TEN HEURISTICS TO EVALUATE THE USER EXPERIENCE OF SERIOUS GAMES

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─Abstract─

The potential of serious games to promote effective learning has been established in the literature. However, designing effective serious games that strike a balance between being entertaining and at the same time instructional, remains elusive. This research turns to the field of human-computer interaction (HCI) to investigate the aspects that are most influential to the player's experiences with serious games. From this, HCI principles to evaluate the user experience of serious games are identified and described. User experience (UX) refers to how individuals perceive and respond to using interactive systems such as serious games. Since UX is regarded as subjective in nature, this study was conducted using interpretative phenomenological analysis, which focuses on idiographic inquiry. Semi-structured interviews were conducted with five participants after they were given time to play a serious game. The serious game, titled *StoryTimes*, aims to teach the user the multiplication tables by employing memory association techniques in a fun and innovative way. *StoryTimes* was developed as part of this research to investigate how HCI principles are applied during the development cycle of a serious game. The data from the interviews were analysed qualitatively to determine which aspects of the serious game were regarded as the most important from the participants' point of view. The findings indicate that players of serious games prefer mobile gaming platforms and have certain expectations regarding how subject content is integrated into video games. It also reveals the design challenges associated with the attention spans and very diverse natures of

individual players. These aspects were recast in the form of ten heuristics that could be applied when evaluating the UX of serious games. Designers of serious games can use these heuristics during the development process to create a learning environment that is both effective and fun.

Key Words: *Serious Games, Human-Computer Interaction, user experience*
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1. INTRODUCTION

Playing video games may promote learning because of the interaction and intrinsic motivation these games provide (Malone, 1980:3; Prensky, 2005:102; Annetta, 2010:107). Video games used for educational purposes often are referred to as serious games (Zyda, 2005:26). Serious game developers must put careful consideration into how they design a serious game so that the game strikes a balance between being fun to play and at the same time being instructional (Prensky, 2005:109).

Researchers and game developers have turned to the field of human-computer interaction (HCI) to look for answers on creating fun video games. Today, the study of games is an established area of research within modern HCI (Carter et al., 2014:27). Some researchers such as Korhonen and Koivisto (2006), Pinelle, Wong and Stach (2008), and Desurvire and Wiberg (2009), specifically investigate how heuristic evaluation, a subset of HCI, can guide in designing a positive user experience (UX) for video games.

Applying the definition of UX as per Hassenzahl and Tractinsky (2006:95) to the context of serious games, UX can be considered the result of the interplay between a player's internal state, the properties of the serious game and the context in which the interaction takes place. One of the core interests of UX, therefore, is on the emotions and perceptions of players while they are interacting with a serious game (Law and Sun, 2012:479). Since the experiences are unique and personal to each individual player, UX is regarded as very subjective in nature (Hassenzahl and Tractinsky, 2006:95; Law and Sun, 2012:479).

Researchers such as Shiratuddin and Zaibon (2011:93), Law and Sun (2012:478) and Engl and Nacke (2013:83) agree that evaluating the user experience of serious games is still limited, especially serious games on mobile platforms. To address these limitations, this research aims to discover which aspects players find the most influential in their experiences with serious games by qualitatively analysing interview data of research participants. Following this, this research identifies and describes heuristics relevant to the UX evaluation of serious games from these aspects.

This paper presents the context of this research and related work, followed by the research methodology. Next, the serious game that was used in this research is

discussed briefly. This is followed by a discussion of the research findings. Lastly, the limitations of this research and implications for future research are discussed.

2. BACKGROUND AND RELATED WORK

The evaluation of the UX of a system can be done using various techniques. One such technique is known as heuristic evaluation (Nielsen and Molich 1990:249). A small group of evaluators walk through the design of the system using a set of heuristics and check whether the design aspects conform to the heuristics. Heuristics are general rules of thumb based on previous design experience and tried-and-tested design practices (Dix et al., 2004:324) and have been adapted for use within different contexts such as video games.

Development of heuristics for video games go as far back as the golden age of arcade video gaming, when Malone (1980) presented a set of heuristics for the design of instructional computer games. Heuristics have been developed by researchers such as Pinelle, Wong and Stach (2008) and Desurvire and Wiberg (2009) to aid in the design of entertainment video games, although not specifically in the context of mobile environments or serious games. However, since mobile serious games are a subset of video games, these heuristics can serve as a springboard when developing heuristics in this context. For example, Korhonen and Koivisto (2006) developed playability heuristics for mobile entertainment games, which were expanded on by Zaibon and Shiratuddin (2010) to include mobile educational games.

Annetta, Lamb and Stone (2011) developed a rubric, which describes fifteen elements that should be considered in the design of serious games. Although the findings have a strong focus on learning theory, the results are still relevant from a UX perspective, as serious games bring together aspects from different fields into one cohesive product.

Jørgensen (2012) explores the personal and subjective experiences of expert players in the pursuit of understanding game dynamics and game design choices. While her research focused on commercially available entertainment titles, the phenomenological approach used is applicable to investigate serious games as phenomena experienced by those who play them.

3. RESEARCH DESIGN AND METHODOLOGY

Similar to Jørgensen's (2012) qualitative approach to investigating game systems, the researchers assumed that to gain an understanding of serious games, it is imperative to explore the experiences that players have when they play serious games and how they interpret these experiences. Through analysing how players made sense of their experiences, the researchers gained a better understanding of which aspects of serious games players were considered the most influential to their experience. In turn, the researchers aimed to identify and describe HCI principles relevant to the UX evaluation of serious games from the aspects that emerged from the data analysis.

Given the subjective nature of how individual participants experience playing a video game, the researchers used interpretative phenomenological analysis (IPA) to explore serious games through the lens of the participants' experiences with these games (Jørgensen, 2012; Smith, Flowers and Osborn 1997). Participants were purposively selected on the basis of having previous experience with playing games on mobile devices (Patton, 2002:273). Each participant played a serious game titled *StoryTimes* (discussed in the next section) and, thereafter, was interviewed by the researchers. Interviews were audio recorded, transcribed and verified with the participants. After five participants were interviewed, data saturation was reached in that no new themes emerged (Saldaña, 2013:222).

In accordance with guidelines provided by Smith, Flowers and Osborn (1997:66) and Biggerstaff and Thompson (2008:221) for conducting IPA research, this research was performed by applying the following four iterative steps after each interview: i) The researchers read through the interview transcripts several times to become familiar with the text and to form a general impression of the participants' accounts and made annotations on the transcript that included the thoughts, questions and reflections of the researchers; ii) the researchers worked through the annotated transcripts again and documented emerging themes. By the end of the study, the researchers identified 35 themes; iii) the researchers searched for connections between the 35 themes and grouped related themes together; and iv) finally, the themes were grouped into seven main clusters. These clusters were labelled and became the seven main themes of this research.

4. DESCRIPTION OF STORYTIMES

StoryTimes is a mobile serious game developed by the Serious Games Institute of South Africa at the North-West University, Vaal Triangle Campus, South Africa in collaboration with Grandmaster of Memory, Kevin Horsley (World Memory Sports Council, 2016). This game allows players to learn the multiplication tables by employing memory improvement techniques such as the Shape Peg Method and the Method of Loci (Bower, 1972:496; Horsley, 2012:9). *StoryTimes* was developed as part of this research to gain a deeper understanding of how HCI is integrated into the development life cycle of a serious game.

In *StoryTimes*, the player journeys around the world to various regions to collect special gemstones. Each region represents a different multiplication table. By completing the puzzles for each region, the player may move on to the next region or level. Figure 1 shows the level representing the eight times table.

Figure 1: The snow setting of *StoryTimes* Level 8

Source: Screenshot from StoryTimes, 2015.

In each level, the player visits 12 locations that represent a multiplication expression. For example, the second location of Level 8 represents the expression 8 x 2 = 16, illustrated in Figure 2. Earlier in the game, the player would have learned to associate various characters with different numbers. For example, the snowman is associated with the number eight, the elephant with six and the pencil with one. At each region, the player is presented with various challenges relating to these 12 locations in order to progress to the next region. Upon completing a region, the player receives a gem as well as a stamp in his or her passport to travel

to the next region. The passport also records the scores that the player obtained for each region.

Figure 2: The pencil and elephant revealed at the second location of Level 8

Source: Screenshot from StoryTimes, 2015.

5. FINDINGS AND DISCUSSION

After analysing the interview data, seven themes emerged that correspond to those aspects that participants considered the most important to their experience with playing the serious game *StoryTimes*.

5.1 The use of technology and convenience of mobile devices

A driving factor for players of serious games is the hardware platform on which games are available. Participants related this with how their children use technology. The participants believed that most children today are very comfortable with using mobile devices, even more so than with the more traditional desktop computer environment.

> *"They like touch screens, they know touch screens. The children are really geared up for these things."*

> *"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."*

Further to being easier to use than other hardware platforms, participants also expressed that mobile devices are more versatile.

> *"Also, when we are travelling on holiday we load games instead of videos on the laptop, which also means that they are learning."*

These remarks indicate that players highly regard the convenience that is offered by mobile devices above other platforms. This corresponds to findings of Burford

and Park (2014:632) that participants enjoy the convenience provided by iPads specifically. Players want games to start up quickly, to be able to switch easily from one application to another and to play games when and where they choose.

5.2 The player's attention

Participants expressed that it is difficult at times to concentrate on a serious game for an extended time and that they may be easily distracted by notifications from their mobile devices or other external events.

> *"...there comes a stage that your concentration levels just begin to fall, where maybe you don't concentrate as fully as you need to."*

> *"...and then an email 'pops'! PING!... and it detracts your attention..."*

Additional to the challenge of keeping the player's attention while playing the game, game developers need to ensure that players' attention is directed to the intended parts of the game, otherwise players may miss important information.

> *"...but actually... I didn't read it... that is why I made mistakes here."*

From the discussion above, it is important for game designers to consider how they will keep players enchanted. This involves enticing players so that they want to return to the game and once inside the game, keeping them captivated and focussing them on the relevant areas. One example of how trending mobile games such as *Plants vs. Zombies* (PopCap Games, 2010) and *Clash of Clans* (Supercell, 2012) accomplish this, is to use push notifications to alert players that new content or surprises are waiting for them in the game.

5.3 Player feelings toward subject content

Serious games vary from other video games in the sense that they contain learning material that developers wish to convey to the player. Participants agreed that the context in which learning takes place is very important. They felt that learning takes place more effectively in a relaxed environment where they can learn by playing.

> *"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."*

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

These comments relate to what Annetta (2010:110) refers to as stealth learning. He believes that serious games are most effective when players do not realise that learning is taking place. Participants also suggested that the game world could provide opportunities for incidental learning. Incidental learning refers to acquiring knowledge that is not explicitly taught, but obtained through contextual cues (Rieber, 1991:322; Rosas et al., 2003:77).

The researchers concluded from the above that players want to learn effortlessly and without really realising they are learning.

5.4 Player feelings towards in-game challenges

The need to be motivated throughout the game was mentioned regularly by participants. Many participants reminisced how teachers reprimanded them in school when they did not know or struggled with the learning material. This caused them to have negative associations with learning material, negatively affecting their learning. Participants felt that games should avoid giving negative feedback and rather provide encouragement, if a player struggles.

> *"...but one can sort of motivate him with 'Well done!' Especially if he gets stuck...because he may really not know the answer."*

Participants insinuated that positive feedback could take the form of rewards and that rewards motivated them to continue playing the game. This conforms to Prensky's (2001:135) argument that players will more likely continue to play a game if they receive frequent rewards as opposed to penalties.

> *"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."*

Some participants also indicated that they want more quizzes in the game and an opportunity to revisit previously completed quizzes. Allowing players to revisit previous challenges enables them to practice and improve their skills (Prensky, 2005:113).

> *"I wonder, could you do that quiz again and change your marks?"*

These observations strongly suggest that when players are confronted with in-game challenges, the game should provide them with positive encouragement if

they struggle, reward them if they successfully complete challenges and allow them the opportunity to revisit challenges to practise their skills.

5.5 The players' feeling towards the game world

Participants discussed the experiences they had with the different sensory elements that make up the world in which the serious game takes place.

> *"Kids love loud tablets. Loud everything, loud radio, loud tablet, loud television."*

> *"I think the characters... they are very cute, yes, they are lively."*

One of the participants suggested that using audio and visual elements in the game enforces knowledge transfer of subject content.

> *"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."*

From these remarks, it was apparent that players enjoy being part of the game world using as many of their senses as possible. Participants pointed out colours, sounds, music and animation as all playing a vital role in being immersed in the game. These remarks of using audio and visual elements in a serious game are consistent with findings from Malone (1980:70), who indicated that visual and audio elements can be used in a game to enhance fantasy, as reward and to convey information.

Furthermore, participants also indicated that they want to know how they were progressing within the game world, both in terms of the game story and the learning content. Consistent with Prensky (2001:121), participants expressed that they enjoy knowing how far they have progressed regarding the storyline of the game and how far they still need to go before finishing or winning the game.

> *"The little diamonds, it gives you progress, you can keep track of where you are."*

> *"And what is nice then is that it goes on to the next adventure."*

Participants also indicated that being provided with relevant feedback about how they are progressing with the learning content is equally essential. This is congruent with Annetta's (2010:107) statements regarding feedback in games.

> *"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."*

The researchers concluded that relevant feedback regarding progress with the game storyline and the learning content is vital for a serious game.

5.6 Assistance with serious games

Participants felt that the game should provide adequate assistance and they appreciated the guidance provided in the game. Guidance in this context relates to both assistance with navigating the game world and with solving the puzzles in the game.

> *"I think for a small child... the game explains well how you must do it..."*

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

Some participants argued that it may even be preferable to have facilitators available to provide guidance when playing serious games, especially were children are the target audience.

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

One participant mentioned that the game should be designed to automatically determine the progress of the player to provide relevant guidance for the player.

> *"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."*

These statements led the researchers to conclude that a serious game should provide relevant guidance whenever the player requires it.

5.7 Challenges associated with a wide target audience

A significant aspect of serious games that surfaced during the interviews was the challenge of adapting the game to suit each individual player's unique

characteristics. Participants pointed out that players differ in terms of gender, age, playing style and skill level and that these greatly impact the gaming experience.

> *"...where...if you are older, one tends to want it to go faster."*

> *"So I think one must sort of see if you can skip quizzes...certain levels."*

> *"And you cannot make it too girly or too boyish..."*

This also ties in with the previous theme discussing how much guidance should be given by the game. Players with different skills will need different levels of guidance to ensure that either they find the game too easy and become bored or too hard and give up.

> *"...or a grade 1 child. I mean he won't be able to do all those quiz levels."*

> *"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..."*

As discussed by Prensky (2005:111), serious games differ from other video games in that their target market usually is very diverse and needs to cater to the different playing styles of the players in order to be successful. Other gaming titles have target audiences that usually are more homogenous; for example, *FIFA 16* (EA Canada, 2015) caters to competitive, action-oriented individuals while gaming titles such as *The Witness* (Thekla, Inc., 2016) focus on exploration and puzzle solving. Incorporating elements to accommodate different playing styles based on existing taxonomies such as Bartle's (2004:131) four playing styles may allow players to better identify with the game and find it more interesting since it caters to their own style of play.

Annetta (2010:109) suggests that artificial intelligence may play a prominent role in adapting a game to the distinct preferences of a player. Law and Sun (2012:479) agree that being able to personalise a game gives rise to a more positive UX. From the above discussion, it is apparent that players want their personal preferences to be accommodated in a serious game.

From the themes discussed above, ten heuristics to guide developers with the design of effective and fun serious games were formulated. The themes and corresponding heuristic with a brief description are summarised in Table 1.

Table 1: Ten heuristics for evaluating the UX of a serious game.

Related Theme	Heuristic	Description
The use of technology and convenience of mobile devices.	Players want convenience.	The game is easy to access; starts quickly and can be played anywhere. The player can easily switch between the game and other activities.
The player's attention.	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.
The player's feelings toward subject content.	Players want to learn without effort.	Players *"forget"* that they are learning. The game incorporates incidental learning.
The player's feelings toward in-game challenges.	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.
The player's feelings toward the serious game world.	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.
Assistance with the serious game.	Player's want guidance.	The game provides guidance on how to play it. Players can request additional guidance if they struggle.
Challenges associated with a wide target audience.	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.

Source: Researchers' own

5. LIMITATIONS AND IMPLICATIONS FOR FUTURE STUDIES

This research investigated the experiences that participants have with serious games and did not evaluate the serious game *StoryTimes* in terms of pedagogical effectiveness. This aspect may be investigated further in future studies to determine if *StoryTimes* is effective in teaching players to learn their multiplication tables.

Since every player has a unique level of skill, the player must be able to change the difficulty level of the game to match his or her own skill level. While the difficulty setting in most games can be set manually, investigating how a serious game can automatically adapt to the player's skill without the player having to explicitly set the difficulty level, could be pursued.

StoryTimes does not have a multiplayer component. With technology and the Internet moving us to being a constantly connected society, research evaluating players' experience of multiplayer serious games using IPA could be worthwhile.

This research indicates that using IPA as a methodology to investigate the UX of serious games may provide conclusions that are in agreement with existing design guidelines for serious games. Additionally, the manner in which IPA was applied in this research provided a unique insight into serious game development: IPA with idiographic inquiry typically would require the participants of the study also to be the target users of a serious game. Yet, in this research, it was adults who provided insight into the UX, albeit through the eyes of their children. In other words, even though the game was designed for children, parents were able to provide suitable serious game design guidelines. The practical value lies in eliminating multiple ethical dilemmas associated with child-participant research and provides an avenue for further research.

6. CONCLUSION

This research focused on how players experience serious games by taking an interpretative research approach. Interviews were conducted with five participants after each played a section of a serious game called *StoryTimes*. Analysing the data using IPA as methodology, aspects of the serious game that players regarded as the most important to their experience were identified. These themes were recast into ten heuristics that developers may use to create serious games that are both fun to play and promote effective learning through positive user experiences.

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