes, maybe this: 'Don't worry, try again!' or so: 'Oh No!' or something like that...I think it can be fine for them."

This relates back to the previous section where participants expressed having negative feelings toward subject content since they were reprimanded when they did not know or struggled with learning material. This finding resulted in the removal of the cross mark from *StoryTimes* when the player answers a question incorrectly, but still keeping the red tint and an appropriate sound, as illustrated in Figure 5.2.

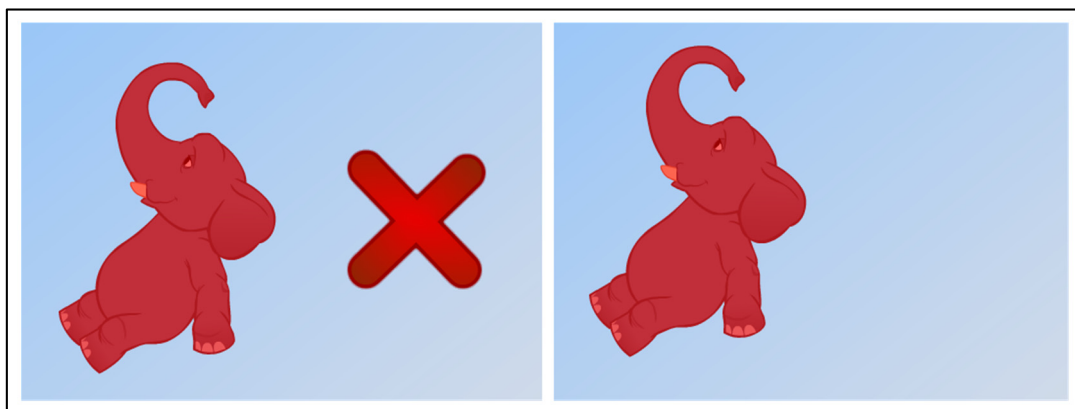


Figure 5.2: Previous version of *StoryTimes* (left) has a cross mark, which has been removed in a subsequent version (right).

When the player answers the question correctly, however, the game still draws a green check mark and tints the character green, as illustrated in Figure 5.3.

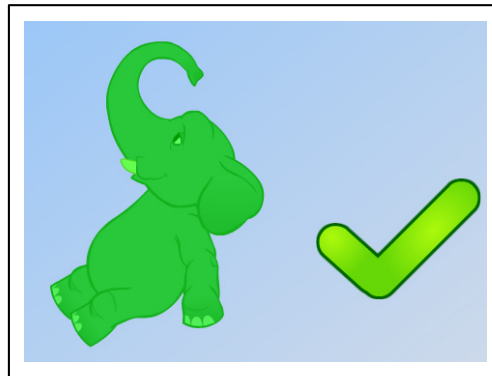


Figure 5.3: One question of a quiz answered correctly.

Further discussion with the participants revealed that they enjoy being rewarded for achievements and for successfully completing challenges.

Participant 1: "Only thing which I would change is the... if the stage is complete it needs a short video. You could maybe [use] real animals... maybe tell more about the little animals."

Participant 3: "Usually if you do something right then it is 'well done', it's balloons, so she associates her correct answer with a balloon or something, like in a celebration. But the balloons and things are usually accompanied by a sound."

Two participants expressed a desire to be able to return to previous quizzes to redo challenges and improve their previous results while another participant felt that players should be able to have quick access to certain quizzes and be able to focus on these.

Participant 5: "I wonder, could you do that quiz again and change your marks?"

Participant 1: "Maybe there can be more questions. It just feels too short for me. Can I go back to the review? Will it then ask me different questions?"

Participant 4: "...but if you could just skip the quizzes, you understand, where my child is in grade 1 now and then I want to do quiz 1 the whole time or maybe [quiz] 2. But if your child is older, then maybe he has to do [quiz] 3; he must do [all three]."

The participants' statements point to a need that players want easy access to those areas of the game where they can practice their skills and improve on previous results.

Conclusion:

The serious game designer should consider incorporating elements that motivate a player if they struggle, for example a message of encouragement if they struggle with a particular challenge. In the words of Participant 3, the players want the game to “celebrate” with them when they have reached an achievement. The game should provide the means to revisit previous levels or areas of the game so that the players may review subject content and practise their skills once more.

From the discussion above, the researcher came to three important conclusions regarding the challenges in serious games namely that players of serious games want to be encouraged if they struggle, they want to be rewarded for achievements and they want to practice.

5.6.5 The player's feelings toward the serious game world

All of the participants enjoyed the general theme of *StoryTimes* very much. They liked the concept of going on a journey around the world to collect gems in each level and have their passport with their results stamped to travel to the next continent.

Participant 1: “I like how it looks. I like the idea behind the passport with the travel, with [PAUSE] the different stages that you visit, and the achievement that you get by completing one and then moving on to the next. I like the whole concept.”

Participant 5: “It's very cute, adventure in Africa.”

Participants also specifically referred to the characters in the world and described them as “lively” and “colourful”.

Participant 1: “I think the characters... they are very cute, yes, they are lively. It's not as if they are these dreary little things.”

Participant 4: “No, it’s stuff that they know, it is stuff that they can identify with. They all know it in stories and such things. I mean the snowman is in Frozen, and you could trace all those things back to some or other animation, believe me!”

Most of the participants explained that their children really enjoy music and sounds and want to turn the volume up as high as possible.

Participant 5: “Kids love loud tablets. Loud everything, loud radio, loud tablet, loud television.”

Participant 3: “My daughter likes background music, if she just starts then she wants to turn up the volume.”

With regard to sound and music in *StoryTimes*, most of the participants said they liked the existing music and suggested adding music to those sections of the game where there was none.

Participant 2: “...but maybe that is something you could try. It can even be serene, because then it breaks the silence a little.”

From the aforementioned quotations, it becomes clear that the game world should be aesthetically pleasing by including appropriate visual and audio elements. Additionally, Participant 4 suggests that for serious games, audio and visual elements should be used in conjunction with the subject content the player is working with to make it more engaging.

Participant 4: “Yes, for if someone uses a program like this then they can speak it while they are typing it so that they can see it, they must say it and they work with it. So I think that can kind of work.”

There was a sense that participants liked to know where they were in terms of both the game world and the subject content. There was a sense that participants liked that progression could be made in the world and liked to see how far they have progressed in this world. Participants also expressed that they liked knowing where they were in terms of their mastery over the subject content.

Participant 3: “The little diamonds, it gives you progress, you can keep track of where you are.”

Participant 1: “And what is nice then is that it goes on to the next adventure.”

Participant 3: “I like the fact, it scores you, so you know exactly how much you got, it helps you to keep track of what you know and what you don’t know.”

Conclusion:

It is clear that the participants consider the sensory stimuli – music, sound, graphics and animations – to be important elements of serious games in that these bring the game world to life so that players can “*identify*” with the serious game and possibly find the subject content more engaging and memorable.

Furthermore, players need to be informed of their progress in the game and where they are. This does not necessarily relate only to a physical location in the game world but includes aspects such as how long players have been playing the game, how many levels they have completed and how far they still need to go to complete the game. Importantly, players must also know where they are in terms of the subject content. Players need indications of how much of the subject content they have mastered and which areas they still need to improve.

The above discussion led the researcher to two conclusions about the serious game world. Firstly, players of serious games want to use all their senses. Secondly, players of serious games want to know how they are shaping.

5.6.6 Assistance with the serious game

Another theme that clearly emerged from the interviews was the participants’ feelings toward assistance provided to the players. Participants pointed to the assistance that the game itself provides but also to other people who might provide guidance, especially for younger children. As a serious game could be used in conjunction with other teaching approaches or media, facilitators might play a valuable role when serious games are implemented.

Some participants explained that even though their own children are still too young to read, they are able to play games based on other visual cues, such as arrows pointing

to objects. The participants also noted that children may initially struggle with a game, but if they are given guidance, sometimes only just once, then they are able to continue on their own.

Participant 1: "I think for a small child... the game explains well how you must do it so you don't have a need to 'Mom, what must I do now?' Because usually you have to write things for them on most of your games and then they are not at a stage where they completely understand."

Participant 5: "But surely there will be someone with the child? You just have to show them once then they will know."

Participant 4: "But I think in general the arrows are good enough to show you what you must do and to follow it."

One participant felt that the *StoryTimes* provides too many hints, and suggested that it would be better if the game could detect whether a player is struggling or not, and provide hints accordingly.

Participant 2: "One can maybe make it so that [the game] picks it up, you know, if one struggles too much, okay, give him a few more hints, if one gets it right, leave it, then you leave the hints, a type of [artificial intelligence] effect."

Conclusion:

Whether or not an educator or other facilitator is available to assist players with a serious game, the game itself needs to provide appropriate guidance for the player.

This analysis led the researcher to conclude that players of serious games want guidance.

Participant 2's comments above regarding the assistance that the game provides, alludes to the final, and perhaps most important aspect of serious game design as will be discussed in Section 5.6.7.

5.6.7 Challenges associated with wide target audiences

From a serious games designer's point of view, the greatest challenge is perhaps developing a game for what appears to be a very heterogeneous target audience. Participants pointed to differences in terms of demographics, such as age and gender.

Participant 1: "...where...if you are older, one tends to want it to go faster."

Participant 5: "And you cannot make it too girly or too boyish...so there's not a lot of pinks or blues, it's all so neutral."

Participant 5 indicated that *StoryTimes*' colour scheme is neutral enough – “not a lot of pinks or blues” – so that it will not be regarded as a game designed specifically for boys or specifically for girls. Participant 4 explained that the third quiz of each level in *StoryTimes* will be difficult for a grade 1 child (around five or six years old) but that a ten-year old child might find the first two quizzes “boring”, even though the subject content – the multiplication tables – is of importance to both age groups.

Participant 4: "...or a grade 1 child. I mean he won't be able to do all those quiz levels. The third quiz, if I can call it that. My child can do it, right, or he is supposed to be able to do it. So I think one must sort of see if you can skip quizzes...certain levels."

Participant 4 furthermore suggested that a player should not have to complete all three quizzes to progress to the next level, but rather that the player makes the decision on which quizzes need to be completed.

Apart from demographics, participants indicated that differences in psychographics – the personality, values and traits of the player – also determine how players experience games.

Participant 2: "And it also depends on the little guy, where is he strong? He is naturally going to focus on where he is strong. So if he is visual, then you will use pictures, if he is mathematical he will probably use the digits and if he can remember well then he can just match the pictures."

Participant 5: "You know that left-brain, right-brain? Those who are more creative, might enjoy it more, as opposed to the people who are not so creative."

Entertainment games usually focus on a specific personality or playing style for example *Myst* (Cyan, 1995) provides a number of island worlds for those players favouring exploration while *FIFA 16* (EA Canada, 2015) caters more to the competitive and action-inclined. In *Mass Effect 3* (BioWare, 2012) dialogue and interaction with in-game characters play a central role. The aforementioned titles all have different themes and approaches to gameplay, determined by which market the game developers are targeting. There are, however, existing game titles which incorporate different playing styles. *Skyrim* (Bethesda Game Studios, 2011) is an example of such a game in which a player could either focus on exploring the vast land of Skyrim open-endedly, focus only on the main storyline of the game and finish it as quickly as possible, interact with the myriad of in-game characters or destroy and kill anything in sight.

Serious games also need to cater for players with a wide variety of preferences and personalities since the subject content still needs to reach all the intended learners regardless of their personality or playing style. Serious games designers could incorporate established character theories such as Bartle's taxonomy (Schell, 2008:110). Bartle (2004:130) distinguishes between four playing styles namely achievers who want to act on the world; explorers who want to interact with the world; socialisers who want to interact with other players and killers who want to act on other players. Figure 5.4 illustrates the four playing styles on the dimensions of player interests.

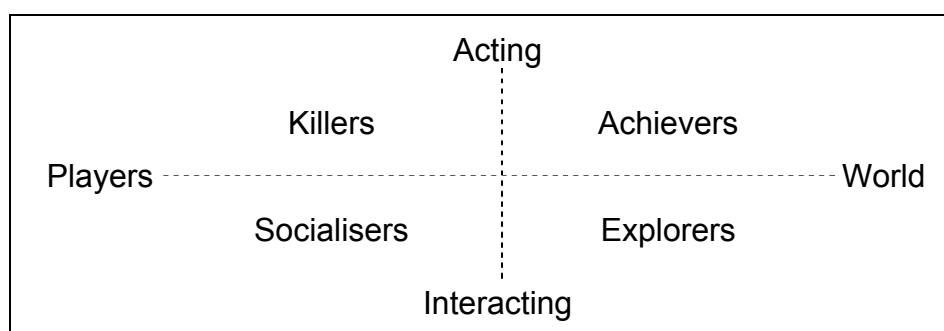


Figure 5.4: Bartle's (2004:131) taxonomy of playing styles.

Incorporating these styles of game play into a serious game, could make it more interesting for individual players since players find the game more interesting if they feel that the game is about them. Although caution must be exercised when attempting

to simplify complex human behaviour with taxonomies such as those presented by Bartle, these do provide guidance in considering the intended audience.

Furthermore, players should have a lot of freedom to customise the game according to their preferences.

Participant 4: "...just give a few choices."

Participant 1: "So that is the problem, that you could maybe increase its speed a little or decrease it a little if it's too fast. It's maybe something that one could add. Yes, that the speed of the gameplay... that one could adjust it."

Participants suggested that the difficulty levels for challenges in the game should also be adjustable, for example controlling whether a challenge must be completed in a certain time or not. Features such as the hints or arrows used as guidance in the game could also be enabled or disabled at the player's discretion.

Conclusion:

Serious game developers should design games in which individual players feel that their preferences are being accommodated.

From the discussion above, the researcher came to the conclusion that players of serious games want to feel that it is all about them.

5.7 Characterising HCI Principles for the UX evaluation of a serious game

From the seven themes discussed in the foregoing section, a set of ten principles were identified that serious game designers could apply when designing serious games. While there is arguably some overlap among the themes, Table 5.2 summarises which principles were identified from which themes. These principles are characterised in the next sections based on the findings from the data analysis.

Table 5.2: Principles identified from the analysis of the interview data.

Theme	Principle
The use of technology and convenience of mobile devices.	Players want convenience.
The player's attention.	Players want to be enchanted.
The player's feeling toward subject content.	Players want to learn without effort.
The player's feelings in-game challenges.	Players want to be encouraged if they struggle.
	Players want to practise.
	Players want to be rewarded for their achievements.
The player's feeling toward the serious game world.	Players want to use all of their senses.
	Players want to know how they are shaping.
Assistance with the serious game.	Player's want guidance.
Challenges associated with a wide target audience.	Players want to feel it is about them.

- **Players want convenience**

Serious games should provide sufficient functionality, but not at the expense of convenience. For example, a serious game developed for entry level Android tablet devices, might be based on a 2D environment instead of a 3D environment. 3D worlds could possibly be too taxing on the hardware and software resources of the targeted devices and cause player frustration if the game runs or starts up too slowly. Furthermore, players of mobile serious games should be able to switch easily between applications and to easily return to the serious game.

- **Players want to be enchanted**

Players can easily be distracted by interruptions such as email or WhatsApp notifications on the mobile device they are playing on or by events in their environment and would want to direct their attention at the interruption. These distractions should as far as possible be minimised. A player's attention must be drawn to relevant areas in the game otherwise important information may go by unnoticed by the player. Players will also become tired and lose focus after some time and thus serious games should be designed to attract or remind players to return to a game after a while.

- **Players want to learn without effort**

In a sense, players want to be whisked away into the gaming world and want to *“forget”* that they are playing in order to learn. The serious game developer needs to carefully embed subject content into the game so that it forms part of the game world. Opportunities to incorporate incidental learning should also be taken advantage of.

- **Players want to be encouraged if they struggle**

Players do not enjoy being reprimanded if they are struggling with subject content. The game should provide motivational support to the player rather than making players feel incapable of overcoming the challenges. If they struggle with a challenge in the game, players should be encouraged to attempt the challenge again.

- **Players want to practice**

Players enjoy to challenge themselves to do better. They do not wish to make mistakes, but if they do, they want to revisit a challenge and attempt to perform better. Players want to better their skills, and therefore the game should provide the means for the player to readily return to previous challenges to exercise and test their knowledge. Players could also be given the option to skip some parts of the game if they want to directly access the puzzle or test parts of the game without having to work through learning material that they already know.

- **Players want to be rewarded for their achievements**

When players solve a problem or overcome a challenge, they expect the game to be glad for them. Players want the game to share in their feelings of accomplishment and “celebrate” their achievements with them. The game should therefore provide rewards for players, which could take on a multitude of forms, such as a score, a short video, sounds or achievement badges. Players could receive rewards for making progress in the game world and also for how well an activity was completed, for example in *StoryTimes*, the more questions a player answers correctly the first time, the higher his or her score will be.

- **Players want to use all of their senses**

Players enjoy the sensory stimuli that video games can provide, such as graphics, animations, haptic feedback, sound and music. These elements should be incorporated into serious games to make learning more memorable and entertaining.

- **Players want to know how they are shaping**

Players want to have an indication of how they are progressing in the game. For example for *StoryTimes*, participants enjoyed seeing the passport with their scores for each level. Players should be able to measure their performance in order to know if and where they could improve their skills and knowledge.

- **Players want guidance**

Players do not enjoy feeling lost in a game and not knowing what to do next. A serious game should provide clear and appropriate guidance on how to progress in the game and also provide for the player to receive additional guidance or hints when a player is continually struggling with certain challenges.

- **Players want to feel it is about them**

Serious games are usually developed for wide target audiences and should therefore incorporate different playing styles to accommodate individual player preferences. Players should be allowed to customise a serious game to a large extent, for example setting the difficulty levels of challenges. Furthermore, serious

games should adapt to the player's needs, for example if a player is struggling with a particular challenge, the game could detect that the player is struggling and provide tailor-made guidance when needed.

Table 5.3 provides a summary of the defining characteristics of the identified principles discussed above. Serious game designers can provide this table to evaluators as a checklist to perform heuristic evaluation of the UX of the serious game.

Table 5.3: Summary of defining characteristics of identified principles.

Principle	Characteristic
Players want convenience.	The game starts up quickly. The player can easily switch between the game and other applications.
Players want to be enchanted.	Notifications from other applications are kept to a minimum. The player's attention is drawn to important areas in the game. Messages remind the player to return to the game.
Players want to learn without effort.	Players " <i>forget</i> " that they are learning. The game incorporates incidental learning.
Players want to be encouraged if they struggle.	The game motivates players if they struggle. Negative feedback is minimised.
Players want to practise.	Players are allowed to revisit previously completed challenges. Players are allowed to jump ahead to specific challenges.
Players want to be rewarded for their achievements.	The game celebrates the player's achievements. Players are rewarded for making progress in the game. The game rewards the player based on performance.
Players want to use all of their senses.	Suitable visual and audio elements are present in the game. The audio and visuals compliment learning.
Players want to know how they are shaping.	The player's progress is tracked. Players can quickly determine their progress.

Table 5.3 (continued): Summary of defining characteristics of identified principles.

Player's want guidance.	The game provides guidance on how to play it. Players can request additional guidance if they struggle.
Players want to feel it is about them.	The game adapts to what the player wants. The game incorporates different playing styles. The player can customise settings.

5.8 Conclusion

This chapter focused on the empirical portion of this study. The research strategy for conducting the empirical research was outlined followed by a discussion of the findings. The findings culminated in the characterisation of principles which could be used by serious game designers when evaluating the UX of a serious game.

6 Conclusions and Recommendations

6.1 Introduction

The objective of this research was to characterise HCI principles relevant to the UX evaluation of serious games. The first two chapters presented the background and literature study of HCI principles, UX evaluation and serious games. The third chapter discussed issues surrounding the philosophy of research with a focus on the approach taken in this research. A prototype of a serious game developed for the purposes of this research was discussed in Chapter 4. The empirical portion of this research, presented in Chapter 5, was conducted to investigate the experiences of participants with regard to serious games. Through an interpretative phenomenological analysis of the collected data, the aspects of serious games which were the most influential in the experience of the participants were identified. From these findings, a set of HCI principles were characterised to guide the UX evaluation of serious games. This final chapter concludes this research by reflecting on the research process and findings.

6.2 Research conclusions

The literature study presented in Chapter 2 discussed general HCI principles from various authoritative works, followed by HCI principles applicable to video game design. Finally, principles aimed specifically at serious games were investigated. This study revealed underexplored areas in the knowledge base regarding the evaluation of the UX of serious games. Subsequently, the objective of this research was to characterise HCI principles relevant to evaluating the UX of a serious game. Two research questions were formulated to realise this objective.

First research question: Which aspects of a serious game do players find the most influential in their experiences with serious games?

The answer to this research question was pursued through an interpretative phenomenological analysis (IPA) research approach. This approach is founded in phenomenology, hermeneutics and ideography, as discussed in Chapter 3, which made it a feasible option in light of the subjective nature of UX.

IPA usually employs small sample sizes to gain in-depth exploration and understanding of the individual's experiences and sense-making of these experiences as opposed to attempting to generalise findings. For this research, five participants volunteered to be interviewed regarding their experiences with a serious game. Interview transcripts were qualitatively analysed through a process of familiarisation with the text, and the identification and clustering of themes. Seven main themes emerged which corresponded to the aspects of serious games that participants felt most strongly about. These aspects were technology use and convenience of mobile devices, player attention, player feelings toward subject content, player feelings toward in-game challenges, player feelings with regard to the fantasy worlds of serious games and lastly the guidance provided for the player. These themes were discussed in Section 5.6.

Second research question: Which HCI principles relevant to the UX evaluation of serious games could be identified and characterised from the aspects of serious games that matter the most to players?

This question was addressed by exploring the aspects that participants considered the most important to serious games. Through this exploration, HCI principles were identified which could offer guidance when evaluating the UX of serious games. These HCI principles were characterised in Section 5.7.

6.3 Research findings

Through the investigation of the meanings that players make of their experiences of serious games, it is possible to gain unique insights into the design of serious games.

The findings of this research indicate that the serious game player particularly enjoys using mobile devices. This is in line with the current global trend where mobile games form a significant and rapidly growing portion of the total video games market. The data analysis also revealed that serious game players have certain feelings and expectations regarding how subject content is integrated into video games to deliver an engaging learning experience. Research findings further point to the elusiveness of player attention and the diverse natures of individual serious game players. These aspects present additional design challenges over and above those of pure entertainment game design.

The aspects above were concluded to be the most important from the perspectives of the research participants. By exploring these aspects, ten HCI principles relevant to serious game design that take into account the most important aspects of a serious game, were identified and characterised. These HCI principles can be used by serious game developers in for instance heuristic evaluation, to evaluate the UX of serious games.

It was concluded that the objective set forth for this research was successfully achieved.

6.4 Research limitations

This research focused on the UX of a serious game and thus the effectiveness of the serious game in terms of pedagogy was not evaluated. Although *StoryTimes* was developed with pre-schoolers and young children in mind, the game was played by adults who have children of their own who, to the researcher's mind, would have been able to better articulate their experiences of playing the game and thus provided a good starting point in investigating player experiences. Moreover, most participants did not consider themselves avid video game players and were not entirely familiar with serious games. Some of the participants' only point of reference for serious games was the game they were introduced to during the interviews. Within this context, HCI principles were derived from these interviews.

6.5 Recommendations for future research

From the limitations of this research, three possible areas for further research were identified.

- It is clear that for serious game developers, the proper balancing of a serious game is elusive. To an extent this balance is dependent upon the skills of the player. Players could set the difficulty level of a game manually, but further research into how a serious game could automatically adapt to suit the player's preference, through an AI system or otherwise, would be warranted.
- The pedagogical effectiveness of *StoryTimes* was not evaluated in this research. Since *StoryTimes* was designed with children in mind to help them learn the

multiplication tables, determining *StoryTimes*' effectiveness on children could be the focus for further research.

- Principles to evaluate multi-player serious games in terms of player experience using IPA could be a possible avenue for further research.

6.6 Contribution to the knowledge base

The literature study of this research revealed that limited research exists on how the UX of serious games could be evaluated. This research contributed to the knowledge base by using interpretative phenomenological analysis to discover and characterise HCI principles. The exploration of the meaning that players give to their experiences when playing serious games resulted in a set of HCI principles that could be used as a possible tool to guide UX evaluations of serious games.

6.7 Conclusion

This chapter summarised the research conclusions and findings, followed by a discussion of the research limitations. Finally, recommendations for future research and the contribution this research made to the literature were presented.