

# **Characterising HCI principles for evaluating the user experience of a serious game**

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degree Magister Scientiae in Computer Science at the Vaal  
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April 2016

It all starts here <sup>™</sup>

## Declaration

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I declare that **Characterising HCI principles for evaluating the user experience of a serious game** is my own work, that all sources used or quoted have been identified and acknowledged by means of complete references and that this dissertation has not previously been submitted by me for a degree at any other university.

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April 2016

## Letter from the Language Editor

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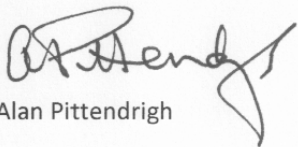
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5 November 2015

To whom it may concern

This is to confirm that I, the undersigned, have language edited the completed research of L. Fitchat for the Master's dissertation entitled: *Characterising HCI principles for evaluating the user experience of a serious game*.

The responsibility of implementing the recommended language changes rests with the author of the dissertation.



Dr Alan Pittendrigh

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## Abstract

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Serious games as a viable learning medium have been documented in the literature. The challenge for serious game developers is to put careful thought into the design of these types of video games so as to deliver fun and engaging learning experiences. Knowledge from the field of Human-Computer Interaction (HCI) provides the foundation for investigating relevant principles to guide developers in evaluating the user experience (UX) of a serious game. User experience relates to how an individual perceives and responds to the use or anticipated use of an interactive system such as a serious game. These perceptions are unique to every individual and thus the UX of a serious game is regarded as highly subjective.

Due to the subjective nature of UX, this research employed interpretative phenomenological analysis (IPA) as a research approach. IPA is a qualitative research strategy grounded in phenomenology and hermeneutics with a focus on idiographic inquiry.

Semi-structured interviews were conducted to gather rich qualitative data on the experiences of participants regarding serious games. During the interviews, participants were introduced to a serious game called *StoryTimes*, which is based on memory improvement techniques to help students learn the multiplication tables. *StoryTimes* was developed as part of this research to better understand how HCI principles are applied during the development cycle of serious games.

A double hermeneutic process was used to analyse the interview data. The analysis provided understanding in how participants gave meaning to those aspects of serious games that they consider to be the most important to their gameplay experience. Interview transcripts were read multiple times and annotated after which emerging themes from the comments and annotations were documented. Connections between themes were investigated, resulting in themes being clustered together. The clusters of themes represent the aspects that participants felt were the most influential in their serious gaming experiences. From these main themes, a set of HCI principles relevant to the UX evaluation of serious games was characterised.

**Keywords:** Human-Computer Interaction, user experience, serious games, interpretative phenomenological analysis

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## List of Abbreviations

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|      |                                          |
|------|------------------------------------------|
| AI   | Artificial Intelligence                  |
| ATM  | Automatic Teller Machine                 |
| CAD  | Computer Aided Design                    |
| DGBL | Digital Game-Based Learning              |
| GSM  | Global Systems for Mobile Communication  |
| HCI  | Human-Computer Interaction               |
| HE   | Heuristic evaluation                     |
| IPA  | Interpretative Phenomenological Analysis |
| MOL  | Method of Loci                           |
| PIN  | Personal Identification Number           |
| PX   | Player experience                        |
| SDLC | Software Development Life Cycle          |
| SEG  | Serious Educational Game                 |
| UX   | User Experience                          |

# 1 Introduction and Problem Statement

---

## 1.1 Introduction

The purpose of this research is to describe Human Computer Interaction (HCI) principles that are relevant to evaluate the user experience of serious games. Ulicsak and Wright (2010:27) define serious games as digital games with an educational intention of teaching specific predefined skills and knowledge. Wrzesien and Raya (2010:179) indicated that serious games provide a powerful and effective learning environment. Serious game designers have to make careful design decisions so as to develop a game that is at the same time both entertaining and instructional for the game players. To get this delicate balance right and develop serious games that provide reliable learning, is regarded by many as the “*Holy Grail*” of education (Prensky, 2005:109). This research explores HCI in an attempt to describe principles that could guide designers to create better serious games. HCI is a well-known multi-disciplined field which focuses on the interaction between humans and interactive systems, such as mobile devices. Dix *et al.* (2004:4) state that “*HCI involves the design, implementation and evaluation of interactive systems in the context of the user’s task and work*”.

## 1.2 Human-Computer Interaction

The aim of HCI practitioners, is to design systems in such a way that users can complete their tasks as effortlessly as possible (Huang, 2009:236). Dix *et al.* (2004:5) list three broad criteria a system has to adhere to for it to be considered successful: i) a system must do what is required by the user, ii) be easy and natural to use and iii) be appealing to the user. These three aspects relate to the usability of the system. Determining how the user perceives these three criteria forms part of a facet of HCI called user experience. User experience (UX) is defined in the ISO 9241-210 (2010) as “*a person’s perceptions and responses that result from the use or anticipated use of a product, system or service*”.

Numerous principles have been constructed to guide developers in the creation of computer systems that provide positive user experiences, such as those developed by Shneiderman (1992:60), Nielsen (1994:115), Dix *et al.* (2004:284) and

Norman (2013:10). HCI as a discipline emerged during the 1970's, a time when people predominantly used computers to run productivity software (Löwgren, 2001:29; Grudin, 2012:11; Carter *et al.*, 2014:28). Since productivity software is task oriented and mostly used mandatorily and in a work setting, classic HCI principles focused extensively on the usability of these types of software, emphasising the tasks and goals that had to be completed or achieved (Dix *et al.*, 2004:732; Jørgensen, 2004:396; Hassenzahl & Tractinsky, 2006:92). Therefore, the usability of software was traditionally determined by objective measurements of user cognition and user performance which for the most part did not consider the user's emotions (Law *et al.*, 2009:719; Carter *et al.*, 2014:28).

Video games, on the other hand, are usually played voluntarily and for enjoyment. As a result of this fundamental difference between games and productivity software, classic HCI principles fall short when applied to video game development (Pagulayan *et al.*, 2002:6; Mandryk *et al.*, 2006:142; Moreno-Ger *et al.*, 2012:2). For example one unit of measurement which is traditionally used to determine the usability of a product is how quickly a user can complete a task. This is not necessarily a valid measure in a game setting, as the goal of a game is often to make it challenging for a player to complete a goal, regardless of the time it might take (Jørgensen, 2004:396; Pinelle *et al.*, 2008:1453). To overcome the limitations of classic HCI, researchers have recently started to focus more intensively on the user experience of video game players (Law & Sun, 2012:479).

Since video games are interactive by nature, different players will have different experiences when playing video games (Jørgensen, 2012:6), rendering the user experience of games highly subjective (Hassenzahl, 2008:12; Law *et al.*, 2009:719). While aspects of classic HCI are still relevant to video games, researchers had to expand on them to answer questions such as "*What makes games fun to play?*" This led to the development of more suitable principles for the design and evaluation of video games (Bernhaupt *et al.*, 2007:309), as well as the development of concepts such as "*player experience*" – user experience in the context of video games (Nacke & Drachen, 2011), Player-Computer Interaction (Carter *et al.*, 2014:27) and playability heuristics (Korhonen & Koivisto, 2006:29).

### 1.3 Serious games

Serious games may be considered a subset of video games with the added dimension of imparting some form of real-life knowledge (Zyda, 2005:26). Areas where serious games have been used include training, advertising, education and health (Raybourn, 2014:472).

In an educational setting, the intrinsic fun and excitement provided by serious games may allow students to be more motivated to comprehend subject matter or improve certain skills (Prensky, 2005:98). Serious games played in an educational context are often referred to as serious educational games (SEGs) (Annetta *et al.*, 2011:75). Incorporating these games into a learning environment is known as digital game-based learning (DGBL) (Prensky, 2005:97; Van Eck, 2006:6). Serious games allow knowledge to be conveyed in an interactive way, unlike traditional non-digital methods. Paper posters, such as those found in classrooms throughout the world, are paper-based visual aids useful in presenting information (Çetin & Flamand, 2013:52). One disadvantage of paper posters is that there is no interaction with the user or learner. The flow of information is one way – the user views and reads the poster passively to absorb the information presented on the poster. Serious games elicit interaction and active participation from users and may be more engaging and motivational than methods using passive means of transferring information (Prensky, 2005:101).

### 1.4 Problem statement

Even though a considerable body of literature is available on the impact and effectiveness of SEGs in imparting subject knowledge to students (Kebritchi *et al.*, 2010:427; Wouters *et al.*, 2011:742; Shin *et al.*, 2012), authors such as Young *et al.* (2012:80), Mayer *et al.* (2014:504) and Egenfeldt-Nielsen *et al.* (2013:241) found the literature still limited or inconclusive. Even so, ongoing research in this field resulted in the development of frameworks, theories and models that could be applied when designing, developing and assessing SEGs. Examples include the Game Achievement Model (Amory & Seagram, 2003:206), the Game Object Model II (Amory, 2007:54) and the Serious Educational Games Rubric compiled by Annetta *et al.* (2011:91).

From the above it is apparent that serious games exhibit additional dimensions that need to be considered when evaluating user experience. For example, the target audience of a serious game may consist of groups both familiar and unfamiliar with the content or even playing video games. Research on framework development for evaluating user experiences in serious games include studies by Nacke *et al.* (2010:5) and Law and Sun (2012:480). Law and Sun (2012:478) believe that a comprehensive understanding of UX evaluation of serious games is still highly anticipated.

Developing serious games for mobile platforms such as wearable devices, mobile phones and tablets brings further challenges that need to be considered from a UX point of view. Aspects like interface designs for various mobile screen sizes, battery life, power consumption, and diverse user bases (Huang, 2009:237-240) need to be addressed. Korhonen and Koivisto (2006:10) point out that even though several models were developed to evaluate user experiences of games, they found them inadequate to some extent when applied in a mobile context. Engl and Nacke (2013:83) and Shiratuddin and Zaibon (2011:89) also share the sentiment that research on the user experience of games for mobile platforms is limited.

Considering the literature above, the problem statement for this study is defined as follows:

Serious game designers need a set of HCI principles to guide the user experience evaluation of serious games.

## **1.5 Research objective**

In light of the limitations pointed out in the literature and the subsequent problem statement of this research, the objective of this study is to describe HCI principles that can be used to evaluate the user experience of a serious game.

## 1.6 Research questions

In order to reach the above research objective, the following research questions have been formulated.

- Which aspects of a serious game do players find the most influential in their experiences with serious games?
- 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?

## 1.7 Research framework

This research is based on the theoretical framework for qualitative research design (Myers, 2009:6) as summarized in Figure 1.1 and illustrated in more detail in Figure 1.2.

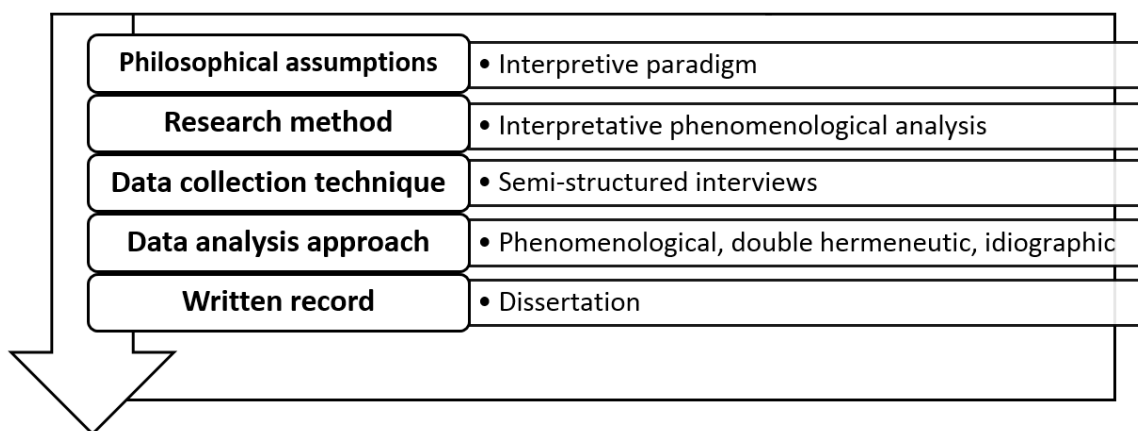


Figure 1.1: Research design summary (Myers, 2009:6).

Since the research revolved around investigating people's interaction and experiences with serious games, this study took a qualitative approach from an interpretivist perspective (Klein & Myers, 1999:69) and used interpretative phenomenological analysis (IPA) (Smith *et al.*, 1997; Finlay, 2009:8) as a research method. This research reports on the literature study that was conducted which led to the formulation of the research questions and the ensuing empirical study which addressed these questions.

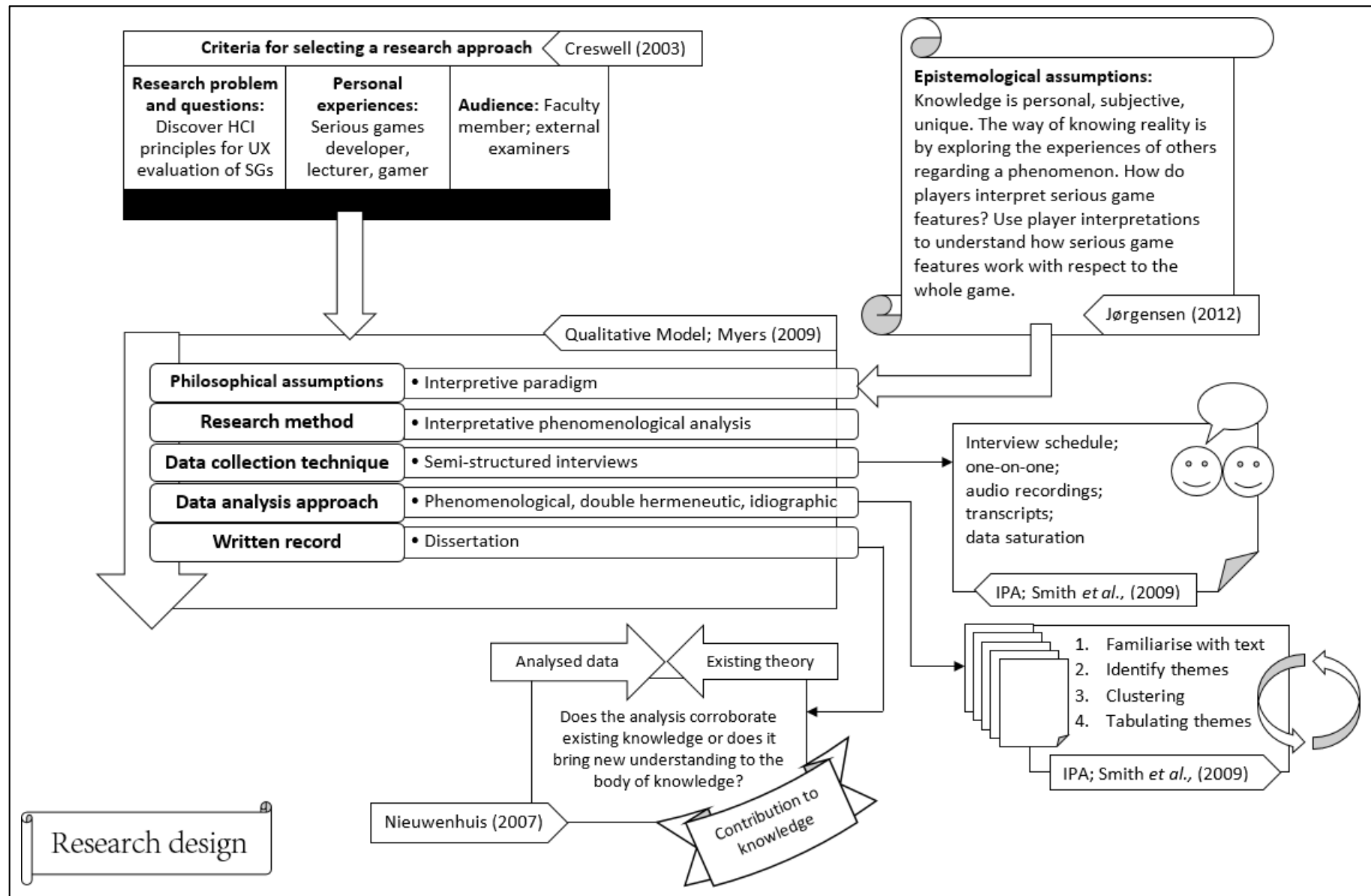


Figure 1.2: Research design for this study.

### **1.7.1 Literature study**

A study of existing literature was conducting at the onset of this research which identified gaps in the knowledge base and resulted in the research questions being formulated. This research presents the literature study to give context to the research questions.

### **1.7.2 Empirical study**

To address the questions posed in this research, an interpretative phenomenological analysis study was conducted. This allowed the researcher to explore how people make sense of their experiences with serious games. This empirical study comprised the following methodology dimensions.

#### **1.7.2.1 Participants and participation selection**

The selection of participants for this research was done through purposive sampling. This sampling approach allows researchers to select participants who can provide rich information regarding issues pertinent to the research (Patton, 2002:273). The serious game that would be played by participants was developed with pre-school and primary school children in mind. Therefore, parents with children in this age range were invited to partake in this study to explore their experiences and perceptions of the serious game. The researcher surmised that adults would be able to better articulate their thoughts than children and would thus be a good starting point to investigate the user experience of serious games.

#### **1.7.2.2 Data collection methods**

The user experience of a serious game is regarded as very subjective (as discussed in Chapter 2). Therefore, semi-structured one-on-one interviews were conducted as these might provide rich data and valuable insights into participants' personal experiences of using serious games.

Interviews were conducted until data saturation was reached (Guest *et al.*, 2006:65), meaning until no new information emerged during data analysis (Saldaña, 2013:222). Data was gathered by audio recording these interviews and transcribing the relevant sections. The interview guide for the semi-structured interviews was developed based on the review of the literature.

### **1.7.2.3 Data analysis methods**

The data gathered from the interviews was qualitatively analysed. The aim of qualitative data analysis is to identify underlying themes, which are common patterns, topics or regularities which may manifest through the process of data coding (Miles & Huberman, 1994:57). Data coding entails labelling sections of the transcriptions to organise these sections from which themes may emerge and conclusions can be drawn (Miles & Huberman, 1994:56). The data analysis approach used in this research is discussed in more detail in Section 3.6.

### **1.7.2.4 Rigour and evaluation of method**

Shenton (2004:63) provides strategies for achieving trustworthiness of qualitative research, as discussed in Section 3.7. The trustworthiness of this research was ensured through participant verification, as explained in Section 5.5.

## **1.8 Ethical considerations**

This research study conformed to the generally accepted ethical principles of academic research, discussed in Chapter 3. The ethical aspects that have been taken into consideration for this study include the following.

- Obtaining the informed consent of participants to conduct the study.
- Assuring individuals that participation is voluntary and that they are free to decline or withdraw from the study at any point without any negative consequences.
- Contacting participants to decide on convenient days and times during July and August 2015 to conduct the interviews.
- Treating all information provided by participants as confidential.
- Protecting the identities and interests of the participants.

## **1.9 Chapter classification**

This dissertation comprises the following chapters:

### **Chapter 1: Introduction and background to the study**

The scope, problem statement and the objectives of this research were presented in Chapter 1.

### **Chapter 2: Literature Study**

Chapter 2 will discuss the problem statement in greater detail and also provide the framework in which the research questions are based.

### **Chapter 3: Research Design**

In Chapter 3, an account of three major research paradigms will be given. The methodology and procedures employed in this research to address the research questions will be presented.

### **Chapter 4: Prototype Design**

Chapter 4 will present a discussion of the prototype of the serious game that was developed for this research.

### **Chapter 5: Data Analysis and Discussion**

Chapter 5 will provide an analysis and interpretation of the empirical findings.

### **Chapter 6: Conclusions and Recommendations**

The closing chapter will provide a summary of the research and provide recommendations for future research.

## **1.10 Conclusion**

This chapter served as an introduction for this research. A brief introduction of human-computer interaction and serious games led to the problem statement, research objective and research questions. Furthermore, the research design and ethical considerations for this study were discussed. Finally, the chapters of this dissertation were outlined.

## 2 Literature Study

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### 2.1 Introduction

This chapter presents a detailed review of available and relevant literature to provide the context within which this research is performed. In this chapter, the topics of human-computer interaction (HCI), user experience, video game design and serious games will be discussed. HCI focuses on the design of interactive systems so that users can effectively, efficiently and satisfactorily complete their tasks. Within the field of HCI, user experience refers to how users perceive their interactions with the system. Video games also need to adhere to HCI principles to ensure that players stay captivated and have fun while playing. Serious games are a subset of video games, with the added dimension of enabling some form of knowledge transfer. HCI principles are at present being adapted and extended to apply to serious games to ensure that these games strike a balance between being fun to play and being instructive.

### 2.2 Human-Computer Interaction

Technology has evolved to such an extent that it is no longer a question of what technology is able to do, but what users want to do, since technology can now offer almost unlimited processing capabilities (Smith-Atakan, 2006:4). It should no longer be assumed that users have to adapt to technology; rather, technology is expected to adapt to fit the user's needs (Hassenzahl, 2008:11). The field of Human-Computer Interaction (HCI) concerns the design of interactive systems where importance is placed on the people using these systems and how people are affected by interacting with these systems (Dix *et al.*, 2004:192).

Smith-Atakan (2006:4) defines an interactive system as a technological system that requires interaction with users. Interactive systems have forged their way into everyday activities and examples of these systems include automatic teller machines, cars, vending machines and cell phones.

Models describing the interaction between users and systems include Norman's execution-evaluation cycle and Abowd and Beale's interaction framework (Dix *et al.*, 2004:125-127). The interaction framework, depicted in Figure 2.1, identifies four major

components for interactions, namely the user (U), the system (S), the input (I) and the output (O), which each have their own respective language.

The input and output components collectively form the interface (Abowd & Beale, 1991:75). The interface can be seen as the layer that allows the user and the system to communicate with each other and mediates the flow of information from the one to the other (Löwgren, 2001:31; Huang, 2009:236).

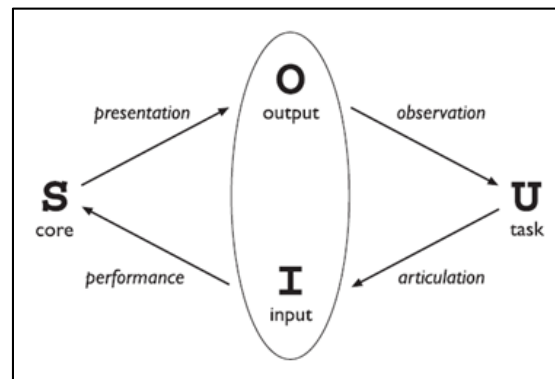


*Figure 2.1: Abowd and Beale's (1991:75) general interaction framework.*

According to the interaction framework, an interaction between a user and system occurs as a four step cycle. The four steps correspond to the translations from one component to the next, labelled articulation, performance, presentation and observation. The cycle progresses in the following manner.

In order to achieve a goal, the user must perform a task or series of tasks. A task is formulated in the user language, also referred to as the task language. To confer instructions to the system, the task needs to be articulated in the input language. The input language is translated to the system's language, or core language. The core language can be seen as a list of instructions that the system needs to execute. Once the system completes this process, the system's new state is translated into the output language. Finally, the user observes the output and translates this into personal understanding.

The dynamics between an interactive system and the user can be illustrated through a well-known example – the vending machine.

The vending machine is the interactive system. The user is the consumer who wants to interact with the vending machine to accomplish some goal, in this case, to buy a

can of cool drink to quench his thirst. The first task the user needs to perform, is indicating the desired cool drink. This is translated into an input language by pressing the appropriate button to select the item to buy. The press of the button is translated to the core language, which instruct the system to retrieve the cost of the selected item from its memory. The response of the system, in this case the number representing the cost of the item, is translated to an output language as a currency value displayed on an LCD screen. The user observes this output and makes the conclusion that the item was successfully selected. The user now proceeds to the next task – paying for the item – in order to complete his overall goal. This task is again articulated into the input language of inserting coins into the slot of the vending machine. The input component translates this into the core language, instructing the vending machine to determine the value of the coin and if it is acceptable and determine how much money is still owed. The system response – the amount still owing – is translated into the output language, where the output component displays the remaining money to be paid on the screen. The user observes the output and translates it into the task language and an understanding that more money needs to be paid to get a cool drink. This interaction cycle is represented in Figure 2.2.

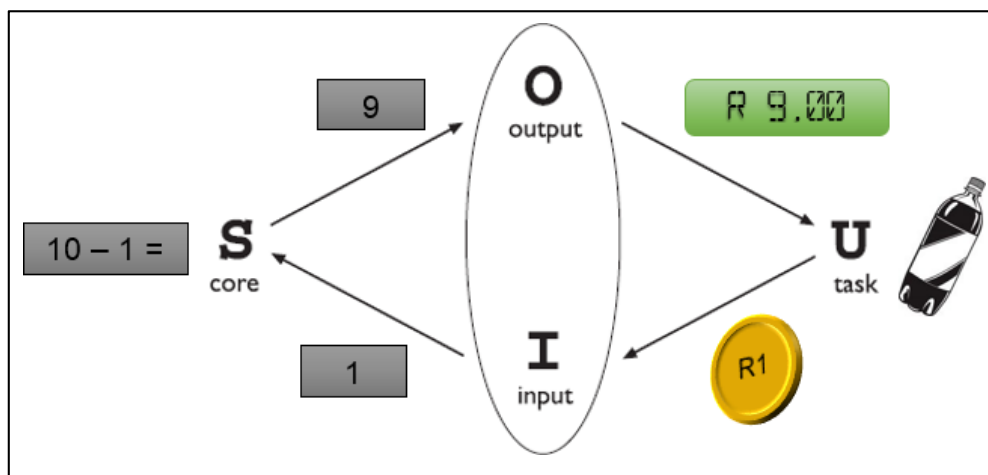


*Figure 2.2: An example of an interaction cycle.*

The user continues inserting coins into the machine until there is sufficient money paid. Once the system determines that the item is paid in full, the response is translated again into the output language. In this case, the output translated to dispensing the cool drink from the machine. The user observes this output and by collecting and drinking his cool drink, completes his desired goal.

Interactive systems do not only include physical systems that provide a single function, like the vending machine. Personal computing devices, such as desktop computers, laptops and mobile devices, are multi-functional interactive systems in the sense that a user can accomplish a wide range of tasks depending on the software available on them (Rogers *et al.*, 2011:6). Computer software has become pervasive, as can be seen in the mobile applications that allow cell phones to be used, among others, as diaries, timers, cameras, banking facilities and gaming consoles (Pressman, 2010:3; Rogers *et al.*, 2011:6; Norman, 2013:109) with new applications being released daily on app stores such as the Google PlayStore and the Apple iTunes store.

It is important for HCI practitioners to put careful consideration into the design of software systems and the possible interactions that can take place in order to provide a positive experience for the user while reducing negative experiences (Rogers *et al.*, 2011:2). Therefore, they must have an understanding of interactive computer systems on the one hand and the human user on the other. Because of this, HCI draws knowledge from many other disciplines, including psychology, cognitive science, sociology, ergonomics, computer science and engineering (Huang, 2009:236). For the most part, designers of interactive systems are interested in knowing how to apply the theories from these different disciplines, although they might not necessarily need an in-depth understanding of the theoretical aspects of them (Dix *et al.*, 2004:4-5). While a unifying framework for interaction design does not exist yet, there are numerous research results available to guide the successful design of the interaction (Dix *et al.*, 2004:5; Hassenzahl, 2008:11; Rogers *et al.*, 2011:15).

## **2.3 User experience and usability**

Dix *et al.* (2004:5) list three broad criteria a system must adhere to for it to be considered successful: i) a system must do what is required by the user, ii) be easy and natural to use and iii) be appealing to the user. Smith-Atakan (2006:9) lists a fourth criteria: the system must be used by the full range of all intended users, regardless of issues like disabilities, past experience or working conditions.

The above criteria relate to the definition of usability put forth in the ISO 9241-11 (1998), which states that usability is the “*extent to which a product can*

*be used by specified users to achieve specified goals with i) effectiveness, ii) efficiency and iii) satisfaction in a specified context”.*

Traditionally, HCI practitioners were mostly concerned with the usability of a system (Rogers *et al.*, 2011:18; Carter *et al.*, 2014:28). The usability of a system relates to *what* a user interacts with in a system and *how* the user interacts with the system. Usability is strongly related to the interface of the system since it is on this level that communication and interaction between the user and the computer takes place (Löwgren, 2001:32).

The focus of HCI has shifted in recent years, however, to also include the user's emotions and perceptions while using a system (Law & Sun, 2012:479; Carter *et al.*, 2014:28). User experience (UX) is defined in the ISO 9241-210 (2010) as *“a person's perceptions and responses that result from the use or anticipated use of a product, system or service”*.

Hassenzahl and Tractinsky (2006:95) believe that UX is the result of the interplay between three perspectives, namely the user's internal state such as mood, motivation and expectations, the properties of the system, such as its usability and purpose, and thirdly the context in which the interaction occurs.

Both usability and UX are closely linked. Bevan (2009:3) identifies three different views on the link between usability and UX: i) User experience is an extension of the satisfaction criteria of usability, ii) user experience is completely subjective and incompatible with the objective measures of usability, iii) user experience subsumes usability. This research embraces the same view as that of Law and Sun (2012:480) wherein UX encapsulates usability. As Rogers *et al.* (2011:18) state that *“usability is fundamental to the quality of the user experience”*. In other words, if the usability of a system is lacking it will negatively affect the UX of the system. The converse might not necessarily be true, that is, a system might conform to all usability principles but the UX may still be negative. This perspective resembles that of the analogy by Hassenzahl and Tractinsky (2006:95) where usability problems are likened to an illness and UX to that of wellbeing. The absence of an illness does not necessarily mean that one is well, as there is more to wellbeing than the absence of an illness.

If the integration of core human needs (e.g., protection, leisure, creation, identity and understanding) with the technical aspects (the hardware and software) of computer devices are carefully considered throughout the development of the system, users may experience delight and feel empowered when interacting with their devices. For computer software systems, this means HCI approaches must be incorporated into the entire development life cycle of the software to design for a positive UX and ensure the success of the software (Zhang *et al.*, 2004:574).

## **2.4 Integrating HCI into the software development life cycle**

Rogers *et al.* (2011:332) and Dix *et al.* (2004:195) provide simple models for the process of interaction design. Both of these models include four main activities.

The first activity is characterised by establishing user requirements. In order to design a system to support users, designers must first determine who these users are and what their needs are. This can be done by interviewing users and observing how they are currently performing their tasks. In the next activity, designers formulate ideas and possible solutions that will meet the needs of the users. The third activity entails prototyping of the system. Designs are rarely ever perfected after the first attempt (Rogers *et al.*, 2011:329). It is therefore important to continually allow users to test the design and give feedback to the designers. This can be done through prototyping, where the system, whether as conceptual models or in a working form, is presented to users. The last activity involves the analysis and evaluation of the users' interaction with the prototype and their subsequent feedback. This allows designers to determine where improvements to the system can be made and to gain further insights into the needs of the users. The designers repeat the process of designing, prototyping and evaluation until the user's requirements are satisfactorily fulfilled. The process of designing interactive systems is therefore iterative, as shown in Figure 2.3, and continues until the system reaches its final version.

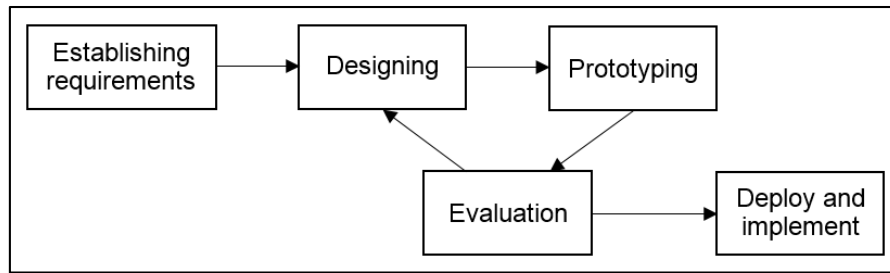


Figure 2.3: A simple interaction design process model adapted from Rogers *et al.* (2011:332) and Dix *et al.* (2004:195).

This interaction design process cannot occur in isolation and its implementation is usually shaped by the type of interactive system being produced. The systems of interest for this research are video games and specifically serious games. Therefore how the interaction design process can be incorporated into software development life cycles within the software engineering discipline is explored next.

Within the computer software engineering field, developers often implement a software development life cycle (SDLC) model to manage their projects more effectively. These models divide the different development activities into various stages. There are many different SDLC models available, with different strengths and weaknesses to suit different types of software projects.

Well-known SDLC models include the Waterfall model, the Spiral model and the Agile model (Pressman, 2010:39,45,66). While the Waterfall model suggests a sequential approach to software development, as illustrated in Figure 2.4, Agile models place importance on iterative approaches.

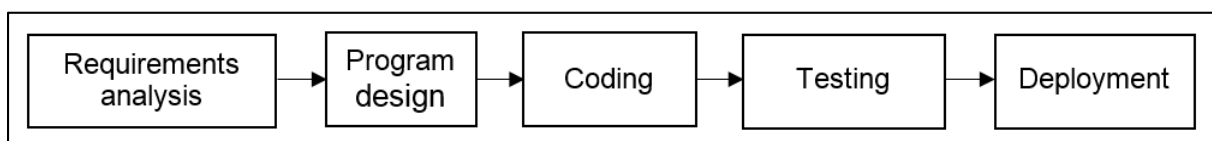


Figure 2.4: The Waterfall model as described by Cohen *et al.* (2004:3).

As argued by Beck (1999:70), Cohen *et al.* (2004:3) and others, a downside of the Waterfall model is that it assumes that the requirements of the users can be known completely before the start of the design stage of the project. Furthermore, there is usually extensive documentation and long development cycles involved throughout the process. The linear structure and rigidity of the waterfall method makes it extremely

difficult and usually expensive to incorporate changes into the system. While the waterfall method and its variations are suitable for some software projects, alternatives to this method were developed to better accommodate inevitable changes to the system. Changes may occur as a result of customers who change their minds mid-way through the project on what their needs are, the rapid change of technology or updates to business rules. These reasons brought rise to various development processes employing the Agile model. In an attempt to respond to changes, the Agile model suggests an iterative approach to software development where development teams collaborate closely with clients. An important aspect of the Agile model is that developers regularly deliver a working piece or prototype of the software to the client. The client evaluates the prototype and provides feedback to the developers. Based on the feedback, appropriate modifications can be made to the system. This cycle of incrementally developing a part of the system, evaluation by the client or user and making changes are performed continuously and forms the basis of agile methods, illustrated in Figure 2.5. The human-centric focus of the Agile model on individuals, interactions, collaboration and change makes it a good fit with the interaction design model presented earlier. Research into holistically merging HCI with software engineering – and Agile methods in particular – is ongoing (Rogers *et al.*, 2011:342; Ferreira *et al.*, 2012:11).

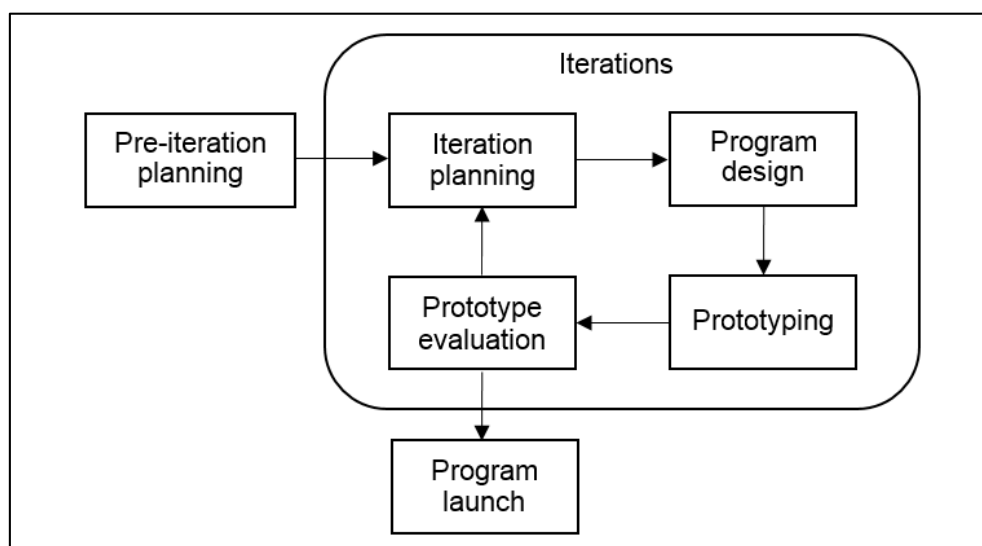


Figure 2.5: A basic agile development process for software development.

Throughout the software development process, HCI practitioners work closely with the rest of the development team and the clients until the final version of the software program is complete. To aid them in creating successful software, HCI practitioners can make use of a wide variety of existing design rules to make design decisions throughout the development process. These interaction design rules are the focus of the next section.

## 2.5 Design rules

HCI practitioners and developers use design rules to guide them in designing a positive UX of interactive systems (Dix *et al.*, 2004:259). Three broad types of design rules exist, namely principles, standards and guidelines (Dix *et al.*, 2004:259).

Principles are abstract and general design rules, meaning that they can be applied to a wide variety of design situations. These design principles are mostly derived from research in the fields of psychology, sociology, cognitive science and computer science and tend to be context free (Dix *et al.*, 2004:259; Zhang *et al.*, 2004:576).

Standards are more specific design rules, meaning that they are usually applied in a more focused design situation. Standards are usually set by national or international organisations and are adhered to by large communities. An example of the power of standardisation is found in cell phone design. Since most cell phone manufacturers designed their devices to support Global System for Mobile (GSM) technology, which has been standardised globally, users are able to use their cell phones in most parts of the world (Huurdeeman, 2003:529).

Guidelines are more specific than design principles but also tend to be more general or abstract than standards (Smith-Atakan, 2006:31). Where the abstract principles are comparable to a philosophy, guidelines are more concrete and provide suggestions on how to adhere to the abstract principles (Dix *et al.*, 2004:279-280). Guidelines are generally created with certain assumptions about the system in mind, and therefore are more specific. For example, if we develop software for a tablet running an Android operating system, it would be beneficial to consider the various guidelines put forth by Google Design (2015).

## 2.6 Design principles

Of the three types of the design rules discussed previously, design principles will be explored in more detail. While there are numerous design principles in the literature (Dix *et al.*, 2004:260; Rogers *et al.*, 2011:26), this research will discuss the authoritative principles framed by Dix *et al.* (2004:260) and Norman (2013:72).

### 2.6.1 Principles to support usability

Dix *et al.* (2004:260) provide a thorough summary of the abstract design principles that are most commonly used. They catalogue these principles into three categories, namely learnability, flexibility and robustness. These principles with examples of how they are applied to software are discussed next.

#### 2.6.1.1 Learnability

Principles falling into the learnability category relate to the ease with which first-time users can learn a new interactive system and how they can achieve their goals most effectively. The principles that affect the learnability of a system are discussed next.

- The principle of predictability is upheld if the previous interaction experience with a system allows a user to determine what the possible actions in the current state of the system are and what effect those actions will have (Smith-Atakan, 2006:31). Another form of predictability is operational visibility (Dix *et al.*, 2004:262). The more visible functions in a current state are, and the more thought went into their placement, the more likely it is that users will be able to find them and know what results these functions will bring about (Rogers *et al.*, 2011:26). Operational visibility also deals with the constraints placed on interactions. The user interface can change to restrict or allow certain interactions to take place (Rogers *et al.*, 2011:27). For example in a word processor, if no text is selected in the document, the copy and cut operations are greyed out, illustrated in Figure 2.6, indicating that the user cannot interact with them in the current situation.

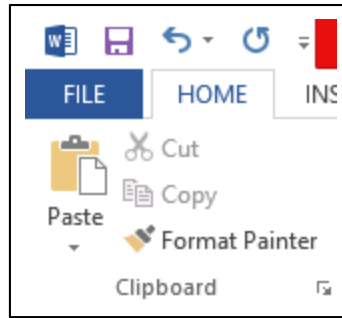


Figure 2.6: Greyed out cut and copy operations.

- The principle of synthesisability refers to the user's ability to assess a previous action's effects on the current state of the system (Dix *et al.*, 2004:262) and his understanding of how these actions resulted in the system reaching its current state (Kristoffersen, 2008:263). If a change occurs in the internal state of the system, it needs to be communicated to the user. An example of how synthesisability is perhaps incorrectly applied is within the EndNote application. Paperclips to the left of reference entries indicate that attachments are available for those entries. After attaching a PDF file to a reference for the first time, a paperclip does not appear. Also, the icon to open the attachment is disabled if the entry is selected. This could confuse first-time users since they may incorrectly conclude that their attempt to attach a file to the entry was unsuccessful.

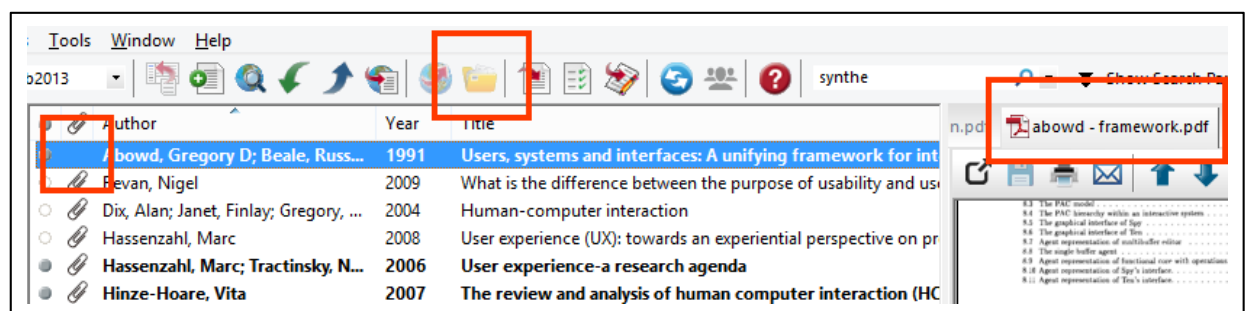


Figure 2.7: An example of the incorrect application of the synthesisability principle.

- The principle of familiarity is concerned with how a user relates an initial interaction with a system to his real world experiences and existing knowledge (Dix *et al.*, 2004:264; Kristoffersen, 2008:264). On a Windows operating system, for example, the file manager uses the well-known filing cabinet as a metaphor for the directory structure on a hard drive. Drives are analogous to filing drawers, directories are

comparable with folders and the files within the directories are analogous to filed papers in a folder. Using the file cabinet analogy, novice users may more readily understand how a computer stores information and how to find and manipulate the files. Windows icons representing directories and files are depicted in Figure 2.8.



*Figure 2.8: Real world metaphors to understand file storage on Windows operating systems.*

A concept that also relates to the familiarity of a system is affordance. Affordance is the relationship between an object and a user that allows a user to correctly deduce or discover how to use the object (Norman, 2013:11). An example of affordance is creating a button for a user interface and giving the button a raised appearance. The user might perceive the raised button as something that can be pushed, like the real life keys on a keyboard. Therefore the raised button on the user interface affords pushing, inviting the user to click on the button.

- The principle of consistency deals with the behaviour of a system when users perform similar tasks (Dix *et al.*, 2004:261). For example buttons on a menu bar are all interacted with by left-clicking on them, and they usually produce similar results by way of displaying a drop down menu with options after being clicked. Also, across a range of Windows applications, the location of the menu bar is consistently located along the top of the application, and more often than not have a File menu and Edit menu to the left and a Help menu as the last item on the menu bar. The Minimise, Maximise and Close buttons for most applications are also consistently found at the top right corner of the application. Consistency can also be achieved if a system conforms to conventions and standards, which can often reduce the time a user needs to learn the new system.

- The principle of generalisability relates to how well a user can apply knowledge of past interactions to similar but new situations. For example, a user knows from previous experience how to select and copy text from a web-browser and pasting it to a document in a word processor. Armed with this knowledge, the user attempts something new by trying to copy an image, instead of text, in a similar manner and pasting it to a document in a paint program. Dix *et al.* (2004:264) state that generalisability is a form of consistency, but Kristoffersen (2008:263) also argues that it is much broader in scope and not confined to functions or components but applied to different situations.

### 2.6.1.2 Flexibility

Flexibility relates to the different ways in which users can interact with a system, the different actions they can take to achieve the same result or goal and how the interaction with a system can be extended (Smith-Atakan, 2006:31). Principles pertaining to the flexibility of a system are discussed next.

- The principle of dialogue initiative relates to the freedom that a user is allowed from artificial constraints in the input dialogue imposed by the system (Dix *et al.*, 2004:266). If the interaction between the user and the interactive system is compared to a conversation between two parties, dialogue initiative relates to who is guiding the conversation. In a system pre-emptive dialog, the system initiates all dialogue and the user only provides responses, which are usually limited (Dix *et al.*, 2004:266). An example of a system pre-emptive dialogue is that used by an automatic teller machine (ATM). If a user wants to withdraw money from the ATM, the system requests information from the user in a structured manner, firstly asking for a personal identification number (PIN) on the first screen. The system moves to the next screen asking the user from which account to withdraw the money, and then asking for the amount of money to withdraw. User pre-emptive dialogue on the other hand gives the user more control over the direction of the dialogue (Dix *et al.*, 2004:267). These systems allow users to stop, pause or continue with any activity at any time. An example of this is a researcher typing a dissertation on a word processor. The researcher has the freedom to work on different sections within the document, use built-in tools such as adding comments and references, printing sections of the document and saving the document. These activities can

be performed in any order at any time, while the intended goal is still achieved. The designer of a system needs to balance the dialogue initiative for an interactive system. While it is desirable to give the user as much freedom as possible, giving the user free reigns might make the user lose track of which tasks need to be initiated, which are in progress and which are completed (Dix *et al.*, 2004:267).

- The principle of multi-threading involves the extent to which a system allows for interactions to support more than one task at a time. Concurrent multi-threading means that tasks can be performed at the same time but in different areas, for example a user can have a word processor open to type a document but also be scanning for viruses on the computer by having an anti-virus package running in the background. Interleaving multi-threading are tasks that appear to happen at the same time and place but input is restricted to one task at a time (Dix *et al.*, 2004:267). Multi-modality is related to multi-threading and refers to how different input and output channels are combined in an interaction. For example, a user who wants to zoom in on an image in Photoshop, can hold down the Alt key on the keyboard while simultaneously scrolling the mouse wheel of the mouse.
- The principle of task migratability applies to how the transfer of control between the user and the system for the execution of tasks is managed (Dix *et al.*, 2004:268; Hinze-Hoare, 2007:11). An example of task migratability is using a word processor's built-in spell checker to search for spelling mistakes in a document. The spell checker automates a task that would otherwise be much more time consuming for the user. As the spell checker searches through the document and finds a possible mistake, control is handed over to the user for the user to decide whether the proposed correction is valid. Once the user makes a decision, control of the task is handed back to the word processor to continue to look for mistakes.
- The principle of substitutivity relates to how the user can perform different actions but achieve the same result (Dix *et al.*, 2004:268). Examples of how the substitutivity principle is applied are using either the mouse or the keyboard to start an application, allowing users to enter values as either inches or millimetres, or copying text using keyboard shortcuts, right clicking the text and using the context menu, or finding the copy option on the menu bar. Substitutivity affects the flexibility

of the system in allowing a user to decide which action is more suitable or comfortable to complete a task (Hinze-Hoare, 2007:11).

- The principle of customisability relates to the extent that the user or the system can modify the interface of the system (Dix *et al.*, 2004:269). Adaptivity refers to the ability of the system itself to make changes to the interface while adaptability is the extent that the user can make the modifications. An example of customisability is the Microsoft Office suit of packages that allows the user to add or remove components and functions from the ribbon. Users can thus remove features they rarely use and add features that they use more frequently to streamline their work.

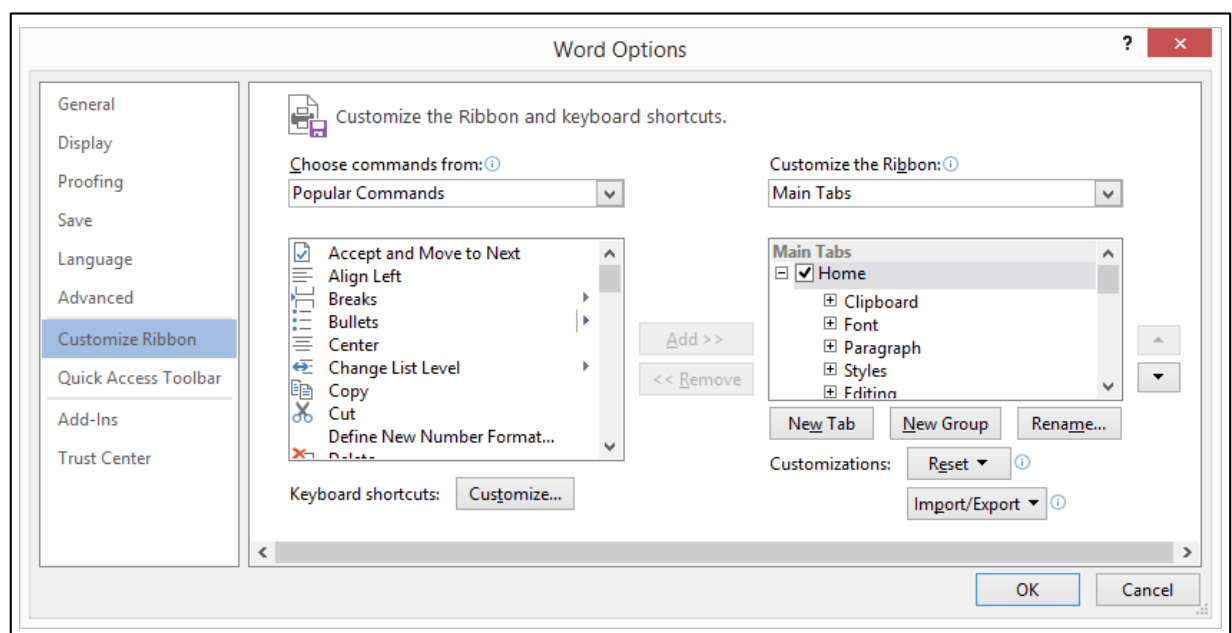


Figure 2.9: The menu bar of Microsoft Word is highly customisable through the Customise Ribbon option.

### 2.6.1.3 Robustness

Principles in the Robustness category relate to the degree to which a system provides feedback to users so that they may determine if goals were achieved successfully.

- The principles of observability concerns a user's ability to determine the current internal state of the system by looking at the interface (Dix *et al.*, 2004:270; Kristoffersen, 2008:264). For example a file transfer utility, shown in Figure 2.10, indicates the progress of the transfer as a running bar that fills up as the file is

being copied. Once the bar is almost filled, the user knows that the file transfer is almost complete.

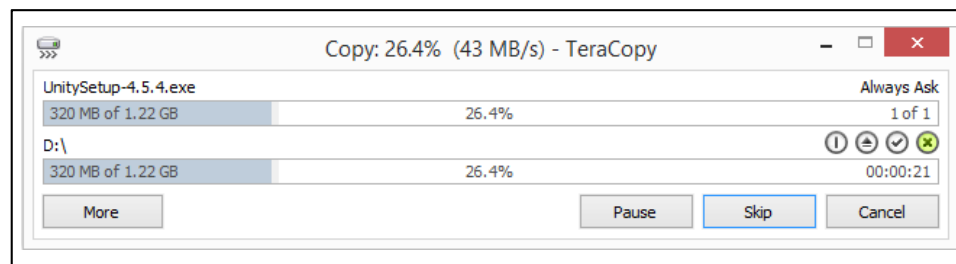


Figure 2.10: The principle of observability applied to a file transfer utility.

- The principle of recoverability involves user's ability to recover from errors. New users tend to learn through experimenting with what happens when they activate certain functions or components of a system and are bound to take actions with unintended results. Even experienced users may accidentally perform actions unintentionally and have to be able to recover from them (Smith-Atakan, 2006:32). The system must therefore allow the user to undo these actions to return to a previous state (Dix *et al.*, 2004:272).
- The principle of responsiveness concerns the rate at which communication takes place between the user and the system (Dix *et al.*, 2004:272; Smith-Atakan, 2006:32). Ideally the response time of the system must be short, meaning that a system must promptly confirm any action taken by the user, otherwise the user may not know if the system accepted his input and become confused and frustrated.
- The principle of task conformance relates to the degree that the system supports all of the features a user needs to achieve his goal and that the features are presented in a manner understandable to the user (Dix *et al.*, 2004:273).

## 2.6.2 Seven fundamental principles of design

Norman (2013:72) developed seven fundamental principles of design which are listed and briefly discussed below.

- **Discoverability.** The user must be able to determine the current state of the system as well as what the currently available actions are.

- **Feedback.** The user must continually receive information about the results of actions and be able to easily determine the new state of the system after actions were executed.
- **Conceptual model.** The system must provide all the information to the user to allow the user to create a good conceptual model of the system, which leads to understanding and feeling in control. A good conceptual model enhances discoverability and evaluation of results.
- **Affordances.** Suitable affordances must exist to make the desired actions possible. According to Norman (2013:11) affordance is the relationship between the properties of an object and the capabilities of the agent interacting with the object. In terms of systems, it relates to the possibilities of how users can interact with a system (Norman, 2013:18). For example, the buttons of the application Calculator, shown in Figure 2.11, affords clicking.

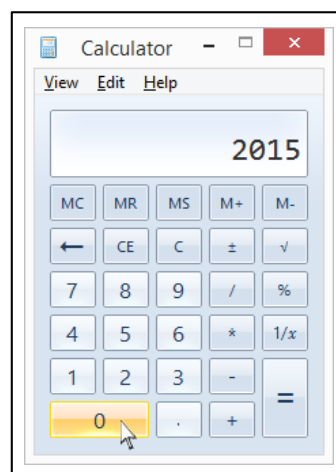


*Figure 2.11: Calculator's buttons afford clicking, signified by their appearance.*

- **Signifiers.** Signifiers must be used effectively to ensure discoverability and that feedback is understandable to the user. Whereas affordances determine the possible actions that a user can perform, signifiers refer to how the user is made aware of the possible actions. For example, Calculator's buttons have a raised appearance and highlight when the mouse hovers over them, shown in Figure 2.11. This signifies to the user that they can be interacted with.
- **Mappings.** Good mappings between controls, their actions and the results must exist. Mappings are enhanced through spatial layout and temporal contiguity. For

example, the rewind, stop and fast forward buttons of media players are usually next to each other, with the rewind button first, followed by the stop button and lastly the fast forward button, as shown in Figure 2.12. Since time is represented as moving from left to right through the blue progress bar, swapping the rewind and fast forward buttons could confuse the user.

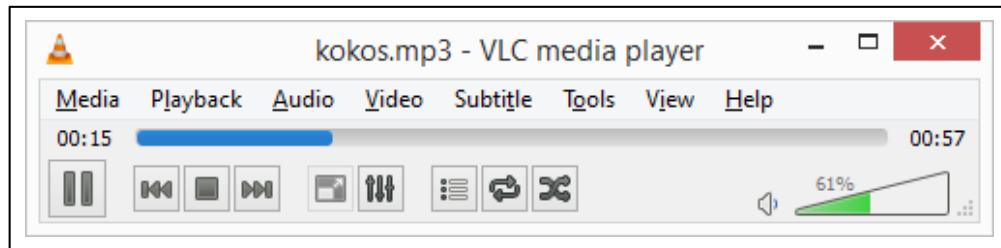


Figure 2.12: Mappings of the controls in VLC Media Player.

- **Constraints.** Providing physical, logical, semantic and cultural constraints guides the user to available actions and eases the user's interpretation when using the system.

## 2.7 Heuristics

Since the design principles and guidelines discussed in Section 2.5 and Section 2.6 are very broad and general, and many more exist, many proponents of interaction design developed sets of design heuristics – a checklist of sorts – to reduce the complexity involved with interpreting these design rules (Nielsen & Molich, 1990:249; Hinze-Hoare, 2007:3). Heuristics are general principles or rules of thumb derived from thoroughly tested design rules and previous design experience to guide design decisions or critique design decision that has already been made (Dix *et al.*, 2004:324). A distinction could be made between usability heuristics, which mainly concern a system's usability, and UX heuristics, which take the user's feelings of the interaction into consideration (Roto *et al.*, 2009:3; Väänänen-Vainio-Mattila & Wäljas, 2009:3680; Rogers *et al.*, 2011:510). Quite a number of design heuristics exist, and many are developed for specific areas, such as the heuristics developed by Garcia *et al.* (2005:201) to evaluate the designs of government websites and the heuristics of Baker *et al.* (2002:98) to evaluate groupware. Heuristics have also been developed for video game evaluation, which are discussed in Section 2.11. Classic examples of sets of heuristics are Nielsen's (1994:30) revised set of usability heuristics and

Shneiderman's (1992:60) eight golden rules (Dix *et al.*, 2004:282; Zhang *et al.*, 2004:576), which are discussed below.

### 2.7.1 Ten usability heuristics

Nielsen's (1994:30) ten heuristics are often used during the evaluation phase of a system's development in an inspection method called heuristic evaluation (discussed in Section 2.9.1). These ten heuristics are discussed below.

- **Visibility of system status.** A user must always be aware of the current state of the system – for example whether the system is waiting for user input or is busy with a processing request – by being provided with relevant feedback in a timely fashion. (Smith-Atakan, 2006:36) states that after a user performs an action, the system should give immediate feedback that is clearly observable by the user.
- **Match between system and the real world.** Feedback to users must be presented in a way that is easily understandable for the user. The language used in the system must reflect the language that the target audience would use in a real world situation.
- **User control and freedom.** Users must at all times have control over the system. For example if users accidentally pressed the wrong button, they must be able to return to the previous state without trouble.
- **Consistency and standards.** The system should be consistent and conform to existing standards. This supports a user's efforts to learn the system more effectively since users can apply previous experiences of using certain features of a system to new actions. Consistency includes the way that different screens are laid out and the position of different features available on each screen. For example a navigation menu to navigate to different screens should ideally be located at the same position regardless of the current screen. By convention, on Windows operating systems, the Close button is located on the top right corner of a programme and is clicked to exit a programme. It would therefore help users to keep to this convention when designing a new programme since they might already be familiar with the position and function of the Close button from previous experiences with other applications.

- **Error prevention.** The system should ideally prevent errors from occurring. Errors in this context refers to users taking an action that has an unintended result. For example, when users click on the Close button of an application like a word processor, the application should ask if they are sure they want to exit and display a warning message that any unsaved work will be lost. This helps the user to remember to save their work before exiting and not lose possibly hours of work. This also prevents the application from immediately exiting if the user accidentally clicked on the Close button and allows the user to cancel the action.
- **Recognition rather than recall.** A system should be developed so that users do not have to remember all the steps required to perform an activity. The system should be intuitive enough for the user to be able to recognise features and navigate intuitively.
- **Flexibility and efficiency of use.** Systems should have methods in place to allow expert users to speed up certain tasks. For example, in a word processor, a novice user can rectify a mistake by moving the mouse to the Undo Typing button on the menu bar and clicking on it. A more experienced user, however, might use the keyboard combination Ctrl-Z to achieve the same result, only faster.
- **Aesthetic and minimalist design.** A system should avoid giving the user information that is not required or irrelevant, otherwise the visibility of the relevant information might become less visible. The designer should direct the attention of the user to important areas by making it clear and prominent, and avoid making the interface too cluttered with unnecessary items.
- **Help users recognise, diagnose and recover from errors.** Should an error occur, an error message that is clear, informative and using plain language, should be displayed to the user. Error messages should state the encountered problem and offer possible solutions.
- **Help systems and documentation.** Particularly when using a system for the first time, a user should be able to find support on how to use the system. This can be achieved using a built-in help system or documentation that the user can access while using the system.

### **2.7.2 Eight golden rules for interface design**

Shneiderman's (1992:60) eight golden rules for interface design can also be applied when evaluating the design of a system and the interactions between the user and the system. The eight golden rules are listed below.

- Strive for consistency in action sequences, layout, terminology, command use and so on.
- Enable frequent users to shortcuts, such as abbreviations, special key sequences and macros, to perform regular, familiar actions more quickly.
- Offer informative feedback for every user action, at a level appropriate to the magnitude of the action.
- Design dialogs to yield closure so that the user knows when they have completed a task.
- Offer error prevention and simple error handling so that, ideally, users are prevented from making mistakes and, if they do, they are offered clear and informative instructions to enable them to recover.
- Permit easy reversals of actions in order to relieve anxiety and encourage exploration, since the user knows that he or she can always return to the previous state.
- Support internal locus of control so that the user is in control of the system, which responds to his actions.
- Reduce short term memory load by keeping displays simple, consolidating multiple page displays and providing time to learn action sequences.

### 2.7.3 Comparing heuristics to design principles

By comparing the above heuristics and design principles, one will note that there is an overlap between them. Table 2.1 maps the heuristics from Nielsen and Shneiderman to the more abstract principles of Norman and Dix *et al.* discussed above. The mapping is based on research from Hinze-Hoare (2007) and the researcher's own interpretation of the literature.

*Table 2.1: Heuristics mapped to abstract design principles.*

| <b>Dix et al.</b>  | <b>Nielsen</b>                                                                   | <b>Shneiderman</b>                                                                         | <b>Norman</b>             |
|--------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------|
| Predictability     | Recognition rather than recall                                                   | -                                                                                          | Mappings<br>Constraints   |
| Synthesisability   | -                                                                                | -                                                                                          | Conceptual model          |
| Familiarity        | Match between system and the real world                                          | Reduce short term memory load                                                              | -                         |
| Generalisability   | -                                                                                | -                                                                                          | -                         |
| Consistency        | Consistency and standards                                                        | Strive for consistency                                                                     |                           |
| Dialog initiative  | User control and freedom                                                         | Support internal locus of control.                                                         | .                         |
| Multi-threading    | -                                                                                | -                                                                                          | -                         |
| Task migratability | -                                                                                | -                                                                                          | -                         |
| Substitutivity     | Flexibility and efficiency of use                                                | Enable frequent users to shortcuts                                                         | -                         |
| Customisability    | -                                                                                | -                                                                                          | -                         |
| Observability      | Visibility of system status.<br><br>Aesthetic and minimalist design.             | Design dialogs to yield closure.                                                           | Discoverability           |
| Recoverability     | Error prevention.<br><br>Help users recognise, diagnose and recover from errors. | Offer error prevention and simple error handling.<br><br>Permit easy reversals of actions. | -                         |
| Responsiveness     | Help systems and documentation                                                   | Offer informative feedback                                                                 | Feedback                  |
| Task conformance   | -                                                                                | -                                                                                          | Affordances<br>Signifiers |

## 2.8 Applying design rules

Design rules can sometimes appear to be contradictory and not all rules may be applicable for a specific system (Rogers *et al.*, 2011:507). Designers must understand the trade-offs and interplay between design rules and apply them accordingly. For example, when designing an interface for a mobile application, the designer needs to take the limited screen size in consideration. Unlike many applications running on a Windows desktop computer, the context menus of most mobile applications do not show inactive options as greyed out, but are rather completely omitted to save screen space. A comparison of the context menus of Notepad on Windows and S Memo on an Android mobile device are shown in Figure 2.13.

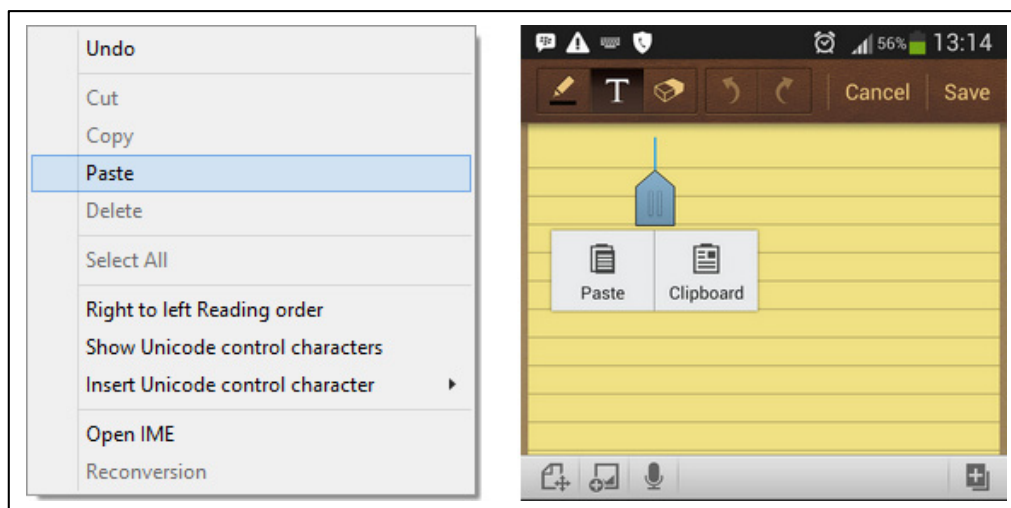


*Figure 2.13: Context menus of Notepad (left) and Memo S (right).*

The principles discussed above are applied differently given the purpose and context of the software. For Notepad, the principle of consistency is given preference in the sense that even though some options are disabled, they are all still visible to the user. For Memo S on the other hand, only available actions are shown. This might free up screen space to show other information, but at the expense of a less consistent interface. This does not mean that the design of Memo S is necessarily poor, but in fact might make the experience for the user better since there is no cluttering. Successful interaction designers therefore design for good or positive UX by overcoming unavoidable design challenges and limitations by carefully considering and applying appropriate design principles.

It should be noted that the literature presents different definitions for design rules, design principles, guidelines and heuristics which are at times used interchangeably. For example, Smith-Atakan (2006:31) defines design rules as giving “*precise recommendations about specific design aspects*”. This is in contrast to the definition provided by Dix *et al.* (2004:259), discussed in Section 2.5. Heuristics are also frequently referred to as usability principles and “*become*” heuristics when they are used during heuristic evaluations (discussed in 2.9.1), for example (Nielsen, 1994:31) and (Pinelle *et al.*, 2008). This research uses the term heuristic to refer to both usability heuristics and UX heuristics. Since there is a strong relationship between high-level abstract design principles and heuristics (Rogers *et al.*, 2011:506) and design rules are frequently turned into heuristics (Rogers *et al.*, 2011:510) the term HCI principles will be used to collectively refer to design rules and heuristics.

## **2.9 User experience evaluation**

A perfect design for a positive UX is very rarely achieved the first time (Dix *et al.*, 2004:192; Law *et al.*, 2009:722). Even though design rules can be used while the software is being developed, the design decisions must eventually be evaluated at some point (Dix *et al.*, 2004:319). Since this is usually an iterative process, as discussed in Section 2.4, different prototypes of the system are usually made and used during the evaluation stage. Depending on factors such as project budget, the type of product and stage of development, prototypes may take on different forms depending on the product. For instance, during the initial stages of software development, prototypes may be storyboards or ideas on paper and later on, can take on the form of working software.

Two distinct types of UX evaluation exist namely summative evaluations and formative evaluations (Dix *et al.*, 2004:220; Rogers *et al.*, 2011:435). Summative evaluations are performed after the development of the product is completed and to ensure the quality of the final product. Formative evaluations are performed during the design and development of the product to allow for continual improvement of the product (Dix *et al.*, 2004:220). Two methods are generally employed when evaluating software namely expert analysis and user participation.

### 2.9.1 Expert analysis

Expert analysis involves asking usability and interaction design experts to evaluate a system and does not include the users of the system in this evaluation method. A number of approaches can be taken in expert analysis to evaluate interactive systems. Four of the more popular approaches are cognitive walkthroughs, heuristic evaluations, model-based evaluations and using previous studies in evaluation (Dix *et al.*, 2004:326).

- Heuristic evaluation is an inspection method where a small group of experts evaluate the usability and UX of a system using a set of heuristics. Examples of such heuristics have been discussed in Section 2.6.2. Heuristics evaluation was developed by Nielsen and Molich (1990:249) as a fast, low-cost and easy-to-use alternative to other formal evaluation techniques (Nielsen, 1994:25). Heuristic evaluation is performed by first conducting a briefing session where a small group of experts are told what to do. Thereafter, each expert evaluates the system independently according to the set of heuristics and notes any problems. Lastly, when all the experts have finished their evaluations, they come together to discuss and aggregate their findings (Rogers *et al.*, 2011:512).
- Cognitive walkthroughs are used to determine how easy it is to learn a system. During cognitive walkthroughs, designers usually concentrate on only a small part of a system, since the process is often time-consuming and labour intensive (Rogers *et al.*, 2011:516). Experts come together and are given a set of tasks to perform, with detailed steps to perform the tasks. At each step, the experts ask themselves questions such as: “*Will the correct action be sufficiently evident to the user?*”, “*Will the user notice that the correct action is available?*” and “*Will the user associate and interpret the response from the action correctly?*” (Rogers *et al.*, 2011:515). The evaluators document their findings at each step and after the walkthrough provide a summary of the findings.
- Model-based evaluations use predictive models to provide estimates of user performance. A popular model is the GOMS (goals, operators, methods, selection) model, which attempt to model the knowledge and cognitive processes of users when they interact with a system and describes the goals, operators, methods and

selection rules related to performing a task. One shortcoming of predictive models is that they consider how the “*perfect*” user would perform achieve a goal and do not take into account the variable behaviour of users (Dix *et al.*, 2004:422; Rogers *et al.*, 2011:527).

- Previous studies with similar contexts may provide insights and evidence as to whether or not the current design of a system is adequate (Dix *et al.*, 2004:326). Using the previous results may make it unnecessary to carry out similar experiments thus saving on time and costs.

## **2.9.2 User participation evaluations**

Evaluation through user participation is performed by allowing users to use the system and gathering their feedback to determine the usability and user satisfaction of the system. The designers of the system can opt to either perform the evaluations in the field, meaning in the users’ normal working environment, or perform the evaluations in a controlled environment, usually by bringing users to a laboratory specifically set up to perform usability studies.

Three approaches commonly employed to gather data from evaluations through user participation are observational techniques, query techniques and monitoring physiological responses of users.

- Observational techniques can either be direct or indirect (Rogers *et al.*, 2011:247). Direct observation entails gathering data from users in the form of video recordings, notes, audio recordings and taking photographs. Direct observations are usually obtrusive and it is sometimes necessary to use less obtrusive indirect observation methods. These methods include diaries and interaction logs.
- Query techniques include interviews and questionnaires. Interviews can take on three types of formats namely structured, unstructured or semi-structured. The differences between these three types are discussed in more detail in Section 3.5.2. Questionnaires and structured interviews are very similar. According to Rogers *et al.* (2011:238) a questionnaire can be used when the motivation of the participant is high enough to answer the questionnaire without anyone present. Otherwise, if the participant requires more persuasion, a researcher could rather conduct interviews.

- Monitoring and recording the physiological responses of users allow researchers to gather data from participants while they are using a system. Methods include using eye trackers, electroencephalogram, heart activity, activity of sweat glands and electrical activity in muscles (Dix *et al.*, 2004:353; Mandryk *et al.*, 2006:143). Involving the users in the design and evaluation phases of a product can be beneficial to get the design right. This could even be crucial for software such as video games, since the experience of the user is paramount to an engaging game.

## 2.10 Video games

Computers paved the way for one of the most successful forms of entertainment: video games. Zyda (2005:25) formally defines a video game as a “*mental contest, played with a computer according to certain rules for amusement, recreation, or winning stakes*”.

The global video games market value, which is estimated to be more than \$90 billion and expected to pass the \$100 billion mark in the next three years (Newzoo, 2015) is testament to the popularity of video games. Games on mobile platforms have an estimated year-on-year growth of 22% from 2014 to 2015 and a current market value estimated at around \$30 billion, a third of the total video games market. These numbers reflect just how popular video games can be.

Although the history of video games date back to the 1950's, video games gained widespread popularity in the early 1980's when they were introduced in the form of arcade cabinets. Figure 2.14 shows screenshots of the popular classic arcade games *Space Invaders* (Taito, 1978), *Pac-Man* (Namco, 1980) and *Donkey Kong* (Nintendo, 1981).

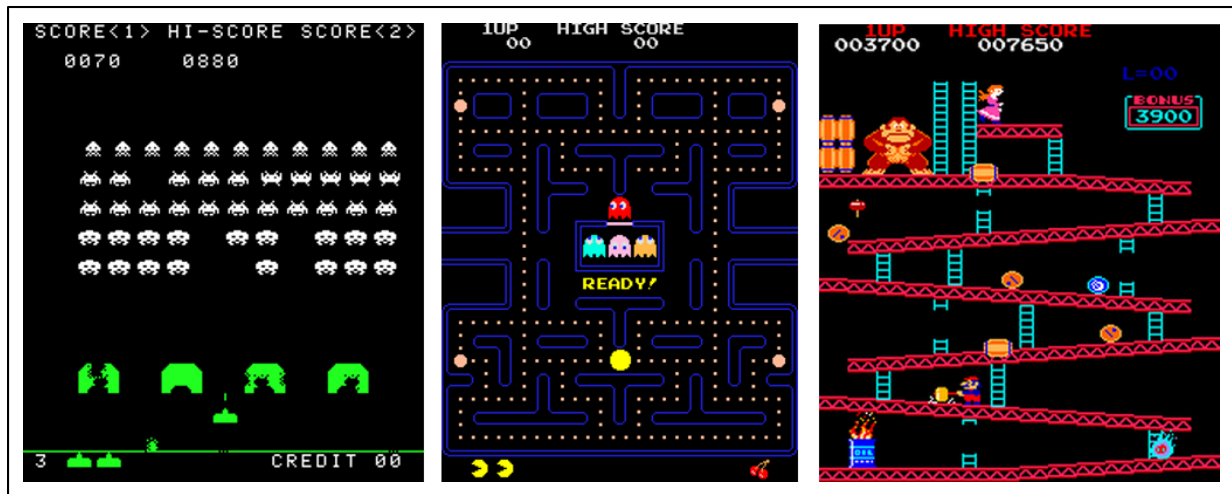


Figure 2.14: Examples of early arcade games.

HCI practitioners in the video game industry are faced by the challenge that classic HCI theory has a strong focus on the usability of task-oriented productivity software and for the most part disregard the “*human aspects*” of the interaction (Löwgren, 2001:29-30; Dix *et al.*, 2004:460; Hassenzahl & Tractinsky, 2006:92; Desurvire & Wiberg, 2009:557). During the 1970’s, when HCI emerged, the use of productivity software was often mandated and confined to work settings (Grudin, 2012:16). Examples of duties that users performed with productivity software include generating managerial reports with word processors, analysing financial data with spreadsheets and designing vehicle components using computer aided design (CAD) software. In a sense, users were extrinsically motivated to use productivity software since they interact with it to attain some external goal (Pagulayan *et al.*, 2002:6; Jørgensen, 2004:396; Ebner & Holzinger, 2007:875; Hassenzahl, 2008:11).

Video games, on the other hand, are played voluntarily and because they are fun (Jørgensen, 2004:396; Nacke & Drachen, 2011:2; Connolly *et al.*, 2012:670). In this sense, playing video games can be regarded as intrinsically motivating since there is no external goal or reward associated with playing the game (Malone, 1980:3). Video games also demand constant interaction with the player (Pinelle *et al.*, 2008:1453).

These substantial differences between video games and productivity software have exposed gaps in classic HCI theory when applied in a video game context (Pagulayan *et al.*, 2002:6; Korhonen & Koivisto, 2006:10; Nacke & Drachen, 2011:1; Moreno-Ger *et al.*, 2012:2). For example, one usability metric from classic HCI frequently used to determine the success of a product, is how quickly a user can complete a task.

The problem is that this is not necessarily a valid unit of measurement in a game setting, as the goal of a game is often to make it challenging for a player to complete a goal, regardless of the time or attempts that it might take (Jørgensen, 2004:396; Pinelle *et al.*, 2008:1453).

In essence, the question that needed answering was, “*what makes video games fun to play?*” The quest for an answer led to growing research into more suitable HCI approaches that took the subjective nature of users’ experiences and perceptions into account (Law & Sun, 2012:479). For Schell (2008:11), video game design is about designing the experience that players will have while playing games; the game artefact itself is merely a means to this end. Furthermore, how people experience the world is unique to each individual, which makes designing games to deliver the intended player experience more intricate (Pagulayan *et al.*, 2002:7; Schell, 2008:10).

According to Carter *et al.* (2014:27), the study of video games has become an established branch of research within contemporary HCI and is occasionally referred to as Player-Computer Interaction (PCI). Within the context of video games, UX is at times referred to as player experience (PX) (Nacke & Drachen, 2011:1). Numerous HCI principles have been advanced to aid in the UX evaluation of video games. Before examining principles from prominent work, it is insightful to first look at a game and identify what makes it engaging.

Prensky (2001:119) discusses six fundamental constituents which he believes are shared by all games considered engaging. These six elements are discussed below in further detail.

- **Rules** are what set games apart from other types of play. These provide structure to a game by placing boundaries on what is allowable to do in the game and what is not. Rules can range from very simple, such as if Pac-Man eats a power pellet, he can temporarily eat enemies, to extremely intricate, such as the rules of real-time war-strategy games like Command and Conquer. Since rules are programmed into computer games, the game usually takes care of applying the rules and determining the state of the game, and can accordingly guide the player on which actions are possible. For example, playing a Dungeon & Dragons type role-playing game on the computer, the player does not have to manually keep

tabs of his skill points or roll dice during combat. All of this is handled by the game itself through the rules it contains, freeing the player to focus on the game itself.

- **Goals and objectives** in the game need to be reached in order to progress - and finally win - the game. Reaching the goal is usually impeded by the rules of the game. In Pac-Man, the goal is to eat all the pac-dots in a maze; but this is hindered because another rule states that touching the roaming enemies will cause Pac-man to lose a life. The satisfaction of achieving the goals in the face of these hindrances is a remarkably strong motivator for playing games (Malone, 1980:16; Prensky, 2001:120). Schell (2008:62) provides three characteristics of goals that are important for a good game namely that goals should be concrete, meaning that players must understand exactly what they are supposed to do; players must feel that they will be able to achieve the goals; and goals should reward the player.
- **Outcomes and feedback** are how a player measures progress against the goals. Feedback informs the player of the outcomes of his actions. Prensky (2001:121) state that a prominent characteristic of feedback in video games is that they are almost always immediate. Feedback can take different forms depending on the type of game. In *Super Mario Bros.* (Nintendo, 1985) as soon as Mario defeats an enemy, the game shows the points that a player scores next to the defeated enemy. These points are added to the running tally in the top left corner of the screen, which is always visible to the player. Feedback can include sound, such as the audible ping when Mario collects a coin.



Figure 2.15: *Super Mario Bros.* (Nintendo, 1985).

- **Conflict, competition, challenges and opposition** are, according to Prensky (2001:122), the problems that we encounter and that need solving in order to win the game. They are what cause the difficulty in reaching the objectives of the game. In *Doom*, the objective of each level is to find three colour-coded key cards located in the level to unlock doors leading to the exit. The challenge is that, more often than not, all of these items are guarded by enemies that the player has to defeat first. When *Doom* (Id Software, 1993) is played in multiplayer mode, the challenge changes in that the player now needs to defeat other players to win the game. Challenges do not have to take the form of other players or computer controlled characters but also appear as puzzles that need to be solved by the player alone, such as Minesweeper or Solitaire found on many Windows machines.
- **Interaction** consists of two important aspects, according to Prensky (2001:123). He differentiates between the interaction that takes place between the player and the computer and the interaction between different players playing the same game. Games have an inherent social aspect, since people enjoy playing games together. With advances in computer networking and the arrival of Internet connectivity in many homes, most video games now support multiplayer modes. Of course, there are still many modern games that only support single player modes, such as *Fallout 4* (Bethesda Game Studios, 2014) and *Deus Ex: Mankind Divided* (Eidos Montreal, 2016). Of course, playing single player games does not necessarily mean that there is not interaction with other players. Players discuss games online, share gameplay videos and may create “*mods*” or modifications for games to extend gameplay, which are also shared with other players. These choices of gameplay styles available to players are indicative of how different players prefer different types of challenges. Prensky (2001:123) and Schell (2008:512) also caution that while many people view computer games as safe, in the sense that it is “*only a game*” and a player is not physically affected by a game, games can have a discernible impact on the player’s emotions and behaviours.
- **Representation** implies that the game is about something, whether tangible or intangible. The content of the game and the narrative and story are all part of the representation of the game. For example, *The Need for Speed* (EA Canada, 1995) is about competing in car races, *Myst* (Cyan, 1995) is about exploring mysterious

islands to discover the fate of the inhabitants and *Fallout 3* (Bethesda Game Studios, 2008) is about surviving a post-apocalyptic future and discovering the fate of your father.

Game designers attempt to develop games that keep players engaged for a long period of time and allow players to enter a state of flow (Schell, 2008:118). Csikszentmihalyi (2008:4) defines flow as a state of being completely absorbed in an activity because of the immense enjoyment a person experiences when performing this activity. Furthermore, Csikszentmihalyi (2008:48) provides eight elements that are present when a person is in a flow state and has the most enjoyable and positive experiences. Applied to video games, these are that a player must be faced with challenging activities that require skills to complete; a player can concentrate fully on the activity; the activity has clear goals; the activity provides fast feedback; the player is deeply involved in the activity; the player must have a sense of control over the actions needed to perform the activity; self-awareness of the player diminishes; and the player experiences an altered state of time.

One approach to aid game designers in their efforts to create engaging games is to adapt and expand on existing HCI principles to make them relevant to video game design. The next section discusses prominent work in developing HCI principles relevant to video game design.

## **2.11 HCI principles for video game development**

A number of researchers have developed principles to design and evaluate design decisions in a video game context. The works of Federoff (2002), Pinelle *et al.* (2008), Desurvire and Wiberg (2009) and Korhonen and Koivisto (2006) are presented and briefly discussed.

### **2.11.1 Heuristics and usability guidelines for fun in video games**

Heuristics were developed by Federoff (2002:41) and grouped according to the game design areas identified by Clanton (1998:1), namely the game interface, game playability and game mechanics. These heuristics are listed in *Table 2.2*.

Table 2.2: *Heuristics and usability guidelines from Federoff (2002:41).*

|                         |                                                                                      |
|-------------------------|--------------------------------------------------------------------------------------|
| Game Interface          | Controls should be customizable and default to industry standard settings.           |
|                         | Controls should be intuitive and mapped in a natural way.                            |
|                         | Minimize control options.                                                            |
|                         | The interface should be as non- intrusive as possible.                               |
|                         | For PC games, consider hiding the main computer interface during game play.          |
|                         | A player should always be able to identify their score/status in the game.           |
|                         | Follow the trends set by the gaming community to shorten the learning curve.         |
|                         | Interfaces should be consistent in control, colour, typography, and dialogue design. |
|                         | Minimize the menu layers of an interface.                                            |
|                         | Use sound to provide meaningful feedback.                                            |
|                         | Do not expect the user to read a manual.                                             |
|                         | Provide means for error prevention and recovery through the use of warning messages. |
|                         | Players should be able to save games in different states.                            |
|                         |                                                                                      |
| Game Interface and Play | Art should speak to its function.                                                    |
| Game Mechanics          | Mechanics should feel natural and have correct weight and momentum.                  |
|                         | Feedback should be given immediately to display user control.                        |
| Game Mechanics and Play | Get the player involved quickly and easily.                                          |
| Game Play               | There should be a clear overriding goal of the game presented early.                 |
|                         | There should be variable difficulty level.                                           |
|                         | There should be multiple goals on each level.                                        |
|                         | <i>"A good game should be easy to learn and hard to master".</i>                     |
|                         | The game should have an unexpected outcome.                                          |
|                         | Artificial intelligence should be reasonable yet unpredictable.                      |
|                         | Game play should be balanced so that there is no definite way to win.                |
|                         | Play should be fair.                                                                 |
|                         | The game should give hints, but not too many.                                        |
|                         | The game should give rewards.                                                        |
|                         | Pace the game to apply pressure to, but not frustrate the player.                    |
|                         | Provide an interesting and absorbing tutorial.                                       |
|                         | Allow players to build content.                                                      |
|                         | Make the game replayable.                                                            |
|                         | Create a great storyline.                                                            |
|                         | There must not be any single optimal winning strategy.                               |
|                         | Should use visual and audio effects to arouse interest.                              |
|                         | Include a lot of interactive props for the player to interact with.                  |
|                         | Teach skills early that you expect the players to use later.                         |
|                         | Design for multiple paths through the game.                                          |
|                         | One reward of playing should be the acquisition of skill.                            |
|                         | Build as though the world is going on whether your character is there or not.        |
|                         | If the game cannot be modeless, it should feel modeless to the player.               |

### 2.11.2 Usability principles for video game design

By investigating game reviews from the video gaming website GameSpot, Pinelle *et al.* (2008:1458) developed game heuristics which focus on usability issues in a gaming context. Table 2.3 lists these heuristics along with a possible mapping to the principles of Dix *et al.* (2004:260) discussed in Section 2.6.1.

*Table 2.3: Comparing game heuristics of Pinelle et al. (2008:1458) to principles from Dix et al. (2004:260).*

| <b>Game heuristics of Pinelle et al. (2008)</b>                                                                | <b>Dix et al. (2004)</b> |
|----------------------------------------------------------------------------------------------------------------|--------------------------|
| Provide consistent responses to the user's actions.                                                            | Consistency              |
| Allow users to customise video and audio settings, difficulty and game speed                                   | Customisability          |
| Provide predictable and reasonable behaviour for computer controlled units                                     | Predictability           |
| Provide unobtrusive views that are appropriate for the user's current actions                                  | Observability            |
| Allow users to skip non-playable and frequently repeated content.                                              | Substitutivity           |
| Provide intuitive and customisable input mappings                                                              | Customisability          |
| Provide controls that are easy to manage, and that have an appropriate level of sensitivity and responsiveness | Familiarity              |
| Provide users with information on game status.                                                                 | Responsiveness           |
| Provide instructions, training and help                                                                        | Responsiveness           |
| Provide visual representations that are easy to interpret and that minimise the need for micromanagement.      | Observability            |

While this research focuses on single player games, it is worth noting that Pinelle *et al.* (2009:174) have also expanded on their work by developing usability heuristics focused on networked games.

It is noted that the heuristics listed in Table 2.3 have a strong focus on usability. The next two sections investigate principles that also incorporate concepts that are unique to video games.

### 2.11.3 Game usability heuristics

Desurvire and Wiberg (2009:560) identified 50 game design principles that distinguish between good and bad game design which consider both usability issues and elements that are distinctly part of games. These principles are organised into three broad categories namely Game play, Coolness / Entertainment / Humour / Emotional immersion, and Usability and game mechanics. These principles are further grouped according to 19 heuristics, as listed in Table 2.4.

*Table 2.4: Game usability heuristics adapted from Desurvire and Wiberg (2009:560).*

| <b>Game play</b>                   | <b>Coolness/Entertainment/<br/>Humour/Emotional<br/>Immersion</b> | <b>Usability and game<br/>mechanics</b> |
|------------------------------------|-------------------------------------------------------------------|-----------------------------------------|
| Enduring play                      | Emotional connection                                              | Documentation / Tutorial                |
| Challenge, strategy and pace       | Coolness / Entertainment                                          | Status and score                        |
| Consistency in game world          | Humour                                                            | Game provides feedback                  |
| Goals                              | Immersion                                                         | Terminology                             |
| Variety of players and game styles |                                                                   | Burden on player                        |
| Players perception of control      |                                                                   | Screen layout                           |
|                                    |                                                                   | Navigation                              |
|                                    |                                                                   | Error prevention                        |
|                                    |                                                                   | Game story immersion                    |

### 2.11.4 Playability heuristics for mobile games

While research from a UX perspective into player experience in mobile settings is still limited (Engl & Nacke, 2013:83), Korhonen and Koivisto (2006:13) have developed a set of heuristics to evaluate the playability of games targeted for mobile platforms. Their principles are categorised according to game usability, gameplay and mobility. Korhonen and Koivisto (2007:31) have also expanded on their work to include heuristics for multiplayer mobile games, but this is outside the scope of this research.

*Table 2.5: Playability heuristics for mobile games developed by Korhonen and Koivisto (2006:13).*

|                                                                      |
|----------------------------------------------------------------------|
| <b>Mobility Heuristics</b>                                           |
| The game and play sessions can be started quickly                    |
| The game accommodates with the surroundings                          |
| Interruptions are handled reasonably                                 |
| <b>Game Usability Heuristics</b>                                     |
| Audio-visual representation supports the game                        |
| Screen layout is efficient and visually pleasing                     |
| Device UI and game UI are used for their own purposes                |
| Indicators are visible                                               |
| The player understands the terminology                               |
| Navigation is consistent, logical, and minimalist                    |
| Control keys are consistent and follow standard convention           |
| Game controls are convenient and flexible                            |
| The game gives feedback on the player's actions                      |
| The player cannot make irreversible errors                           |
| The player does not have to memorize things unnecessarily            |
| The game contains help                                               |
| <b>Gameplay Heuristics</b>                                           |
| The game provides clear goals or supports player-created goals       |
| The player sees the progress in the game and can compare the results |
| The players are rewarded and rewards are meaningful                  |
| The player is in control                                             |
| Challenge, strategy, and pace are in balance                         |
| The first-time experience is encouraging                             |
| The game story supports the gameplay and is meaningful               |
| There are no repetitive or boring tasks                              |
| The players can express themselves                                   |
| The game supports different playing styles                           |
| The game does not stagnate                                           |
| The game is consistent                                               |
| The game uses orthogonal unit differentiation                        |
| The player does not lose any hard-won possessions                    |

## 2.12 Serious games

With technologies like video games, mobile devices and the Internet becoming more widespread (De Freitas & Liarokapis, 2011:1), the new generation of learners are growing up with technological concepts and artefacts unheard of just a few years earlier. Prensky (2005:98) refers to this new generation as “*digital natives*”. According to Prensky (2005:97), since digital natives have grown up in a ubiquitous technological environment, the way that they process information is profoundly different from previous generations of learners. The implication is that digital natives need to be motivated in new ways to stick to the learning process. Malone and Lepper (1987:224) agree that the level of intrinsic motivation of learners may influence how effectively they learn. Many researchers agree that video games can be used as powerful and motivating learning tools if these are carefully incorporated into the learning environment (Prensky, 2005:97; Van Eck, 2006:2; Kebritchi *et al.*, 2010:436; Wrzesien & Raya, 2010:179; Shin *et al.*, 2012:558). Using video games in an educational setting is often referred to as digital game-based learning (DGBL) (Prensky, 2001:90; Kiili, 2005:16; Van Eck, 2006).

Studies indicate that people tend to remember facts better if it is delivered together with surprise and unexpectedness (Kock *et al.*, 2009:360; Stahl & Feigenson, 2015:91). Furthermore, constructivist learning theory advocates that learning takes place effectively when a learner is actively involved in the learning process and learning material is presented within a meaningful context for the learner (Amory & Seagram, 2003:208; Prensky, 2005:115; Charsky, 2010:183).

This makes video games an ideal platform to deliver such content since elements of surprise, mystery, suspense and intrigue are fundamental to many video games (Dempsey, 1996:7; Schell, 2008:27). The player’s inherent sense of curiosity and wanting to discover the unknown and uncover what happens next, can prompt the player to keep on playing the game, effectively allowing more time for interaction with content knowledge.

The concept of using video games as a teaching aid is not new. Many video games have been developed with embedded educational content as early as the 1970’s. *The Oregon Trail* (MECC, 1978) is an example of a classic video game – initially developed in 1971 – with the purpose of teaching 19<sup>th</sup> century American history to children

(Rawitsch, 1978:132). This game proved to be so popular among learners that it is still frequently played today (Djaouti *et al.*, 2011:33).

In the mid 80's and early 90's, Sierra On-Line released several notable educational video games apart from their entertainment titles (Egenfeldt-Nielsen *et al.*, 2013:79-81). *Mixed-Up Mother Goose* (Sierra On-line, 1987) is an educational title where children had to help Mother Goose to fix nursery rhymes by bringing various items to the land's inhabitants (Sipe, 1988:54; Prošić-Santovac, 2009:16-17). One example is where the player had to find and return Mary's missing lamb to Mary for her to complete the nursery rhyme "*Mary had a little lamb*". Another educational title is *The Island of Dr. Brain* (Sierra On-Line, 1992), which is a type of point-and-click adventure game consisting of various puzzles that need to be solved in order to progress the story of the game. Puzzles in the game focus on various educational subjects like math, chemistry and art appreciation (Ito, 2006:7,9).



Figure 2.16: *Mixed-Up Mother Goose* (Sierra On-Line, 1987) (left) and *The Castle of Dr. Brain* (Sierra On-Line, 1992) (right).

Educational video games form part a larger category of video games called serious games. Zyda (2005:26) defines serious games as games played on computers to "*further government and corporate training, education, health, public policy and strategic communications*". Apart from educational games, serious games also include video games used for training, advertising purposes, physical rehabilitation, and to raise social and cultural awareness (Connolly *et al.*, 2012:662; Raybourn, 2014:472).

According to Djaouti *et al.* (2011:38) and others (Susi *et al.*, 2007:2; Le Marc *et al.*, 2010:24), the term serious games started gaining popularity around 2002 in part due to the establishment of the Serious Games Initiative, an association to promote serious

games, and the release of the serious game *America's Army*. *America's Army* was released in 2002 by the United States Army with the aim of raising awareness of the military and finding recruits (Zyda, 2005:27; Raybourn, 2014:474). This game is considered by Zyda (2005:27) to be "*the most widely used and successful serious game to date*". It is of note that during the 1970's the term serious games was used by authors such as Abt (1970:11) and Jansiewicz (1973) (cited by Djaouti *et al.*, 2011:27) to include non-digital games such as board games, but at the time of writing the term is used to refer mainly to digital games (Djaouti *et al.*, 2011:28).

For the purposes of this research study, the term serious game will henceforth refer to digital games used specifically for educational purposes, and will be used interchangeably with digital game-based learning. Also, the term player and learner will be used interchangeably since within the context of serious games, the player and learner are assumed to be the same person.

### **2.13 HCI principles for serious game development**

Serious games have to be carefully designed to strike a balance between the educational and entertainment values (Kiili, 2005:16; Prensky, 2005:109; Kickmeier-Rust & Albert, 2012:16). It is of no use if a serious game contains all of the educational content but it is not immersive or entertaining to play, since no one will want to play the game. On the other hand, if a game is entertaining and fun, but the transfer of intended knowledge does not take place, the goal of using the serious game in the first place is missed.

There are several models and elements that have been developed to aid in the development of successful serious games. This research examines the leading work of Malone (1980), Annetta *et al.* (2011) and Zaibon and Shiratuddin (2010) which has relevance to the UX evaluation of serious games.

### 2.13.1 Heuristics for designing instructional computer games

Malone (1980:65) presents heuristics to aid the design of intrinsically motivating educational video games. The heuristics are organised in the three categories of challenge, fantasy and curiosity.

#### 2.13.1.1 Challenge

- **Goal.** Players should have a goal that they need to reach in the game and should be able to determine their progress in reaching the goal (Malone, 1980:65-66).
- **Uncertain outcome.** The player must not know whether or not he or she will reach the goals of the game. Malone (1980:66) states that this can be achieved by having different difficulty levels in the game, having different types of goals, hiding information and selectively revealing it, and introducing randomness to the game. Schell (2008:153) posits that games containing randomness or chance can elicit emotions of surprise, which is essential to a fun experience.
- **Performance feedback.** To remain challenging, games must provide feedback that is clear, frequent, and encouraging. Malone (1980:69) states that to be educational, feedback should also be constructive, meaning players must not only be told whether they are right or wrong, but also be guided to understand why they made a mistake or why answers are correct.
- **Self-esteem.** A major factor contributing to intrinsic motivation is the satisfaction from solving problems and overcoming challenges. When we win a game, we feel good about our achievement and about ourselves.

#### 2.13.1.2 Fantasy

- **Intrinsic and extrinsic fantasy.** A game should have fantasy elements or themes, either possible or impossible for instance managing a railroad company or piloting a spaceship. Malone (1980:56-58) distinguishes between intrinsic fantasy, where fantasy and the use of skills are interdependent and extrinsic fantasy where the fantasy is dependent on skill but not vice versa. For example, suppose a racing game requires the player to solve mathematics problems. The faster the player answers the questions, the faster his racing car will move. The player's mathematics skills affects the fantasy world of racing, but the driving fantasy does

not affect the use of the skill. A player could just as well have moved the racing car by typing words as fast as possible. Intrinsic fantasy intertwines the skills of the player with the fantasy world. For example, when a player calculates the exact amount of fuel to add to the race car to have enough fuel to reach the finish line but not too much to weigh down the car and slow it down, the skill of computing the quantity of fuel is intrinsically linked to the fantasy. Malone (1980:58) also postulates that intrinsic fantasy is possibly more intrinsically motivating than extrinsic fantasy.

- **Emotional aspects of fantasy.** Different fantasy themes may stir up stronger emotions in players than others. Also, different players may prefer different fantasies to others and factors such as the gender of players may play a role in this. According to Malone (1980:69), themes of war, destruction and competition usually evoke greater emotion than other types of fantasy.

#### **2.13.1.3 Curiosity**

- **Informative feedback.** In order to make games more interesting, they should be responsive. In particular, feedback should be surprising and just enough to make the player's existing knowledge seem incomplete (Malone, 1980:62).
- **Audio and visual effects.** Video games should employ the proper use of audio and graphics to make the game more interesting. Malone (1980:70) suggests using audio and visuals as decorations, to enhance fantasy, as reward and as a representation system to make the game more engaging.

### 2.13.2 Serious Educational Game Rubric

Annetta *et al.* (2011:75) provide a rubric that could be used to assess effectiveness of serious games. The rubric was developed with a strong focus on learning theory and constructivist teaching. The rubric centres around fifteen elements identified by Annetta *et al.* (2011:76) which influence the success of a serious game. Although the findings are based on a more pedagogical approach, they are also relevant from an HCI and UX perspective. The fifteen elements of the rubric are discussed below (Annetta *et al.*, 2011:76).

- **Prologue.** A serious game should have an introduction where the goals of the game are clearly conveyed to the player.
- **Tutorial / Practice.** For a serious game, Annetta *et al.* (2011:77) state that it is critical to provide players with the means to revise what they have learnt. This can be achieved by including practise levels in the game that players can return to to practice their skills.
- **Interactivity.** The player should be able to interact with objects and other characters in the game and their interactions should result in feedback. The characters could be either other human players in a multiplayer setting or non-player characters (NPCs) that are computer controlled.
- **Feedback.** Serious games should provide relevant and timely feedback after the player interacted with the game.
- **Identity.** Players must feel as if they are part of the game world. In many games, this is achieved by representing the player through an avatar. An avatar is an individual or entity who lives in the game world and by playing the game, the player's identity is essentially manifested through the avatar.
- **Immersion.** Players must be highly engaged and feel present in the game. If players are sufficiently immersed, they can reach a state of flow (discussed in Section 2.10).
- **Pleasurable frustration.** Challenges should be designed to be just above the abilities of the player. If challenges are too simple, players become bored, but on

the other hand, if challenges are too difficult, players become frustrated. Annetta *et al.* (2011:79) state that to get this balance right is one of the more difficult aspects of serious game design.

- **Manipulation.** Annetta *et al.* (2011:79) found evidence that players immersed in serious games enjoy manipulating in-game objects. Any action, however, needs to impact the game, whether in a positive or negative manner.
- **Increasingly complex.** A game should become increasingly complex in the sense that challenges must become increasingly difficult to solve as players progress through the game and their skills increase. This concept ties in with that of pleasurable frustration since as a player overcomes one obstacle, the next challenge must again feel just outside of the player's reach.
- **Rules.** In line with Zyda's (2005:25) definition of a video game, Annetta *et al.* (2011:80) state that rules form the basis of gameplay. Players learn that in order to win a game, they need to adhere to the rules of the game, while breaking the rules for short-term gain often results in negative consequences.
- **Informed learning.** When a player's progress and results can be tracked and accessed by an educator or the learners themselves, they can identify problem areas and learning can be adjusted to focus more on these areas. The collected data can also be used by the game itself to provide relevant feedback to the player. It is critical for players of serious games to be provided with feedback that will allow them to review their progress and determine their areas for improvement.
- **Learning.** Serious games endeavour to teach players new content. After playing a serious game for the first time, the player may not have yet mastered all of the learning content. Serious games should allow for repeat plays, in order for the player to keep on learning or practising the content.
- **Pedagogical effectiveness.** Serious games reach their full potential when they are able to transfer this knowledge that would otherwise be very difficult or even impossible to do. For example, a serious game might contain a scene where players have to fix an electronic circuit board to continue the game. Through this process players might learn about Ohm's law and how different electronic

components look like. Setting up a similar experiment in real life could be more costly in terms of time, equipment and components needed to set up the experiment. Teaching electronics concepts through a serious game would also be much safer than using live electricity for example.

- **Reading efficiency.** Many games rely on text-based dialogues to communicate with the player. This text needs to be matched to the reading level of the target audience so that it can be understood, or that the meaning becomes clear through the context. Voice recordings often accompany the onscreen text that further aid in understanding the text.
- **Communication.** According to Annetta *et al.* (2011:81) audio feedback in serious games should be carefully implemented. They state that few other game components can destroy the immersion for players than poorly delivered audio.

### 2.13.3 Heuristics for mobile game-based learning

The heuristics of Korhonen and Koivisto (2006), discussed in Section 2.11.4, have been expanded upon by Zaibon and Shiratuddin (2010) to be relevant to mobile serious games. Apart from the game usability, gameplay and mobility heuristics, another group of heuristics focusing on the learning content of a mobile game was added by Zaibon and Shiratuddin (2010:128). These additional heuristics are listed in Table 2.6.

*Table 2.6: Learning content heuristics from Zaibon and Shiratuddin (2010:128).*

|                                                 |
|-------------------------------------------------|
| The content can be learned easily.              |
| The game provides learning content.             |
| The learning objective of the game is achieved. |
| The content is understandable.                  |

## **2.14 Limitations to user experience evaluation in serious games**

The sections above discussed concepts of UX from the viewpoint of classic HCI, video games, and serious games. A relatively new field in HCI is to determine the UX of serious games in the context of a mobile environment. Examples of work in this field include the mobile game-based learning engineering model of Shiratuddin and Zaibon (2011:90) and the four dimensional evaluation framework based on activity theory developed by Law and Sun (2012:478).

Many researchers agree that the field of UX is still maturing (Roto *et al.*, 2009:3) and that research on how to specifically evaluate and measure UX is limited (Vermeeren *et al.*, 2010:521). These limitations are noticeable in the area of evaluating UX of serious games (Law & Sun, 2012:478) and heuristic evaluations in particular (Shiratuddin & Zaibon, 2011:93).

In light of the limitations in the existing literature pointed out above, this research endeavours to extend the knowledge base by characterising a set of HCI principles for serious game developers to guide the UX evaluation of serious games. The following chapter discusses how this research sets about achieving this goal.

## **2.15 Conclusion**

This chapter introduced the field of Human-Computer Interaction and the concepts of usability and UX. Established HCI principles were discussed, followed by a discussion of UX evaluation methods. Subsequently, video games and their fundamental elements were discussed, followed by a review of prominent research in the development of HCI principles relevant to video games. Furthermore, a discussion on serious games was presented along with notable work from an HCI perspective. Lastly, the limitations that this research aims to address have been highlighted.

## 3 Research Design

---

### 3.1 Introduction

In order to contribute to research regarding expanding the body of scientific knowledge, it is vital for researchers to have a fundamental understanding of how research should be planned and conducted. Myers (2009:6) defines research as an original investigation that is conducted to produce new knowledge and contributes to existing knowledge and understanding in a specific field.

In an attempt to understand video games as an activity and as a design artefact, Jørgensen (2012:377) used interpretative phenomenological analysis (IPA) as an approach to interpret skilled players' experiences of playing video games.

Similarly, this research uses IPA as research method to gain an understanding of serious games. The researcher conducted semi-structured interviews with five purposively selected participants and analysed the data qualitatively to identify and describe HCI principles that emerged from the data which could be relevant when evaluating the UX of serious games.

The remainder of this chapter discusses the major approaches of conducting research, followed by a discussion of the background of IPA. This is followed by a discussion on various data collection methods that could be used in research and the data analysis approach taken in this study. Finally, information on the research quality, research value and ethical considerations applicable to this research is discussed.

### 3.2 Background

The practice of research involves combining paradigms with research methods and implementing these using specific procedures. Creswell (2003:21) mentions three factors which affect the researcher's choice for a particular research endeavour:

- The research problem and questions.
- The researcher's personal experiences.
- The intended audience to whom the research will be presented.

How the researcher answers these questions will lead to research that *tends* to take a more qualitative, quantitative or mixed method approach.

- Quantitative approach

Researchers undertaking a quantitative approach to research often base their knowledge claims on positivistic or post-positivistic grounds (Creswell, 2003:18). The data collection usually results in data that is quantitative, or of a numeric nature, which the researcher analyses with statistical methods.

- Qualitative approach

Qualitative researchers generally take an interpretive, or constructivist perspective, and focus on the meaning that individuals give to phenomena instead of investigating a general population. Collected data is usually of a descriptive or qualitative nature, such as text, pictures or audio which the researcher then use to develop themes from which to discover the essence of phenomena.

- Mixed method approach

Researchers conducting mixed-method research tend to take a pragmatic or pluralistic stance, involving themselves with the collection of both qualitative and quantitative data. The premise for this approach is that combining qualitative and quantitative approaches can provide a more complete understanding of research problems than taking either approach alone (Creswell, 2014:19).

### **3.3 Research paradigms**

A paradigm is a framework or belief system that guides researchers in performing research and which is accepted by a community of research practitioners (Kuhn, 1975:viii). Researchers conducting research within a shared paradigm are committed to the same standards, rules and assumptions (Kuhn, 1975:23). Each paradigm, or worldview, has its own strengths and weaknesses which should be considered at the onset of performing research. Paradigms can be characterised through their ontology, epistemology, axiology, rhetorical structure and methodology (Ponterotto, 2005:126).

Ontology is the study of being and concerns assumptions about the form and nature of reality and what can be known about that reality (Hitchcock & Hughes, 1995:19;

Ponterotto, 2005:130). Ontological stances include realism, relativism and idealism (Ponterotto, 2005:130).

Epistemology refers to the study of knowledge. Within this branch of philosophy the nature of knowledge and how it can be known is studied and concerns the relationship between the “*would-be knower*” (the researcher) and what can be known (Hitchcock & Hughes, 1995:19; Ponterotto, 2005:131; Cohen *et al.*, 2007:7).

Axiology concerns the role of the researcher’s values and ethics in the scientific process while rhetoric structure refers to the style and language that are used when reporting the procedures and results of the research to the intended audience (Creswell, 2003:6; Ponterotto, 2005:131,132).

Methodology is the study of the methods that can be used by the researcher to collect and analyse data (Hitchcock & Hughes, 1995:20). The research method that the researcher decides on will depend on his ontological, epistemological and axiological stance (Ponterotto, 2005:132). Two common methodological approaches are idiographic and nomothetic approaches to conducting research. Idiographic approaches place importance on the experiences of individuals whereas nomothetic approaches concern the discovery of general patterns or behaviours (Ponterotto, 2005:128; Cohen *et al.*, 2007:8).

Numerous paradigms exist in the literature, each with their own ontological, epistemological and axiological assumptions. Orlikowski and Baroudi (1991:5), following Chua (1986:626), suggest that Information Systems (IS) studies can be classified according to their underlying epistemological assumptions as being either positivistic, interpretive or critical. These philosophical paradigms are summarised in Table 3.1 and discussed in the following sections. It should be noted that while these paradigms are theoretically distinct, the distinction can be less clear in practice (Nieuwenhuis, 2007b:57). While most IS research have traditionally had a positivistic orientation, interpretive and critical research are on the rise and becoming more accepted (Orlikowski & Baroudi, 1991:7; Klein & Myers, 1999:68; Richardson & Robinson, 2007:252; Myers, 2009:41).

Table 3.1: Summary of philosophical paradigms adapted from Ponterotto (2005:130) and Lincoln et al. (2011:100).

|                                                                                                                                   |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Paradigm</b> – A set of interrelated assumptions setting the context for a researcher’s study.                                 |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| <b>Positivism</b>                                                                                                                 | <b>Interpretivism</b>                                                                                                                                                                                      | <b>Critical Theories</b>                                                                                                                                                                                                         |
| <b>Ontology</b> – What is the form and nature of reality and what can be known about that reality?                                |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| Naïve realism – “real” reality but apprehensible                                                                                  | Relativism – local and specific co-constructed realities                                                                                                                                                   | Historical realism – virtual reality shaped by social, political, cultural, economic, ethnic and gender values; crystallised over time                                                                                           |
| <b>Epistemology</b> – What is the nature of the relationship between the knower and the would-be knower and what can be known?    |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| Dualist/objectivist; findings true                                                                                                | Transactional/subjectivist; co-created findings                                                                                                                                                            | Transactional/Subjectivist; value-mediated findings                                                                                                                                                                              |
| <b>Axiology</b> – What are the role and place of values in the research process?                                                  |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| Values have no place in the research process. Researchers remain emotionally detached from the investigative inquiry.             | The researcher’s values and lived experience ( <i>Erlebnis</i> ) cannot be divorced from the research process. Researchers acknowledge, describe, and “ <i>bracket</i> ” values but do not eliminate them. | Researchers admittedly hope and expect their value biases to influence the research process and outcome. Researchers want to empower participants to transform the status quo and emancipate themselves from ongoing oppression. |
| <b>Rhetorical Structure</b> – What language is used to present the procedures and results of research to one’s intended audience? |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| Precise and “ <i>scientific</i> ”. Objective, emotionally detached. Passive voice, past tense.                                    | Researchers detail their own experience, expectations and biases. Often first person and personalised.                                                                                                     |                                                                                                                                                                                                                                  |
| <b>Methodology</b> – How can the inquirer (would-be knower) go about finding out whatever he or she believes can be known?        |                                                                                                                                                                                                            |                                                                                                                                                                                                                                  |
| Experimental / manipulative; verification of hypothesis; mainly quantitative methods                                              | Hermeneutical / dialectical                                                                                                                                                                                | Dialogic / dialectical                                                                                                                                                                                                           |

### 3.3.1 Positivistic paradigm

Positivism is historically associated with Auguste Comte (1798 – 1857) (Cohen *et al.*, 2007:9), and has been the dominant paradigm during the last two centuries (Ritchie *et al.*, 2003:6; Nieuwenhuis, 2007b:47). The fundamental view from this perspective is that natural phenomena, including human behaviour, can be explained by universal, physical laws. The positivistic researcher aims to uncover these natural laws that govern the universe, and by knowing them, will lead to prediction and control over phenomena, including human behaviour. The only acceptable manner to determine these laws is through the scientific methods of experimentation and through what can be observed through the senses (Nieuwenhuis, 2007b:48).

The ontological assumption of positivism is that one true reality exists which is external to human cognition (Nieuwenhuis, 2007b:53). Positivists believe that the universe behaves in a predictable manner where there are apprehensible relationships between cause and effect (Cohen *et al.*, 2007:11). This implies that human behaviour too, is determined by preceding events or circumstances and governed by natural laws (Cohen *et al.*, 2004:8).

The epistemological base of positivism is that a researcher may know reality by discovering knowledge using the scientific method. Positivistic researchers assume that the researcher and the participants or topic are independent from one another, a concept known as dualism. Researchers also stress the importance of objectivism, meaning that researchers must remain objective and perform their study without biases to discover the truths of reality (Ponterotto, 2005:131).

From an axiological perspective, positivists believe that the researcher's values are irrelevant in the research process. If the research is influenced by the researcher's values and biases, the research becomes flawed. Therefore, the researcher remains emotionally detached from the study at all times (Ponterotto, 2005:131).

From a methodological perspective, positivists favour the scientific method (Sciarra, 1999:7; Cohen *et al.*, 2004:128). Researchers take on a nomothetic approach, where the aim is to discover the general laws or rules that govern phenomena (Ponterotto, 2005:128; Cohen *et al.*, 2007:10). Research is generally carried out through the

scientific method and is often concerned with knowledge that is quantitative in nature (Cohen *et al.*, 2007:16).

The rhetoric structure of positivist research reports is precise, technical and presented in an objective manner (Ponterotto, 2005:132), written using mainly the passive voice, third person and in past tense (Mouton, 2001:130; Gibbs, 2007:36; Myers, 2009:233).

### **3.3.2 Interpretivistic paradigm**

Interpretivism emerged as a result of researchers beginning to question and disagree with the positivistic approach to research (Nieuwenhuis, 2007b:50). Much of the foundation for interpretivism was laid by Immanuel Kant (1781 – 1804) and Wilhelm Dilthey (1894 – 1929) (Ritchie *et al.*, 2003:6-7). Interpretivism has roots in hermeneutics, which is the study and practise of interpretation (Nieuwenhuis, 2007b:58). The interpretivistic researcher aims to understand the world by examining and reflecting on how individuals interpret and give meaning to the world around them. Interpretivists accept that individuals are typically not generalizable and that human behaviour is not deterministic (Cohen *et al.*, 2007:18). Kant's position was that we perceive the world through *both* what we pick up through our senses as well as how we process, organise and interpret these sense impressions mentally (Ponterotto, 2005:129). Each of us therefore produce our own environment or reality based on how we experience the world.

Ontologically, then, interpretivists take a relativist stance where they are of the opinion that multiple constructed realities exist (Ponterotto, 2005:129). These realities are constructed in the minds of individuals through their ideas and concepts that they have of the world, although elements of these realities may be shared with other individuals (Guba & Lincoln, 1994:110). Since people are considered unique and have a free will, one individual can experience and interpret the same event or phenomenon differently than someone else would. Reality is therefore also considered to be subjective since multiple meanings can be given to phenomena, depending on the individual, the context of the situation and interactions with other people (Ponterotto, 2005:130).

On an epistemological level, these subjective realities can be known by investigating people's experiences and uncovering the meaning that they give to their experiences of the world (Ponterotto, 2005:129; Nieuwenhuis, 2007b:55). A distinguishing feature

of interpretivism is that the researcher studies phenomena from the participant's point of view, and to do this, the researcher and participant actively interact through dialogue (Ponterotto, 2005:129). Through this interaction, the researcher can gain a deeper understanding of the participant's lived experience and views of reality. Therefore the researcher is no longer seen as external and separate from the research study. It is also assumed that we are mostly unaware of the meanings that we give to phenomena or situations, but that through a hermeneutic approach, these hidden meanings could be brought to consciousness (Ponterotto, 2005:129). The concept of hermeneutics will be discussed in more detail in Section 3.4.2.

From an axiological view, interpretivistic researchers assume that their own values and lived experiences cannot be separated from research. Therefore, they usually acknowledge, discuss and bracket their values, but it is assumed that *both* the researcher and the participants, each having their own unique lived experiences and backgrounds, will influence the outcome of a research project (Creswell, 2003:9; Ponterotto, 2005:131).

At the methodological level, researchers place importance on and attempt to describe the individual's particular behaviour and do not normally attempt to generalise results to other groups of people. This approach is idiographic, as opposed to a nomothetic approach where generalizable results are sought. Researchers usually wish to provide thick descriptions (Geertz, 1973:6) of a participant's lived experiences to portray the participant's feelings and thoughts about a phenomenon and describe the context or situation in which the research was performed. For this reason, and the strong focus on the dialogic interaction between the researcher and participant, researchers usually take a qualitative approach to collecting and analysing data (Ponterotto, 2005:132).

Due to the subjective and interactive role of the interpretivistic researcher, research reports are usually written in the first person and in many instances personalised. Researchers also often report on their experiences, expectations, values and biases and discuss and reflect on how the research study intellectually and emotionally influenced them (Ponterotto, 2005:132).

### 3.3.3 Critical theories

Critical theories emerged as an alternative to positivistic and interpretivistic research, since some researchers argued that research outputs were generally based on the interests of a particular group of people which could discriminate or marginalise another group of people (Cohen *et al.*, 2007:26). The researcher who takes a critical theory approach to research aims to empower a specific group of people by bringing about change and transformation through research and strive for an egalitarian society where marginalised people can be emancipated or liberated from oppression (Creswell, 2003:11; Cohen *et al.*, 2007:26).

From an ontological viewpoint, reality is shaped not only within social and historical contexts but also facilitated by power or political relations (Ponterotto, 2005:130; Nieuwenhuis, 2007b:62). Guba and Lincoln (1994:110) explain that from the critical perspective, reality was assumed to be shaped by various social, political, cultural, economic, ethnic and gender factors and then crystallised into structures that were then, inappropriately, taken as the natural and immutable reality.

Similar to the epistemological perspective of interpretivism, in critical research, the focus is on the interaction between the researcher and the participants. Furthermore, this relationship is also dialectic, where the researcher aims to incite transformation in the participants that will cause group empowerment and emancipation from oppression (Guba & Lincoln, 1994:110; Ponterotto, 2005:131). Critical researchers believe that valid social knowledge arises from challenging the current social system and structures and laying bare the power relationships within them. Through this, the oppressive nature of the system can be revealed (Nieuwenhuis, 2007b:62).

The critical researcher, from an axiological point of view, believes that the values of the researcher cannot be separated from the research, similar to interpretivism. Moreover, critical researchers intend their value biases to influence the research outcome. Specifically, they aim to empower participants to transform current social systems and structures and emancipate themselves from oppression (Ponterotto, 2005:131).

In the effort to avoid any discrimination or marginalisation of participants, the researcher usually employs a methodological approach that is qualitative in nature,

with a focus on dialectic interaction (Creswell, 2003:18; Ponterotto, 2005:130). The research is collaborative in nature, where both the researcher and participants develop questions and gather and analyse data (Creswell, 2003:10).

The rhetoric structure of critical research is similar to the structure for the interpretivistic paradigm (Ponterotto, 2005:132). Furthermore, critical researchers use and present their research in a form to challenge and pressure social systems to change and often make recommendations for improvements (Myers, 2009:43).

### 3.4 Research method

Research method refers to the strategy of inquiry that researchers employ to conduct research (Myers, 2009:24). Selecting a research method depends on whether researchers are interested in generalisation and discovering objective laws to explain phenomena (nomothetic) or if they are interested in understanding unique or subjective phenomena (idiographic). Table 3.2 provides a short list of common methods associated with qualitative, quantitative and mixed research approaches, as mentioned by Creswell (2003:14), Maree and Van der Westhuizen (2007:34) and Ivankova *et al.* (2007:271).

*Table 3.2: Common research methods.*

| Quantitative                                                                                                                                                                                                                                                                                                | Qualitative                                                                                                                                                          | Mixed methods                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Experimental Designs <ul style="list-style-type: none"> <li>- True experimental</li> <li>- Quasi-experimental</li> <li>- Single subject</li> </ul> Non-experimental designs <ul style="list-style-type: none"> <li>- Descriptive</li> <li>- Comparative</li> <li>- Correlation</li> <li>- Survey</li> </ul> | Ethnographies <ul style="list-style-type: none"> <li>Case studies</li> <li>Phenomenological research</li> <li>Grounded theory</li> <li>Narrative analysis</li> </ul> | Sequential <ul style="list-style-type: none"> <li>- Explanatory</li> <li>- Exploratory</li> <li>- Sequential transformative</li> </ul> Concurrent <ul style="list-style-type: none"> <li>- Triangulation</li> <li>- Embedded</li> <li>- Concurrent transformative</li> </ul> |

### 3.4.1 Situating this research

The three factors mentioned by Creswell (2003:21) which influence the choice of a particular research approach relates to the research problem and research questions, the researcher's personal experience and the intended audience. The three factors in the context of this research are summarised in Figure 3.1 and subsequently discussed.

| Criteria for selecting a research approach                                                 |                                                                          |                                                     | Creswell (2003) |
|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------|-----------------|
| <b>Research problem and questions:</b><br>Discover HCI principles for UX evaluation of SGs | <b>Personal experiences:</b><br>Serious games developer, lecturer, gamer | <b>Audience:</b> Faculty member; external examiners |                 |
|                                                                                            |                                                                          |                                                     |                 |

Figure 3.1: Criteria for selecting a research approach.

As discussed in Chapter 2, the research problem pertains to limitations in the existing literature involving the evaluation of UX of serious games. The goal of this research is to characterise a set of HCI principles which will be relevant to serious game developers when they evaluate the UX of serious games. In order to reach this objective, this research poses the following two questions.

- Which aspects of a serious game do players find the most influential in their experiences with serious games?
- 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?

The researcher's own interests lie in the use of serious games as a teaching and learning medium, with background knowledge in software development, playing entertainment games and lecturing undergraduate students. This researcher recently started focusing on the development of serious games and on widening her knowledge in this field. Furthermore, this research forms the core of a postgraduate study and as such, identifies the audience as the examiners who will evaluate the research findings. Therefore the findings of this research are reported on in the form of a dissertation.

On an epistemological level, the researcher assumes, in a similar vein as Jørgensen (2012:376), that knowledge is personal, subjective and unique. This means that the way of knowing reality is by exploring the experiences of other people regarding a phenomenon, in this case serious games. The researcher explores and makes sense of how participants interpret the aspects of serious games and uses the participant's interpretations to understand how aspects of serious games work with respect to the whole game. This assumption situates this research within the interpretive paradigm and suggests that interpretative phenomenological analysis (discussed in the next section) is used as the research method to answer the research questions. The contextualisation of this research is illustrated in Figure 3.2.

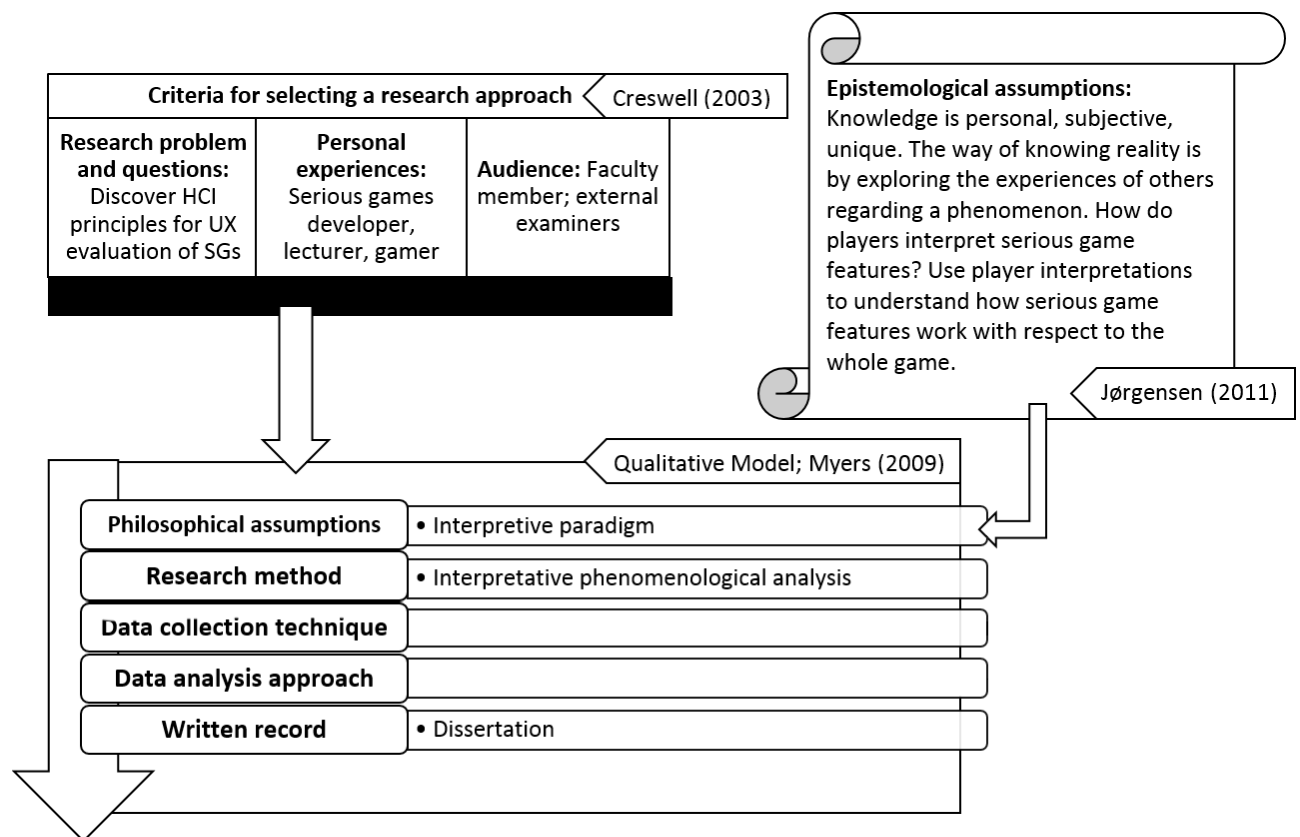


Figure 3.2: This research is situated within the interpretive research paradigm.

### 3.4.2 Interpretative phenomenological analysis

Interpretative phenomenological analysis (IPA) is focused on exploring how participants are making sense of their world and the meaning that participants hold of particular experiences, events or states (Smith *et al.*, 1997:53). IPA has its origins in both phenomenology and hermeneutics. IPA is phenomenological since it revolves around detailed investigations into the life-world of participants and their perceptions and experiences of phenomena. At the same time, IPA draws from hermeneutics, since the researcher is attempting to interpret or make sense of the participants who are trying to interpret their world (Smith *et al.*, 1997:53).

Phenomenology is considered to have its origins in the works of Edmund Husserl (1859 – 1938) and have since then branched into various forms (Richards & Morse, 2007:48). Phenomenology refers to both a philosophical movement and also to a related group of qualitative research methodologies (Richards & Morse, 2007:48; Gill, 2014:1). In this study, phenomenology henceforth refers specifically to the various types of methodologies.

With phenomenological research, researchers aim to identify and understand the “*essence*” of human experiences regarding a phenomenon, as described by the participants in the study (Creswell, 2003:15). Thus phenomena are studied by focusing on the way that they appear to us through experiences or consciousness. These experiences include not only sensory experience but also imagination, thought, desires, emotions and perceptions.

While phenomenology shares similarities to other qualitative approaches there are distinct differences between them. For example, phenomenology differs from narrative research in the sense that the phenomenological researcher views the experience and the meaning these experiences hold as the main objects of investigation, whereas in narrative research the focus is on the story of an experience and meaning originates from words (Gill, 2014:12). Also, while phenomenological researchers concern themselves with understanding individuals’ experiences, they do not necessarily aim to connect these experiences to a particular cultural identity, as in the case of ethnographic researchers (Gill, 2014:13).

Approaches to phenomenological research are diverse but can be broadly classified as being either descriptive or interpretive (Laverty, 2003:3; Finlay, 2009:11; Gill, 2014:10).

Husserl's work greatly influenced descriptive, or transcendental, phenomenology whereas hermeneutic, or interpretive, phenomenology originated from the works of Martin Heidegger (1889-1976), one of Husserl's assistants (Moran, 2002:205; Gill, 2014:2). Heidegger, influenced by Wilhelm Dilthey's (1833 – 1911) works, transformed Husserl's descriptive phenomenology by incorporated concepts from hermeneutics, a field originally concerned with interpreting ancient religious texts and later any form of human communication (Moran, 2002:276).

One of the main differences between transcendental and hermeneutic phenomenology is that transcendental phenomenology requires that the researcher must bracket any presuppositions and is therefore descriptive as opposed to interpretive. Hermeneutic phenomenology, on the other hand, assumes that a researcher can never be free of presuppositions and that interpretation is part of the study of human beings. Heidegger calls this "*Dasein*" – being-in-the-world – and maintains that *Dasein* implies that we are always engaged in the world and always interpreting to understand, or make meaning of, the world and to know reality (Richards & Morse, 2007:49). Importantly, the way in which we interpret is always influenced by our background and previous experiences (Laverty, 2003:9) and cannot be bracketed.

Hermeneutic phenomenology is commonly associated with the interpretivistic paradigm (Butler, 1998:285). Klein and Myers (1999:72) provide seven principles based on hermeneutics, phenomenology and anthropology to guide researchers performing interpretive studies of a hermeneutic nature. These principles are:

- The fundamental principle of the hermeneutic circle

Myers and Klein state that this first principle forms the basis for the remaining six principles. The hermeneutic circle refers to the interpretive process that lies at the heart of achieving an understanding of a phenomenon. In order to gain a global understanding of a phenomena, we need to continuously move between interpreting the "*parts*" and interpreting the "*whole*" of a phenomena (Gadamer, 1988:68). This forms an iterative cycle where we explore and gain a preliminary

understanding of the “*parts*”. This informs the understanding of the “*whole*”, and this understanding in turn provides an improved understanding of the “*parts*”. When investigating a phenomenon, Meyers and Klein note that the “*parts*” could refer to the preliminary understanding of the researchers and participants, while the “*whole*” refers to the shared meanings that arise from their interaction with each other. In other words, as Moran (2002:276) explains, to question the nature of a phenomenon, we *already* have to understand something regarding the phenomenon, as questioning cannot arise from ignorance. The answers to the questions will force us to revise our initial understanding and pose new questions.

- The principle of contextualisation

This principle implies that a researcher must present the social and historical background of the research setting and the current context in which the research takes place.

- The principle of interaction between the researcher and the subjects

Researchers need to critically reflect on how the research data was socially constructed through the interaction between the researchers and participants.

- The principle of abstraction and generalisation

This principle requires that researchers relate the idiographic details revealed by the data interpretation through the application of the first two principles to theoretical, general concepts that describe the nature of human understanding and social action.

- The principle of dialogic reasoning

Researchers must be sensitive to possible contradictions between theoretical preconceptions guiding the research and the actual findings.

- The principle of multiple interpretations

Researchers must be sensitive to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study.

- The principle of suspicion

Researchers must be sensitive to possible “*biases*” and systematic “*distortions*” in the narratives collected from the participants.

Since the goal of IPA research is to gain an understanding of people’s experiences regarding a particular phenomenon, the researcher usually employs purposive sampling when selecting participants (Smith *et al.*, 1997:56). Purposive sampling is a non-probability sampling technique that allows individuals who have expert knowledge of the phenomenon being researched or individuals who have certain characteristics that may help in answering the research question to be selected to participate in the study (Patton, 2002:273; Cohen *et al.*, 2007:115).

Using purposive sampling, the number of participants involved in the research will depend on when data saturation is reached (Guest *et al.*, 2006:59). Data saturation means that a researcher will continue to recruit participants until the participants provide no new information regarding the topic under investigation (Saldaña, 2013:222). As stated before, the aim of IPA is to gain in-depth insights into a phenomenon through the subjective perspectives of individuals and not necessarily to generalise the findings. Thus IPA tends to be more idiographic in nature as opposed to more nomothetic (Smith *et al.*, 1997:56). Thus data saturation in the context of this research will mean that a comprehensive understanding of the phenomena under investigation is achieved and that this understanding could be represented in a coherent and integrated manner while preserving nuances in the data (Elliott *et al.*, 1999:222; Brocki & Wearden, 2006:94). Thus data saturation will assumed to be achieved when the data collected from participants yields no further insights into the phenomenon.

Table 3.3 provides examples provided by Gill (2014:5) of previous studies from both the descriptive and interpretive phenomenological perspectives. From this table, it is apparent that IPA, the approach taken in this study, is considered an interpretive phenomenological method.

**Table 3.3:** *Different phenomenological methodologies adapted from Gill (2014:5).*

|                                | Phenomenology                                                                                                                                        |                                                                                                                                                                       |                                                                                                                       |                                                                                                                                                 |                                                                                                                    |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
|                                | Descriptive phenomenology<br>(Husserlian)                                                                                                            |                                                                                                                                                                       |                                                                                                                       | Interpretive phenomenology<br>(Heideggerian)                                                                                                    |                                                                                                                    |
|                                | Sanders'<br>phenomenology                                                                                                                            | Giorgi's<br>descriptive<br>phenomenological<br>method                                                                                                                 | Van Manen's<br>hermeneutic<br>phenomenology                                                                           | Benner's<br>interpretive<br>phenomenology                                                                                                       | Smith's<br>interpretative<br>phenomenological<br>analysis                                                          |
| <i>Disciplinary origin</i>     | Organisational studies                                                                                                                               | Psychology                                                                                                                                                            | Pedagogy                                                                                                              | Nursing                                                                                                                                         | Psychology                                                                                                         |
| <i>Methodology as</i>          | Technique                                                                                                                                            | Scientific method                                                                                                                                                     | Poetry                                                                                                                | Practice                                                                                                                                        | Craft                                                                                                              |
| <i>Aims</i>                    | To make explicit the implicit structure (or essences) and meaning of human experiences                                                               | To establish the essence of a particular phenomenon                                                                                                                   | To transform lived experience into a textual expression of its essence                                                | To articulate practical, everyday understandings and knowledge                                                                                  | To explore in detail how participants are making sense of their personal and social world.                         |
| <i>Participants (sampling)</i> | 3-6                                                                                                                                                  | At least 3                                                                                                                                                            | Unspecified                                                                                                           | Until new informants reveal no new findings                                                                                                     | 1 or more                                                                                                          |
| <i>Key concepts</i>            | <ul style="list-style-type: none"> <li>• Bracketing (<i>epoché</i>)</li> <li>• Eidetic reduction</li> <li>• Nomematic / noetic correlates</li> </ul> | <ul style="list-style-type: none"> <li>• Bracketing (<i>epoché</i>)</li> <li>• Eidetic reduction</li> <li>• Imaginative variation</li> <li>• Meaning units</li> </ul> | <ul style="list-style-type: none"> <li>• Depthful writing</li> <li>• Orientation</li> <li>• Thoughtfulness</li> </ul> | <ul style="list-style-type: none"> <li>• The background</li> <li>• Exemplars</li> <li>• Interpretive teams</li> <li>• Paradigm cases</li> </ul> | <ul style="list-style-type: none"> <li>• Double hermeneutic</li> <li>• Idiographic</li> <li>• Inductive</li> </ul> |

## 3.5 Data collection techniques

Data collection techniques are the specific procedures and instruments that researchers use to collect data (Myers, 2009:25). Data can be either qualitative or quantitative, and collected through a variety of methods.

### 3.5.1 Quantitative data

Quantitative data refers to measureable, numerical data that can be investigated through methods like statistical analysis (Ponterotto, 2005:128). In the context of usability, examples of quantitative data include the time it takes a user to complete a task and the number of errors that a user encountered while using a system (Rogers *et al.*, 2011:477). Maree and Pietersen (2007:149) classifies quantitative data collection techniques into two groups, experimental and non-experimental designs.

- Experimental designs are used to answer cause-and-effect research questions for example investigating if a treatment (independent variable) has an effect on a dependent measure (dependent variable). An experimental design that is used very often is the pretest-posttest designs with a control group (Maree & Pietersen, 2007:149).
- Non-experimental designs are mainly used in descriptive research to describe or explore certain research topics. Surveys are very commonly used in non-experimental designs (Maree & Pietersen, 2007:152).

### 3.5.2 Qualitative data

Qualitative data are usually in the form of words or pictures (Miles & Huberman, 1994:9). Examples of qualitative data from UX studies include the text colour a user prefers when using a system, the features a user likes most of a system and reasons for liking certain features. This research study focuses on qualitative data in the form of words and text. Textual data can be collected from observations, interviews and documents (Miles & Huberman, 1994:9; Myers, 2009:8).

- Interviews  
Nieuwenhuis (2007c:87) defines an interview as a two-way conversation in which the researcher collects data by asking a participant questions on a one-to-one

basis. Another form of conducting interviews is by using focus groups, where the researcher directs questions at a group of individuals (Myers, 2009:125). A qualitative interview allows researchers to see the world through the eyes of the participants and learn about their ideas, beliefs, behaviour, views and opinions because participants can express their visions of the world using their own personal way of communicating. This in turn will allow researchers to understand the participants' construction of knowledge and social reality (Nieuwenhuis, 2007c:87). Data from interviews are usually collected by audio recording the interviews and transcribing the relevant sections (Cohen *et al.*, 2007; Smith *et al.*, 2009:74).

Research interviews can be classified as being unstructured (or open-ended), structured or semi-structured (Nieuwenhuis, 2007c:87; Myers, 2009:123).

Unstructured interviews usually take the form of a discussion or conversation around a particular topic and usually go into considerable depth. Questions in an unstructured interview are mostly open-ended, meaning that the participant can provide answers that are as brief or elaborate as the participant chooses. Both the participant and researcher are free to steer the interview in a particular direction, determined by how the interview progresses. An unstructured interview is therefore exploratory in nature and usually conducted to obtain rich descriptions. This allows issues to surface that a researcher might not have even considered before the interview and allow these issues to be further explored during the interview. Due to their nature, unstructured interviews with each individual participant will be different and may provide unique insights and information from the participants. While there is usually no predetermined set of questions, the interviewer or researcher must prepare the main topics to be covered during the interview (Rogers *et al.*, 2011:229).

Structured interviews fall on the opposite end of the spectrum of unstructured interviews. In structured interviews, questions are predetermined and the same for each interview. Questions are usually closed, meaning that the answers from participants will be one of a known range of possible answers. Questions from a structured interview must be short, clearly worded and asked in the same order for all participants (Rogers *et al.*, 2011:229).

Semi-structured interviews can be seen as a combination of structured and unstructured interviews (Rogers *et al.*, 2011:229). When conducting semi-structured interviews, the interviewer has a set of predetermined questions or topics to provide guidance, called an interview guide or an interview schedule, but may probe participants to further explain certain answers until no further new data is obtained. Semi-structured interviews are commonly used to corroborate data originating from other sources (Nieuwenhuis, 2007c:87). Smith *et al.* (1997:57) suggest that semi-structured interviews are the most suitable technique for data collection when conducting IPA research and is the chosen data collection technique for this research. This technique as used in this research is summarised in Figure 3.3.

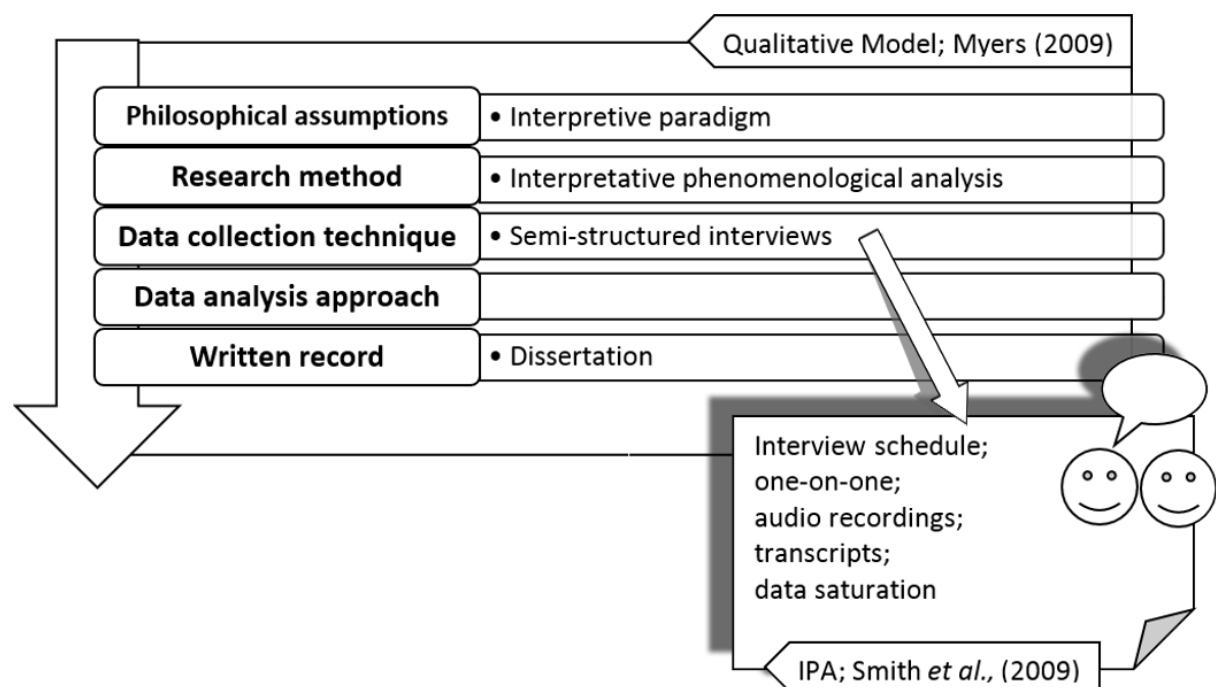


Figure 3.3: Semi-structured interviews.

- Observation

Observation is a method to systematically record the behavioural patterns of participants, objects and events without necessarily communicating with them (Nieuwenhuis, 2007c:83). Myers (2009:138) distinguishes between *observation*, where the researcher observes participants from a distance and does not interact with the participants, and *participant observation*, where the researcher engages with the participants. Data gathered from observations may be of various forms, such as video recordings, field notes, audio recordings and photographs (Myers,

2009:150). In the context of HCI, Rogers *et al.* (2011:247) notes that the aforementioned observations are usually obtrusive and it is sometimes necessary to use less obtrusive indirect observation methods. These methods include diaries, where participants write down their activities and experiences on a regular basis and interaction logs, where the software that participants use records a log that the researcher can examine later (Rogers *et al.*, 2011:258-260).

- Documents

Apart from interviews and observations, a researcher can also gather data from documents. Documents include letters, emails, web pages, newspapers, photographs and business records (Myers, 2009:153). Data obtained from documents are frequently used to supplement data from interviews and observations (Myers, 2009:159). Documents are independent of the research process (Richards & Morse, 2007:112), meaning that they were not created as a result of the research project. For example, by this definition, interview transcripts are not considered documents.

### **3.6 Data analysis approach**

A possible process consisting of four steps is presented by Smith *et al.* (1997:67) and further discussed by Biggerstaff and Thompson (2008:221) to perform data analysis when taking an IPA research approach and conducting semi-structured interviews to collect data. The steps are performed iteratively for each interview.

Step 1: Familiarisation with text.

The interview transcript is read a number of times - usually in conjunction with listening to the audio recording - and the researcher makes annotations and comments where the participant said something interesting or significant. These annotations can include recurring phrases and the researcher's questions, thoughts, observations and reflections.

Step 2: Initial identification of themes.

The researcher works through the annotated transcript again and documents emerging themes.

Step 3: Grouping themes together as clusters.

The researcher lists the emergent themes and looks for connections between them. Related themes are then clustered together. At this stage, the researcher continually refers back to the transcripts to check his own interpretation, sense-making and development of connections against what participants actually said. The clusters are usually also labelled and become the main themes.

Step 4: Tabulating themes into a summary table.

A coherent table is produced which lists the main themes and related sub-themes, along with a quotation from the transcript as evidence for the theme.

After completing the above four steps with the first interview, the researcher can start the process over with additional interviews. Themes that emerge from each previous interview may be used to orient the subsequent analysis.

The data analysis process discussed above is used to analyse the data collected for this research and is illustrated in Figure 3.4.

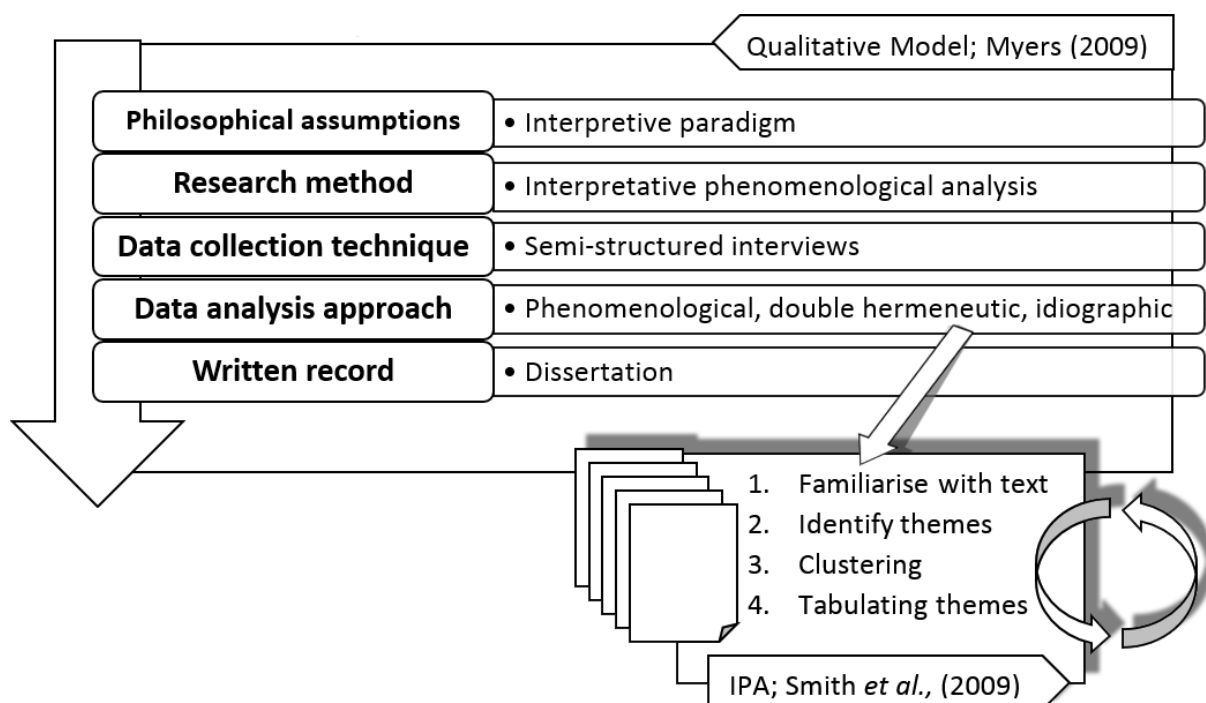


Figure 3.4: Data analysis approach for this research.

### 3.7 Quality criteria for research

Researchers endeavour to conduct research that is of good quality and of worth to other researchers. Due to the divergent nature of quantitative, qualitative and mixed method research, different criteria exist to determine their soundness or quality (Guba, 1981:80; Bryman *et al.*, 2008:274).

#### 3.7.1 Quantitative approaches

To establish rigour in quantitative research, a researcher must consider the internal validity, external validity, reliability and objectivity of the results. Internal validity is achieved if a researcher measures or tests the intended variables (Shenton, 2004:64). Results obtained in one study are externally valid if they can be generalised to apply to other situations or a wider population (Shenton, 2004:69). Reliability is achieved if similar results are obtained when a study is repeated within the same previous parameters (Shenton, 2004:71). Researchers must also strive for objectivity, meaning that they must minimise bias. The researcher cannot allow his own beliefs or values to influence the results of his studies (Guba, 1981:81).

#### 3.7.2 Qualitative approaches

Four constructs are proposed by Guba (1981:83) to ensure the trustworthiness of qualitative research namely credibility, transferability, dependability and conformability.

**Credibility** relates to the accuracy with which data was recorded. Some of the methods discussed by Shenton (2004:64) to ensure credibility include the following.

- The adoption of well-established research methods.
- Adopting early familiarity with the participants.
- Random sampling.
- Triangulation.
- Ensuring honesty in participants.
- Employing iterative questioning.
- Negative case analysis.
- Frequent debriefing sessions.
- Scrutinising research by peers.

- Using reflective commentary.
- The qualifications and experience of the researcher.
- Participant verification.
- Examining previous research results and comparing them with the current research.

**Transferability** relates to the extent that research results are applicable to other research studies. Qualitative research usually concerns a small group of participants and therefore the results cannot generally be used to make inferences about other populations. However, a researcher might be able to compare previous work to his own research if there is sufficient detailed descriptions of the context of the previous work. This allows a researcher to determine if previous research results are applicable and transferable to his own work.

**Dependability** of research is attained if the research process is described in sufficient detail so that other researchers can repeat the research. Within a qualitative framework, repeating the research process will not necessarily result in reaching the same conclusions or obtaining the same results since situations and perceptions of participants may inevitably change.

**Confirmability** is equivalent to objectivity in quantitative approaches. Data confirmability can be promoted if the researcher uses triangulation as well as acknowledging his own beliefs, preferences and assumptions in research reports.

### 3.7.3 Mixed method approaches

Bryman *et al.* (2008:169) suggest four criteria to determine the quality of mixed-method approaches to research.

- Relevance to research questions – this implies that the researcher must carefully select the most appropriate methods to answer the research questions.
- Transparency – the nature and content of the methods used in the research must be available to other researchers or interested parties.

- Integration of mixed method findings – researchers must carefully integrate quantitative and qualitative components in their analysis and not only handle or analyse these separately.
- Rationale – researchers must be clear about their reasons for using both qualitative and quantitative approaches in their research.

### 3.8 Research value

To determine whether research findings are both sound and original, the findings are scrutinised and formally evaluated by experienced and qualified researchers in the field. If these experts, after evaluating the research, find that the results are sound and that the findings are new *to them*, then a research study represents an original contribution to knowledge (Myers, 2009:7). In the context of qualitative research, a researcher may make a unique contribution to knowledge by establishing whether the analysed data corroborates the existing literature or brings new insights to it (Nieuwenhuis, 2007a:111). The findings of this research are presented along with a discussion of the relevant existing literature in this dissertation, illustrated in Figure 3.5.

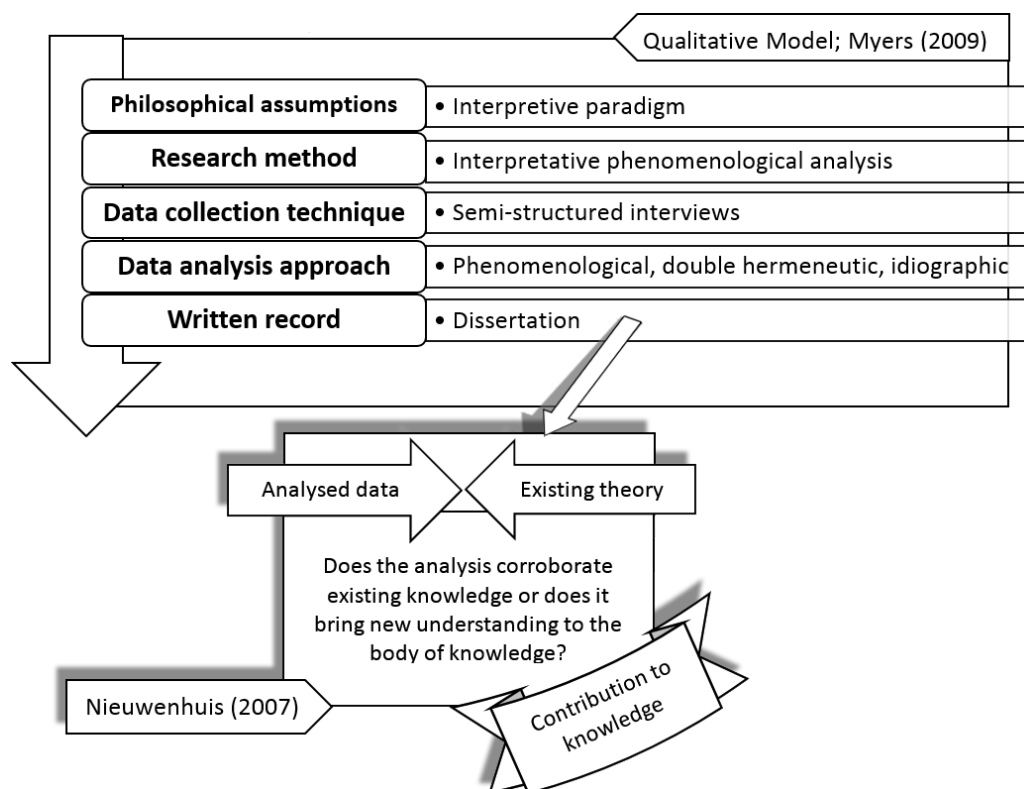


Figure 3.5: Contribution of this research to existing literature.

### 3.9 Ethical considerations

Mouton (2001:239) maintains that researchers have obligations and responsibilities with regard to ethical issues towards the practice of science, society, the environment, and the participants involved in research.

Ethical issues regarding the practice of science revolve around the moral principles that researchers have to adhere to in the search for truth and knowledge (Mouton, 2001:239; Myers, 2009:45). These principles include that a researcher will never fabricate or falsify data, misrepresent any findings, and should always indicate the limitations of the findings. Another important principle regarding the practice of science concerns plagiarism. Researchers may never claim another researcher's work as their own and must always acknowledge any previous work that was consulted and that made a contribution to their own research (Myers, 2009:47).

Researchers often rely on public funding and work in public institutions like universities. Therefore, researchers also have a responsibility to conduct research in a socially acceptable and responsible manner. This includes that research findings from publicly funded projects will be published or made available and that researchers will not engage in clandestine research (Mouton, 2001:242; Ritchie *et al.*, 2003:290).

Researchers must also ensure that they do not harm or damage the environment through their research, since they have an obligation to allow future generations to also enjoy the environment (Mouton, 2001:246).

Lastly, one of the most important ethical aspects, especially for qualitative research, revolves around the responsibilities toward the research participants. Myers (2009:45) state that when ethical dilemmas do occur, the researcher's primary concern should be for the welfare of the participants.

Mouton (2001:243) lists four of the most basic rights that research participants have as the right to privacy; the right not to be harmed in any manner; the right to anonymity and confidentiality and the right to full disclosure about the research.

The right to a participant's privacy include that a participant may refuse to partake in a study, refuse to answer certain questions or to be interviewed at inconvenient times, such as at night or for long periods of time (Mouton, 2001:243; Cohen *et al.*, 2007:64).

In the process of conducting research, a researcher may not expose participants to substantial risk of personal harm, whether physically, emotionally or psychologically (Ritchie *et al.*, 2003:68; Cohen *et al.*, 2007:60). Participants also have a right to remain anonymous in that their identity is not disclosed and also the right to confidentiality in that it must not be possible to reveal the identity of participants through the data they provided. Furthermore, it is preferable if researchers obtain approval from participants whose quotations are used in reports (Orb *et al.*, 2001:95).

The right to full disclosure about research involves informing the participants of all the aspects of the research. In qualitative research, this is achieved through informed consent (Orb *et al.*, 2001:95). Obtaining the informed consent of participants includes informing participants about the aim of the research, the expected outcomes of the research, the role of the participants and any risks and benefits associated with the research. Furthermore, the researcher must explain to the participants that partaking in the research is voluntary, that they may withdraw from the research at any time without any negative consequences and that their confidentiality will be respected at all times (Mouton, 2001:244; Orb *et al.*, 2001:95; Myers, 2009:48).

### **3.10 Conclusion**

This chapter discussed three paradigms that commonly underpin research projects, namely positivism, interpretivism and critical theories. Interpretative phenomenological analysis, which is used as the strategy to conduct this research, was subsequently discussed. This chapter continued with a discussion on data collection and analysis methods, quality criteria of research and research value. Finally, ethical considerations of research were discussed.