The effect of Visual Design Quality on Player Experience Components in Tablet Games

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Abstract

Research in the field of Human Computer Interaction Design indicates that there is a need to develop further methods, tools, and frameworks for the design and evaluation of digital game interfaces. This thesis aims to design, develop, and evaluate two different types of tablet games with varying visual design quality interfaces to examine users' perceptions of hedonic quality, visual design, emotions, and game enjoyment in different channels of experience. The design-oriented approach was adopted to combine both creative practice and scientific inquiry in the game design process and empirical evaluation. Hypotheses were formulated to explore the significance of visual design quality in relation to the components of player experience. The study entailed two phases. In the first phase, participatory design methods were employed to design and develop the tablet games encompassing mind-mapping techniques, focus groups, iterative prototyping with multiple cycles of usability testing of user interfaces. In the second phase, survey instruments were applied to collect and analyze data from 111 participants using tablet games as stimuli in a controlled experimental condition. The main contribution of this research is creation of a player experience model, validated in the domain of tablet gaming, to serve as a new theory. This research will allow for game researchers and practitioners to obtain a deeper understanding of the significance of the player experience framework components to create optimal player experience in tablet games. The finding shows that highly attractive game user interfaces were perceived to have higher utility and ease of use. Participants exhibited higher levels of arousal and valence in the high visual design quality interfaces mediated by hedonic quality. Participants who were highly sensitive to visual design did not necessarily derive the highest level of game enjoyment. Participants derived a heightened level of engagement in the *arousal* channel of experience and the highest level of *enjoyment* in the *flow* state. The use of 2.5D graphics and analogous color schemes created a spatial illusion that captivated users' attention. Practitioners are encouraged to design game artifacts with feature sets and mechanics capable of transporting players into the state of flow, as this is the stage where they experience game control, excitement and relaxation in addition to game immersion in the state of arousal.

“To design is much more than simply to assemble, to order, or even to edit; it is to add value and meaning, to illuminate, to simplify, to clarify, to modify, to dignify, to dramatize, to persuade, and perhaps even to amuse.”

Paul Rand (Design, Form and Chaos, 1993)

Dedication

This thesis is dedicated to my two daughters, *Prerna* and *Laetika,* who are both sources of my inspiration, creativity and encouragement. I am also indebted to my late father for his immense sacrifices in my upbringing and inculcation of the true value of education.

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Certificate of Authorship

I certify that the work in this dissertation has not been previously submitted for a degree nor has it been submitted as part of requirements for a degree. I also certify that the dissertation has been written by me. Any help that I have received in my research work and the preparation of this dissertation has been acknowledged. I confirm that all the sources of information and literature used are indicated in the dissertation.

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Chapter 1

INTRODUCTION

1.1 Background

It is anticipated that the revenue generated from tablet gaming will grow by 42.3% in 2021, according to IDATE digiworld 2017 (as cited in *Video Game Industry Statistics, April 2019*). The ubiquity of tablet gaming has contributed to a wider demographic of users (Feijoo et. al, 2010; Ziefle, 2010). Clearly the rate of tablets' adoption is due to an innovation that has been perceived to have a greater relative advantage by the end-users, as per the Diffusion of Innovations Theory (Rogers, 2003). Digital games span a wide spectrum of genres, classifications, and categories; a taxonomy of 42 game categories has been proposed by Wolf (2003). In fact, Frasca (2003) differentiates between the two approaches to examine video games: "ludology" and "narratology." *Ludology* is based on the appreciation of game rules, mechanics, structure and elements whereas *narratology* is concerned with game story telling.

A product has two sides: instrumental and non-instrumental quality. Instrumental quality is also referred to as the "pragmatic" aspect of product which incorporates the functionality, usability, practicality, and utility; non-instrumental quality englobes aesthetics, and hedonic quality (Mahlke, 2008)[2]. Considerable research has been conducted in the field of HCI to study the relationship between visual design and usability, demonstrating that visual design influences perceived usability (Koutsabasis & Istikopoulou, 2013; Trackinsky, Katz & Ikar, 2000; Tractinsky et al., 2006; Sonderegger,

& Sauer, 2009; Sonderegger & Sauer, 2010; Mbipom & Harper, 2009), which in turn impact emotional outcomes and user experience (Thuring & Mahlke 2007). However, limited research has examined the components giving rise to user experience from a user-centered design perspective (Kübler et al., 2014; Mahlke 2008; Garrett, 2011), psychological perspective (Takatalo, 2011; Forlizzi & Battarbee, 2004), and no study has been conducted to investigate player experience in the domain of tablet gaming at the time of this writing. There is no consensus on an acceptable model of user experience (Lallemand, Gronier, & Koenig, 2015; Law, van Schaik & Roto, 2014), apart from Mahlke's (2008) CUE model proposed in the domain of interactive systems. Research on motivation (Technology Acceptance Model) within the HCI area has proven that both functionality and visual elements affect user motivation and behavior, which in turn influence perceived usability (Davis, 1989; Lee, Kozar & Larsen, 2003). A user perceives two main attributes in a product - pragmatic and hedonic (Hassenzahl, 2003; van Schaik & Ling, 2008); pragmatic quality has a utilitarian purpose whereas hedonic quality is associated with non-task activities, towards derivation of pleasure and enjoyment during product use. Visual design and usability attributes play important roles in user interfaces as they elicit emotional responses from users during product use (Hassenzahl, 2003; Mahlke, 2008; Silvennoinen, Vogel & Kujala, 2014; Wrigley, 2011). Since, numerous studies have shown that visual design affect perceived usability of interactive products, therefore interactive products are no longer regarded for their usefulness and usability, but for heightened level of user experience they emanate (Thuring & Mahlke, 2007). The concept of user experience is regarded in terms of a holistic perspective and is defined as an array of "sensations, feelings or emotional" elicitations that take place during human technology interaction (González Sánchez & Gutiérrez Vela, 2014; Minge & Thűring, 2018). It is a new field of research with limited scope and few experiential constructs to measure the phenomenon (Law, van Schaik, & Roto, 2014).

Despite the fact that considerable research has been conducted in the field of Human Computer Interaction (HCI) on visual design and usability (Desmet & Hekkert, 2007; Hassenzahl, 2001; Hassenzahl, 2003; Hassenzahl & Monk, 2010; Thüring & Mahlke, 2007; Tractinsky, 2012; Tuch et al., 2012), there are only a few methods and knowledge from a user centered design perspective on aesthetics exists (Koutsabasis & Istikopoulou, 2013), and relating to tablet gaming in particular. Carr (2012, p. 2) reinforces that much research has been conducted on the effects of video games on players from a psychological and behavioral point of view, but "little work has taken a critical eye at the aesthetic and interactive appeals of games." Mattila et al. (2008) explains that there is a lack of methods, guidelines, tools, and frameworks for the design and empirical evaluation of aesthetics as it relates to visual design in HCI.

In addition, there has been a significant amount of research done from a psychological and behavioral perspective on the effects of video games (Carr, 2012). For instance, cross-sectional and longitudinal studies examined the effects of video games on (i) aggressive behaviors (Anderson et al., 2004; Durkin & Barber, 2002; Gentile, Coyne & Walsh, 2011), (ii) physiological arousal (Krcmar, Farrar & McGloin, 2011), (iii) affect (Ballard & Wiest, 1996; Persky & Blascovich, 2004) and (iv) aggressive cognition (Farrar & Krcmar, 2006). Consequently, we have witnessed a technological shift towards the adoption of touch screens, which in turn popularized mobile gaming. As per Moore's Law, the processing power of tablets has exponentially increased; tablets are portable, with relatively larger display sizes compared to smart phones, greater flash storage, & faster processing speed. This is a turning point of a disruptive technology, as the demand for tablets have surpassed those of the PC (Cortimiglia et al., 2013). According to the Pew Research Center, tablet computer ownership has risen from 3% in 2010 to 51% in 2016 in the USA (Smith, 2017).

Schell (2008) explains that game elements structure can be classified into four categories: (i) aesthetics; (ii) story; (iii) game mechanics; (iv) technology. Technology acts as a catalyst for the changing medium of game interaction, from consoles to touch screen devices. In fact, traditional keyboard and console-based games are dramatically shifting to the more affordable touch-screen games for tablets and mobile devices (Oshita & Ishikawa, 2012). The mobile platform has tremendous scope for the development of newer types of games, targeted to a broader demographic of users (Feijóo et al., 2010). The advent of touchscreen computing has revolutionized the field of HCI as it has become part of our everyday life and experience (Schiphorst, 2009). Designing digital games for a broader audience is complex in the sense that users have their own preferences and motives in terms of game genres, such as action, adventure, serious.

Lazzaro's theory of Four Keys to Fun (2004) support this concept as it classifies games into four Keys: *Hard Fun, Easy Fun, People Factor* and *Altered States.* The Four Keys to Fun theory was developed by observing 2000 video transcripts, facial expressions and questionnaire responses. This theory forms the basis for the creation of the two types of tablet games in this thesis. Palmer, Schloss, & Sammartino (2013) have stated that daily judgments and decisions based on an individual's view of the aesthetic world help to navigate daily life. On one hand, an individual's aesthetic responses, whether on the positive or negative spectrum, remain subjective and internal as a relationship is formed between the object and the viewer. On the other hand, aesthetic responses may be considered objective as an individual's aesthetic experience has links to the physical background associated with external objects. The definition of aesthetics as a cognitive process associated with spectral reactions evoked by visually experiential situations remains the same. Digital games, as visually experiential artifacts, require the player to devote time and mental effort into game play. As a player consumes the game narrative, the aesthetic experience becomes self-rewarding because the intrinsic need within satisfactory game play is dominated by hedonic values of arousal and affect (Cooper-Martin, 1991). Markovic (2012) agrees that the relationship between the hedonic and aesthetic experience is the pursuit of a higher level of arousal. Verzer and Hutchinson (1998) argue that aesthetic response factors cannot be generalized as the experience can be both subjective and objective in nature. At this time, a researcher cannot predict how two individuals will react when exposed to the same stimuli. The visual design quality of a product has an intrinsic value that can satisfy users' needs (Postrel, 2002). Clearly, HCI practitioners have linked user experience to components beyond instrumental quality to include hedonic, visual design, affective, emotions, and "experiential" technology-interaction (Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006; Desmet & Hekkert, 2007). User experience is the response of a subjective evaluation of one's inner-self, considering the aspects of the product and the context of use (Hassenzahl & Tractinsky, 2006).

1.2 Purpose of Study

Touch screen gaming on mobile devices has received increasing attention in the HCI area, but a lack of understanding in regards to the individual components contributing to player experience in touch screen gaming perseveres (Wiemeyer, Nacke, Moser, & Mueller, 2016; Takatalo, 2011) and there is a scarcity of validated scales to measure PX (Abeele, Mekler, Nacke, & Johnson, 2016). When measuring the hedonic values and player experience, one must acknowledge the limitations within the aesthetic response needing to be addressed. The first is lack of generalizability due to subjective methods of evaluation. Second, participants may not be familiar with the products used as stimuli in the experiments. Third, the aesthetic response is related to an overall experience. Researchers face certain challenges to measure the effect of entertainment technology on users in a "collaborative entertainment" like digital games since a successful player experience cannot be judged by "productivity and performance" alone, but by the hedonic aspect, which is subjective (Mandryk & Inkpen, 2004). Only a few theoretical works have been devised to investigate the concept of computer game enjoyment, while most research has been geared towards player experience during gameplay (Fang et al., 2010). Hence there is a need for a new conceptual player experience design framework capable of disentangling the two components, *perceived hedonic quality* and *perceived visual design quality*, so as to examine their relationships and to understand how the component of player experience design framework such as visual design quality affect the following continuous dependent variables: perception of usability, perception of visual design, perception of hedonic quality, channels of experience, game enjoyment and player experience. Extant literature has also revealed inconsistencies between perceptions of instrumental and non-instrumental qualities of interactive products; these studies found a correlation between visual design and usability in products (Kurosu & Kashimura, 1995; Tractinsky, Katz, & Ikar, 2000; Ben-Bassat, Meyer, & Tractinsky, 2006; Lee & Koubex, 2010; Sonderegger & Sauer, 2010) while these research did not find any relationship between the two components (Hassenzahl, 2004; Lindgaard & Dudek, 2003; Mahlke, 2008; van Schaik & Ling, 2009) There is a lack of rigor in methods to study the individual components of a user experience framework in interactive systems, according to Obrist et al. (2009). For instance, it has been indicated that in order to obtain accurate and meaningful results, the experimental conditions of the stimuli should be devised with different levels of perception of visual design and usability (Seo, Lee, Chung, & Park, 2015). Therefore, it becomes necessary to examine the components of player experience in the context of tablet games. A detailed examination of the research gaps is provided in Chapter 3.

The purpose of this study is twofold. In phase 1, the design-oriented research approach was used to devise two types of tablet games to serve as stimuli using qualitative methods, including researcher-practitioner self-reflective approach. In phase 2, mixed methods (quantitative dominant) were then used to assess how a variation of visual design quality influenced player experience components such as perceived visual design, usability and hedonic, channels of experience, emotions, and game enjoyment. Furthermore, to bridge the knowledge gap, this thesis proposes a new conceptual player experience design framework in the domain of tablet gaming (figure 3.2). The goal is to fill the gaps between the perception of visual design and the other above listed components. A major objective is to assess emotional elicitations at the visceral, behavioral and reflective levels during gameplay, by repositioning Norman's (2004) *Three levels of Emotional Processing* into a player experience design framework. In addition, the research will focus on the role of visual design quality in relation to game enjoyment of two category of users - those who have low and high affinity to visual design elements in products (Bloch, Brunel, & Arnold, 2003) and two types of tablet games - Hard Fun Key and Easy Fun Key (Lazzaro, 2004). By testing specific hypotheses empirically, a new theoretical player experience design model will be developed and validated to advance domain-specific knowledge.

1.3 Aims and Objectives

The aim of this study was to design and develop two types of tablet games in order to evaluate the effects of variations of their visual design qualities on different components of a player experience design framework in the domain of tablet gaming. The goal was to develop a conceptual model for player experience design (figure 3.2) to be empirically evaluated by six hypotheses (section 3.4) using dominant quantitative mixed methods research. This was achieved by applying the design-oriented research methodology to devise two types of tablet games based on the *Four Fun Keys Theory* (Lazzaro, 2004). Each of the two games was modified into two visual design conditions used as stimuli in a controlled experiment to collect data from 111 participants. A framework for player experience design was devised comprising of several variables (figure 3.2) to examine if the visual design quality of game user interfaces influences perception of usability, visual design, hedonic quality, emotional responses, channels of experience, player experience and game enjoyment. These aims gave rise to the following research objectives:

1. To examine how variations in the visual design quality of the game interfaces affects a player's perceived usability.
2. To examine the impact of varying visual design quality of two types of tablet game interfaces on the emotional responses (valence and arousal) of players.
3. To examine the impact of varying visual design quality of two types of tablet game interfaces on the perception of hedonic quality.
4. To examine if a specific user characteristic such as *Centrality of Visual Product Aesthetic* influences game enjoyment.
5. To compare game enjoyment of players in different channels of experience.

1.4 Thesis Outline

In *Chapter 2*, a literature review is conducted on topics related to models of user experience (referred to as *player experience* in the context of gaming). Different approaches of visual design and their relationship to hedonic quality are discussed. Emotion and game flow theories are addressed.

Chapter 3 focuses on the formulation of six research questions based on the analyses of gaps from which a new player experience design framework was developed.

Chapter 4 presents the methodology of the research paradigms, approaches, and research design, including the mixed methods research, sampling frame, experimental study, instrumentation development, and methods adopted to evaluate each dependent variable.

Chapter 5 sets out the practice-based approach devised for the thesis which comprises of the tablet game design and development process, iterative prototyping and user testing.

Chapter 6 presents the key findings of the study whereby the hypotheses are analyzed using both quantitative and qualitative methods.

Chapter 7 discusses the new findings in relation to extant research, reflects on the examination of the new results, and provides an explanation of the results that do not support the hypotheses.

The final *Chapter 8* concludes the thesis by highlighting the key points of the new knowledge of the study. The practical and theoretical significance of the research are elucidated, and the limitations of the research expounded. Recommendations for further research are proposed.

1.5 Statement of Interest

The integration of design and technology has given a new impetus and meaning to the design field, more precisely, interaction design. The application of interaction design in the field of human computer interaction is constantly taking a new dimension. It aims at improving social computing ranging from usability issues of websites to player experience of mobile gaming. Consequently, interaction design is now associated with other fields like sociology, psychology and computer science, and hence, it becomes imperative for a designer to understand the practice from an inter-disciplinary perspective.

Design is more of a process, which requires different competencies. My focus has changed from a graphic designer to that of an interaction designer to study aspects of user experience design and human technology interaction as they relate to user interfaces. As a designer, I am always fascinated by the genesis of new ideas and user interaction with products. I experiment with a variety of artistic styles and techniques so that I may communicate my design with simplicity and in a creative manner. I translate my skills to come up with innovative design solutions in the field of interaction design. My research interests within HCI design now include cross disciplinary topics in emotional design, user interface design, aesthetics, usability, user experience design, and evaluation.

1.6 Chapter Summary

Existing studies have not fully explored the relationship between usability and visual design, particularly in the tablet gaming environment. Moreover, in the area of tablet gaming, the association between perceptions of hedonic quality and visual design has not been sufficiently understood. Research in HCI has shown inconsistencies in how users perceive usability and visual design in products. These studies have mainly focused on the interactive domains of mobile devices and websites while a critical analysis of visual design in the domain of tablet gaming has remained understudied.

This chapter sets out the development of the thesis, which employs a new methodological approach known as design-oriented research to devise two types of tablet game, *Easy Fun and Hard Fun Key*. Their visual design conditions are manipulated into a high and a low-quality level to assess the impact of visual design quality on the perception of usability, perception of visual design, perception of hedonic quality, channels of experience, and perceived game enjoyment. A new theoretical player experience design framework is proposed using the above components and empirically validated. The validated framework will serve as a new theory in the domain of tablet gaming and provide robust guidelines for researchers and practitioners during game design and development. By carefully considering the components associated with player experience design, optimum level of user experience in tablet games can be designed and created.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the theories that inform the development of the proposed research model, specifically, the components of player experience (PX). The relevance of each component that plays a key role in the design for user experience (referred to as PX in the context of digital gaming) are structured into different sections: 2.2 Visual Design; 2.3 Hedonic Quality; 2.4 Emotional Design; 2.5 Game Flow; 2.6 Models of User Experience; 2.7 Research Gaps. The relationship between visual design and hedonic quality in products/systems are reviewed. Moreover, the *Three Levels of Emotion Processing* theory has been discussed to show how it fits into the theoretical framework for player experience. The concept of *channel of experience* in games is explicated, along with an extensive review of each PX component and their influence on game enjoyment.

2.2 Review of Theories

There are several key theories that have been reviewed and considered in this study. For instance, the *Three Levels of Processing theory* (Norman, 2004), *Appraisal theory* (Frijda, 1988; Lazarus, 1991), *Component Process Model* (Scherer, 1984), *Circumplex Model* (Russell, 1980), *What is beautiful is usable* (Tractinsky, Katz, & Ikar, 2000), *Three levels of product experience* (Desmet & Hekkert, 2007), *Inference Model of user experience extended to hedonic quality* (Hassenzahl, 2003), *User Engagement* (O'Brien & Toms, 2008), *Classical* *and Expressive Aesthetics* (Lavie & Tractinsky, 2004), *Aesthetic theory* (Engholm, 2010), *Hedonic Experience* (Hassenzahl, 2003), *Motivational theory* (Malone, 1981), *Component of User Experience* (Mahlke, 2008), *The Four Fun Keys* (Lazzaro, 2004), *Flow theory* (Csikszentmihalyi, 1990), *Game heuristics* and *Usability Guidelines* (Federoff, 2002), *Game flow* (Sweetser & Wyeth, 2005), *Self-Determination theory* (Przybylski, Scott Rigby, & Ryan, 2010), *Channels of Experience* (Nakamura & Csikszentmihalyi, 2009), *Pleasures of Play* (Costello & Edmonds, 2007), *Centrality of Visual Aesthetics in Products* (Bloch, Brunel, & Arnold, 2003).

2.3 Visual Design I Interface Design

Aesthetics is a topic that has gained momentum among HCI researchers (Hassenzahl, 2010) as it is a fundamental part of user experience. *Form* and *function* have both played an important role in the making of an artefact, while it is only recently that the notion of *form* has gained considerable value in several areas (Katz, 2010). Function is connected to the usability and usefulness of a product, whereas *form* is associated with the aesthetic, social and emotional needs of designers and end-users (Tractinsky et al., 2000). HCI researchers and designers are paying much attention to the aesthetic and hedonic quality of interactive products to provide end-users with positive experiences. Consumers' preferences and choices now tend towards appeal and pleasure.

In its broadest sense, there are different meanings to the concept of aesthetics when applied to games (Niedenthal, 2009; Andersen, Liu, Snider, Szeto, & Popovic, 2011). First, it is associated with the "sensory phenomena" through visual, auditory, haptic cues and embodiment. The second perspective is that digital games are regarded as "artistic objects"; game aesthetics is considered an art form as the player is receptive of an experience similar to appreciating a work of art (Fonseca, 2016). Third, Engholm (2010) describes aesthetics as the "sensuous qualities, the emotions, moods, and experiences" that occur during interaction with a product. Visual design appeals to our senses, which in turn influences our perception, and is considered an important element that can engage a user (O'Brien, Toms, Kelloway, & Kelley, 2010; O'Brien & Toms, 2008). This thesis positions itself to understand and examine the perceptual impact of visual design on human behavior in tablet game user interfaces.

Several methods exist to study aesthetics within HCI. For instance, the *Functionalism* approach (Udsen & Jorgensen, 2005) is similar to the concept of visual design, which is viewed from the following angles – *design*, *psychological* and *pragmatic* or practical perspectives (Lavie & Tractinsky, 2004). These three different aspects overlap to a certain extent in the study of aesthetics. For instance, visual design adds value or credibility to a product (Robins & Holmes, 2008; Li & Yeh, 2010; Lindgaard, Dudek, Sen, Sumegi, & Nunan, 2011). Visual design has been studied from a psychological lens. And from a practical perspective, visual design can help a user to make distinction among similar products for purchase decisions or to shape user perceptions toward product use (Righi, Gronchi, Pierguidi, Messina, & Viggiano, 2017; Zhang & Von Dran, 2000).

Lavie and Tractinsky (2004, p. 271) claim, "Aesthetics has different meanings for different schools of thought." From the *Vitruvian design* point of view, the authors refer to the Vitruvian theory of architecture from the 1st Century B.C. (see Kruft, 1994) that stipulates how architecture was based on three main foundations: strength (*firmitas*), utility (*utilitas*) and aesthetics (*venustas*). Utility of Information System was measured objectively in the early 1980s whereas subjective evaluation gained more importance a decade later (Lavie & Tractinsky, 2004). *Venustas* did not fit the concept of computing or interactive systems, as it was associated with fashion or glamour, while computing was connected to physical science, efficiency or utility. Subsequently, visual design started to gain importance in the computing community as important conferences like ACM SIGGRAPH, ACM CHI (Computer Human Interaction), Mobile HCI, and HUCAPP (Human Computer Interaction Theory and Interaction) emerged. The Apple iMac, for instance, revolutionized computers' look and feel that brought about the aesthetic revolution in the field of computing.

Some studies have even shown that there is a correlation between the visual design quality and perceived usability of products (Tractinsky et al., 2000, Lavie & Tractinsky, 2004; Sonderegger & Sauer, 2010). But when the two attributes, visual design and usability overlap in heuristic questionnaires, measuring each attribute accurately becomes problematic. For instance, the item "clear design" showed dualism by indicating both classical aesthetics and perceived usability (Lavie & Tractinsky, 2004). Similarly. Hassenzahl (2007) (as cited in Mahlke, 2008[1]) pointed out that the construct of Lavie & Tractinsky's (2004) *expressive aesthetics* questionnaire gauged motivational factors expressed by visual attributes rather than emphasizing aesthetic properties of the interactive product.

Lavie and Tractinsky (2004) devised a tool, the "Classical and Expressive aesthetics" questionnaire, to measure visual design in products. *Classical aesthetics* refers to the traditional design guidelines adopted by artists/designers such as symmetrical design, grid system, and the Golden Ratio, which is a mathematical theory for aesthetically pleasing proportions when the ratio of 1:1.61 is applied to a design. *Expressive aesthetics* is defined as a creative manipulation of the guidelines to devise an original or sophisticated design solution. Aesthetically pleasing objects induce positive emotions in users (Jordan, 2000) that in turn accentuate creativity and thought processes (Norman, 2004). Visual design plays an important element because it adds value such as credibility and trust to the products (Robins & Holmes, 2008).

In a study, the visceral criteria related to the aesthetic components were evaluated using low and high-quality websites; with no conscious effort involved, what was perceived at first glance was automatically recorded (Robins & Holmes, 2008). They confirmed that the credibility rating increased when the level of visual design quality was accentuated for the same content displayed, a phenomenon known as the "melioration effect." The average response time to make a judgment on a website stimulus was 3.42 seconds. The researchers affirmed that it was a visceral and not a cognitive judgment. Yet, it is crucial to find out which "elements, features, or configuration of features affect judgment of credibility (Robins & Holmes, p.398)." As these authors suggested, further work needs to be done to explore the "rhetoric of visual interface." Consequently, we understand that the visual elements of any digital interfaces – such as a game or website have an influence on players' behavior and interaction and hence it is imperative to examine the perception of visual design in the context of touch screen game interfaces.

Game mechanics, dynamics and aesthetics form the MDA model explaining how the components are inter-rated (Hunicke, Leblanc, & Zubek, 2004). Furthermore, game dynamics sustain the *challenge* aesthetics. And game mechanics are the actions that are afforded to the player within gameplay. Kim (2015) explains that game aesthetics can be characterized by *challenge, fantasy, story, sensory* (e.g. visual, auditory). Gameplay therefore gives rise to an aesthetic experience, which entails sensory engagement capable of transporting a player to a fantasy world. Visual design is the creation of imagery for a game interface whereas game design is concerned with the rules and contents. The player first encounters the imagery of the visual design which expresses the game concept (Friedman, 2015). Meaning is derived at the conceptual level where the visual design and game rules meet.

Aesthetic quality plays an important role in determining the amount of enjoyment a user experiences while interacting with a system or product (Jordan, 1998). Aesthetics enhances the overall product look and feel, and also determines user expectation that gives rise to user experience (Thuring & Mahlke, 2007). It has been found that factors such as gaming interface, sound effects, player interaction, player skills, and game challenge level can affect perceived enjoyment (Su, Chiang, Lee, & Chang, 2016). Tractinsky (2000) explained how aesthetics would influence the perceived usability of a system before and after use, and user satisfaction also depends on aesthetics (Lindgaard

& Dudek, 2003). Hassenzahl and Monk (2010) have justified that the study of "beauty" has become a predominant part of user experience research. HCI researchers have analyzed "beauty" objectively using a psychological approach, unlike art historians, who evaluated "beauty" through a subjective lens (Norman, 2004[2]; Palmer, Schloss, & Sammartino, 2013). Ashby and Johnson (2003) delineated a distinction between a good design and a superior design; good design may be usable and functional, whereas a superior design will make the user happy (Norman, 2004).

Merikivi, Tuunainen, & Nguyen (2017) explain that visual attractiveness in user interfaces plays a crucial role in sustaining game play and interest. They further reiterate that elements such as layout, colors and attractiveness are drivers for game immersion. According to Van der Heijden (2003), mobile game enjoyment is also influenced by design aesthetics. Okazaki, Skapa, and Grande (2008) indicated that visual appeal is governed by design aesthetics. Translating Tufte's (2001) theory of information visualization into the arena of mobile game user interfaces, it is inferred that players are able to process graphical information swiftly if the interface graphical elements are showcased in a hierarchical manner and with clarity (Quispel, Maes, & Schilperoord, 2018). Clarity of visual information in interfaces gives rise visual attractiveness (Ngo, Teo, & Byrne, 2003). Yin, Yeh and Wei (2013) conducted a study on website screen space and found out that a ratio of 3:1 (image to text) enhances the look and feel.

In sum, aesthetic quality plays a crucial role in tablet game interfaces as it is one of the components that affect player experience. Subjective judgment of the visual aspect of a product can influence product use. By focusing on a single manipulation of a product feature, a researcher can measure the perceptions and preferences of a subject to identify the relationship between product and subject. Both Verzer and Hutchinson (1998) and Markovic (2012) feel that more research is needed to understand the possible reasons for the differences and similarities between individual aesthetic responses. Furthermore, everyone has a different level of perception of beauty. Verzer and Hutchinson (1998) argue that aesthetic response factors cannot be generalized, as the experience can be both subjective and objective in nature. At this time, a researcher cannot predict how two individuals will react when exposed to the same stimulus. Therefore, in order to obtain a more accurate evaluation of the visual gestalt of game interfaces, it is essential to consider the degree of sensitivity a user has to visual design. Hartmann, Sutcliffe, & De Angeli (2008), explain that it is imperative to study the behavior of aesthetically sensitive and non-aesthetically sensitive participants in user populations, especially if the aim is to investigate different levels of visual complexity in a user interface design. Product acceptance depends on both the instrumental qualities or pragmatic properties (such as functionality, practicality, utility, usability) and non-instrumental qualities (such as visual design and hedonic quality).

2.4 Hedonic Quality

Hedonic quality is an extension of pragmatic quality such that the former is inherent to pleasure or enjoyment in products (Diefenbach, Kolb, & Hassenzahl, 2014). Hassenzahl and Monk (2010) define hedonic quality as "*a judgment with regard to a product's potential to support pleasure in use and ownership* (p. 239)." The three aspects of hedonic quality are:

stimulation, identification and *evocation* (Hassenzahl, 2004, 2003, 2001). *Stimulation* has to do with how the product affects "proliferation of knowledge and skills." *Identification* is how a person can express himself through ownership or possession of physical objects. *Evocation* occurs when certain products "provoke memories" (Hassenzahl, 2003). Based on the above definition, the most important hedonic component that pertains to digital games in this research is "stimulation", which includes type of interaction and motivation.

Figure 2.1 below illustrates the User Experience (UX) Inference Model (Hassenzahl 2003; Hassenzahl & Monk, 2010), later validated by another study conducted by Van Schaik et al. (2012), illustrating the relationships among four constructs: *beauty, hedonic quality, usability* and *goodness.* In relation to the product, this model shows that hedonic quality is influenced by beauty (visual design), and usability is mediated by goodness. In simple terms, a user has a perception of a product before and after use, based on its properties or feature sets. The perceived usability in turn has a specific outcome judged by the user as good or bad, hence the term "goodness". Hassenzahl and Monk (2010) explain that "perceived usability" of a product is not context-dependent, but how usable a product is, certainly depends on the context of use.

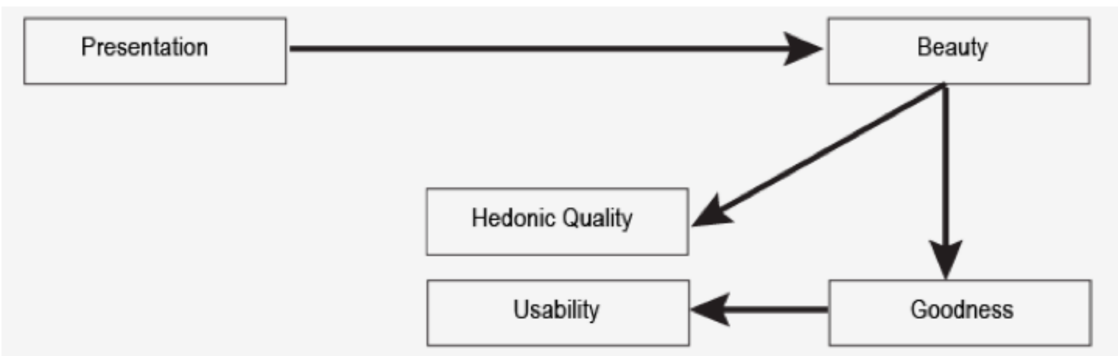

Figure 2.1. Inference Model of UX extended to Hedonic Quality (Hassenzahl, 2003)

Aranyi and Van Schaik (2015) found that positive valence affects perception of hedonic quality but not the perception of pragmatic quality, whereas negative emotions affect the perceived pragmatic quality but not the perceived hedonic quality (as cited in Minge & Thuring 2018). It has been argued that visual design quality has a strong influence on hedonic quality in the domain of website design (Jetter & Gerken, 2006). According to the Fluency theory, an individual makes use of his perceived hedonic reaction as a shorter alternative route to evaluate the aesthetic quality of a product (Reber, Schwarz, & Winkielman, 2004). Mahlke (2007) defines non-instrumental quality of a product to include hedonic (symbolic, motivational) and aesthetic (haptic, acoustic, visual design) aspects. Hedonic user-perception is also linked to perceived enjoyment, novelty, and stimulation (Hassenzahl, 2010). According to Malone's (1981) motivational theory, intrinsic motivation is dictated by challenge, fantasy, curiosity and control. In order to promote optimum player experience, a game needs to maintain some kind of balance between these (Hunicke, 2005). This implies that a game should not be too easy, nor too difficult. The presence of a dynamic difficulty component makes a player adapts to the game (Chen, 2007). Therefore, the inclusion of motivational factors such as Dynamic Difficulty Adjustment (or adaptive challenge) in games serves as a basis for the hedonic component, and this is therefore incorporated into this thesis. This specific component will be discussed further in the game design chapter, Chapter 4.

2.5 Emotions

In this section, the emotional theories are discussed with elaboration on the importance of emotional components built into games, and the different kinds of emotions experienced during gameplay. Modern games appeal to both brain and body. They are engaging, entertaining, and filled with learning experiences. They require thinking and acting, cognition and emotion, body motion and mental creativity (Norman, 2010). A lack of emotions impairs cognitive abilities. More specifically, both brain and body interact to generate certain kinds of emotion and experience. Emotions can be caused by thoughts and by physical mechanisms we are not conscious of. Hence, user behavior and motivation are accentuated and governed by emotions (Desmet, 2008). Finally, the three levels of product experience are "aesthetic pleasure, emotional response and attribution of meaning (cognition)" (Desmet & Hekkert, 2007, p. 13).

The word "affect" is a broad term that covers a wide spectrum of experiences like emotions and moods. Emotions are experiences that last for a short duration but are intense, as opposed to moods, which occur for a longer period but are less intensely experienced. According to the Appraisal theory, emotional responses go through a prompt evaluation process, such that the beholder appraises the stimulus (Demir, Desmet, & Hekkert, 2009; Lazarus, 1991). Parkinson (1994) explains that four components give rise to an emotional experience independently: (i) cognitive appraisal of an external stimulus, (ii) bodily reactions (e.g. arousal), (iii) facial expressions, (iv) action tendencies, such as preparing to approach a positive stimulus or retreat from a negative stimulus. These four factors are dependent upon each other such that cognitive appraisals have an effect on bodily reactions, facial expression and action tendencies. Lazarus's (1982, 1991) Appraisal theory is fundamental to emotional theory and its essence is that "*appraisals start the emotion process, initiating the physiological, expressive, behavioral and* *other changes that make up the resultant emotional state*" (Roseman & Smith, 2001, p. 7). Frijda (1988) explains that if a user appraises a stimulus that is favorable to her concerns, then that person will experience positive emotions. By contrast, if a stimulus is appraised as against an individual's concerns, negative emotions will be experienced. It is speculated that different appraisals give rise to different types of emotions (Orthony & Foss, 1987). There are generally two main categories of emotions, positive and negative emotions (Desmet, 2002).

Emotion forms part of our affective system that helps us interpret what is good or bad. The three levels of processing theory (figure 2.2) on *visceral, behavioral, and reflective* affect the function of our brain and every activity we perform triggers the cognitive and affective component respectively (Norman, 2004). According to the Three Levels of Processing theory, when the player is exposed to the user interface, *visceral* responses occur, which are immediate reactions based on perceptual features. Visceral emotional responses are followed by *behavioral* level responses that take place during game play, which is the total experience of using the product/system (Norman, 2002). In this case, the player's expectations are considered, which are measured by the playability evaluation, and hence we can obtain a confirmation or denial of those expectations (Don Norman, email communication, Feb 2014). The cognitive part of our brain assigns "meaning" or seeks understanding whereas the affective part concerns "value." The *visceral* layer or the top-most layer, refers to the sensory input as per how things look, feel and sound to prompt the user to make rapid judgment of a stimulus as it relates to the impression conceived. *Behavioral* design occurs at our subconscious level; it is the level that conveys the pleasure and effectiveness of use. *Behavioral design* level has to do with functionality, understandability, usability, and physical feel. Additionally, at the *reflective* level, the user derives the meaning of things. It has to do with personal satisfaction, self-image. Both *behavioral* and *reflective* layers are influenced by knowledge, experience and culture (Norman, 2004). The author asserts how negative affect helps an individual to focus deeper whereas "positive affect arouses curiosity and engages creativity" (p. 26). He adds that a minor usability problem with a product is soon ignored if the product is fun to utilize. A group of researchers explored the area of "affective gaming" by studying the effect of Dynamic Difficult Adjustment (DDA) to adapt game activity to the skills of game players (Liu, Agrawal, Sarkar, & Chen, 2009).

In addition, Wrigley (2011) explained the significance of "*visceral hedonic rhetoric model*" for designers to create interactive products that elicit continuous emotional reaction from end users. The researcher further asserted that the entire choices of visual elements in a product prompt emotional response. It is therefore necessary to examine which features of the visceral rhetoric emanate hedonic responses. Consequently, Wrigley (2011) mentioned that the *visceral hedonic rhetoric model* required further exploration in other design areas so that designers could draw insights on the influence of *visceral hedonic rhetoric* by visceral reactions.

In the context of tablet games, a player is exposed to a variety of design elements (HUD, character, obstacles, environment) on stage, and has to make quick and thoughtful decisions for gameplay to occur. Hence it is important to understand the impact of these elements on human behavior and reaction in different game categories.

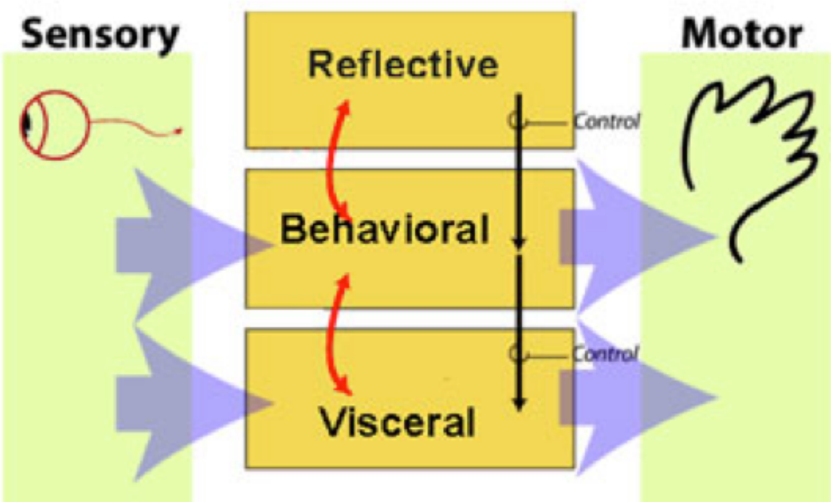

Figure 2.2: Three levels of Processing Theory (Norman, 2004)

A product or interface is designed to specifically elicit the desired emotions from the user. For example, as explained by Helander & Tham (2003), during the use of a complex technological device, positive emotions (e.g. fun) may diminish the intensity of negative emotions (e.g. anxiety), and therefore enhance the perception of usability with a product (Tractinsky, Katz, & Ikar, 2000), and contribute to a better user experience (Vink, 2005). This implies that well designed products evoke a wide range of distinct positive emotions that are pleasurable to use (Desmet, 2012). However, in digital gaming, challenge is not regarded as a usability obstacle and game enjoyment is not always derived solely by positive emotions (Hazlett, 2006). It has been shown that there is an episode of negative emotion that is built up during a challenging gameplay, and as soon as this challenge is overcome by the player, there is a surging "positive emotion spike" (Hazlett, 2008). It has been found that although a player elicits acute negative emotions during game activity, this may often give rise to a satisfying experience, adding to the overall game enjoyment (Bartsch, Vonderer, Mangold, & Viehoff, 2008; Jäger & Bartsch, 2006). A user may react differently to each kind of emotion. Since less importance has been attributed to negative emotions in digital games, this thesis aims to understand its connection with positive player experience.

In particular, an intense or repetitive emotional occurrence perpetuates into mood (Brave & Nass, 2002). In the following study, Hutton and Sundar (2010) varied the levels of arousal (low, medium, high) in the video game entitled "*Dance Dance Revolution*" and induced a positive or negative mood to investigate how emotion could affect an individual's creativity when the two independent variables, arousal and valence, would interact. This revealed that lower levels of arousal gave rise to higher creativity scores when induced with a negative mood. The outcome of higher levels of arousal coupled with positive mood increased the amount of creativity in an individual. This study reveals that games devised to inspire creativity should induce enough excitement to incite players who win the game to be happy, or if they lose, they should not be frustrated.

2.6 Game Flow

Game mechanisms are designed for emotional elicitation, and gameplay can evoke more than 30 different types of emotions (Isbister & Schaffer, 2008). Admittedly, emotional elicitations help enhance interaction with a product or system (Brave & Nass, 2003). GameFlow (Sweetser & Wyeth, 2005) is a set of heuristics based on the fundamentals of the *Flow* theory (Csikszentmihalyi, 1990) to design and evaluate enjoyment of players in games. It is aimed at evaluating individual player game experience (Sweetser et al., 2012). Previous research focused mainly on three components of game usability: game mechanics, interface, and gameplay (Federoff, 2002), but without any aspect of enjoyment considered. According to Csikszentmihalyi (1990), flow is described as the state of "optimal experience", irrespective of social class, age and gender, which is cross culturally validated (Fave & Massimini, 2004; Moneta, 2004). The author further explains that flow activity is not passively experienced. Optimal experience occurs within activities that are goal oriented, bounded by rules, which is the essence of games. It is not necessary for one to experience all the above conditions for flow to occur. The constituents of Csikszentmihalyi's (1990) flow are:

- *A challenging activity that requires skill*
- *Merging of action and awareness*
- *Task must have clear goals*
- *Direct and immediate feedback*
- *Ability to concentrate on the task*
- *The sense of time disappears*
- *Exert a sense of control*
- *Loss of self-consciousness*

Csikszentmihalyi (1998) explains how experience occurs during a span of time, an essential factor of product/system interaction; he coins the concept of optimal experience as "*flow*." According to Pavlas's (2010) model of flow and play, the main components of *flow* pertinent to digital games are: (i) clear goals (ii) sense of control (iii) feedback (iv) balance between challenge and skills. Many game research studies relate the concept of *flow* with games (Sweetser & Wyeth, 2005; Ermi & Mäyrä, 2005; Takatalo et. al, 2010).

Csikszentmihalyi's (1991) theory of flow describes when a user's mind is so engaged in an activity that there is a convergence between her actions and awareness. This optimal experience linked to motivation and attention, is essential in games. Pleasure is a kind of experience that is embedded into games and can be viewed as a "physical reactions or a cognitive response". One aspect of pleasure in games is the intensity with which it is experienced (Salen & Zimmerman, 2008, p.8). Optimal engagement is caused by the "engagement in actions out of intrinsic motivations," an effect that is most pleasurable, gratifying and meaningful emotional state one can experience (McGonical 2011, p. 45). *Flow* may be described as an optimal motivating experience, as the player is immersed into the game activity. *Flow* occurs when the optimal levels of challenge and skill are reached. Therefore, in a game scenario, a player is in a state of *flow* when his skills match the difficulty level he encountered during gameplay. Figure 2.3 shows if the game challenge exceeds the skills level of the player, this will give rise to anxiety; whereas if the player's skill level surpasses the game challenge, the player will feel bored (Chen, 2007). Csikszentmihalyi (1991) emphasizes that *flow* activity is not passively experienced. It requires active and direct engagement of the user.

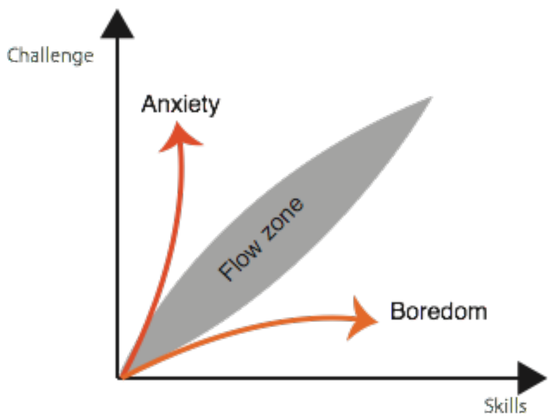

Figure 2.3 Flow Graph (Csikszentmihalyi, 1990)

To summarize, it has been found that intrinsic *motivation* (e.g. challenge, fantasy and curiosity) is more powerful than any extrinsic motivation (Malone, 1982; Lepper, Green, & Nisbett 1973). For the most part, the effect of *flow* has been studied on user experience and game enjoyment (Sweetser & Wyeth, 2005; Ermi & Mäyrä, 2005; Takatalo et. al, 2010,) but little research has been conducted to examine the effect of other channels of experience (such as anxiety, boredom) on game enjoyment and player experience (Guo & Klein, 2009; Reese 2010). Each condition of the *Channels of Experience* is a measure of the ratio of challenge to skill that the user reports (Csikszentmihalyi & Hunter, 2003). In order to create a challenging activity, the outcome of the game should be uncertain. Therefore, the aim of game designers is to provide an optimal level of experience and engagement to the game players.

2.7 User Experience Models

Within the HCI arena, more emphasis is being geared on user experience, which is considered the non-utilitarian side of a product, as compared to the "cognitive task performance" facet, also known as utilitarian aspect (van Schaik & Ling, 2012). The non-utilitarian facet is commonly referred to as the hedonic attribute, which elicits "pleasurable and playful experiences" from end-users. Yet, there is no consensus on a well-established player experience model despite the fact that player enjoyment is such an imminent factor in the domain of computer games (Sweetser & Wyeth, 2005). In fact, researchers have suggested several models of user experience from different perspectives (Korhonen et al., 2009). The concept of *user experience* is subjective in the sense that the experience, expectations and knowledge of a particular product will affect the user's evaluation and perception of similar new products (Kankainen, 2003). Researchers have defined user experience to be "subjective, dynamic, context dependent" (Hassenzahl & Tractinsky, 2006, p. 95). UX is the result of a user's personal state and feelings, based on the feature sets and interaction with the product (Hartmann, Sutcliffe, & De Angeli, 2008; Hassenzahl & Monk, 2010; Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009). The emotional reactions and feelings evoked during interaction with a product or system form part of user experience (Desmet & Hekkert, 2007). Game designers need to produce various experiences in order to generate enjoyment or frustration within the player. Birk and Mandryk (2013) utilized the concept of *Self-Determination theory* (Ryan & Deci, 2000) as a way to understand the relationship between game play and player experience through the player's experience of needs satisfaction (PENS) survey. Self-Determination theory stipulates a set of theories, one of which is linked to intrinsic motivation. This survey measures competency, autonomy, relatedness, presence and intuitive controls as five separate functions that are proven to correlate with player satisfaction and enjoyment. Przybylski, Rigby, and Ryan (2010) concur that player satisfaction and enjoyment can be predicted using the PENS tool to measure the intrinsic motivation of the player. Therefore, the motivational factor in digital games is prominent.

There are two frameworks for playful experience that provide a starting track for designers and researchers to pursue. For example, Costello and Edmonds (2007) proposed a framework depicting "*pleasures of play*" whereby they developed thirteen pleasure categories, namely: *Captivation, Camaraderie, Creation, Competition, Danger, Discovery, Difficulty, Exploration, Fantasy, Sensation, Sympathy, Simulation, Subversion.* This framework is useful for understanding playful experiences of interactive artworks, but does not reflect the typical user experience archetype, mainly geared towards aspects of usability. Another group of researchers investigated the concept of playfulness in three video games, expanded the list to nineteen categories, and deduced that the subtlety of experiences that digital games produce are myriads (Korhonen et al., 2009). This multi-category playful experience may be used as an instrument for designing and assessing non-utilitarian properties in products to make them more appealing for end-users. The 49 items heuristics UX framework devised by Hochleitner, Hochleitner, Graf, & Tscheligi (2015) poses certain challenges as it was based solely on quantitative score reviews which did not incorporate the qualitative nature of gaming experience.

2.7.1 Component of User Experience (CUE) Model

Furthermore, a user experience (UX) model such as the Component of User Experience (CUE) Model is addressed (Mahlke, 2008). It is comprised of three components: instrumental and non-instrumental quality perceptions, in addition to emotional responses elicited by users. The CUE model shown in figure 2.4 is based on the following three empirical studies conducted by Mahlke (2008) and was devised to evaluate user experience in interactive systems. Below, the direction and results of study 1 and 2 relevant to this thesis are discussed.

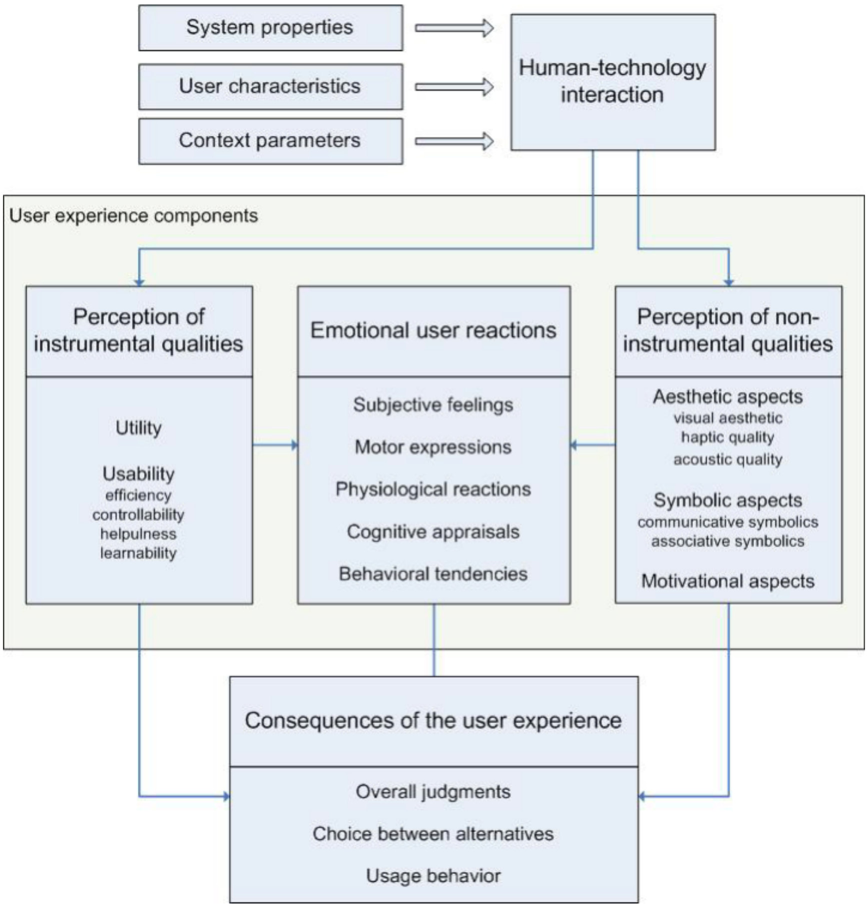

Figure 2.4 Components of User Experience (Mahlke, 2008)

STUDY 1: SYSTEM PROPERTIES OF EXISTING PRODUCTS (Mahlke, 2008)

The first study tests the following assumption of the model: "*the properties of an interactive system influence interaction characteristics, quality perceptions (instrumental and non-instrumental aspects), emotional user reactions, and overall judgments*." Four different portable audio players from the same manufacturer were utilized as stimuli to investigate if the modified system properties would have the proposed influences on UX components. Thirty participants took part in the study. A within-subjects ANOVA test was conducted, followed by regression analyses. The independent variables in this study were the variation of system properties - the size of each display, interaction style (input button and slider), and presentation of information in each portable audio player, icons, and text for the menu. The dependent variables were: interaction characteristics (time on task and number of accomplished tasks), instrumental qualities (perceived ease of use and usefulness), non-instrumental qualities (perceived visual design, perceived haptic quality, perceived symbolic quality), emotional user reactions (subjective feelings), and consequences of UX (overall judgment, and ranking of devices).

The functionality aspect, such as the task the participants were required to execute in each portable device was similar. The results of study 1 concluded that the differences in the four stimuli affected the experience of each user's interaction. Furthermore, it was found that the features of the interactive systems (portable audio players) affected the perception of non-instrumental qualities and perception of instrumental qualities independently. This means that usability features did not influence the aesthetic qualities of the products. It was not possible to differentiate to what extent the multiple system properties had an effect on the perception of instrumental and non-instrumental qualities. Also, emotional responses were only influenced by perception of instrumental qualities (perceived ease of use and usefulness respectively), whereas both instrumental and non-instrumental quality perceptions affected the overall judgments.

STUDY 2: EXPERIMENTAL VARIATION OF SYSTEM PROPERTIES (Mahlke, 2008)

Forty-eight participants took part in Study 2 in which simulated portable audio players were presented as stimuli on a touch screen. The features of the products were deliberately modified into unique interaction styles for users to convey distinct perceptions of instrumental and non-instrumental qualities. In order to accommodate a low and high version of non-instrumental perceptual qualities into the system, the visual design of the two simulated audio portable devices were altered in the following manner: symmetry (low or high), color combination (low or high color differences), and shape (round or square). In addition, in order for the two different devices to yield two different versions of perceived instrumental qualities, the following items were altered into low and high quality: number of menu items that are shown in each screen (two and five); a scrollbar on the left of the menu item to indicate that the user could find more hidden menu items (with scrollbar and without scrollbar). Consequently, two independent variables were created, usability and visual design, and each variable was modified into a low and high-quality condition. this gave rise to four treatments in all: (i) high usability, high visual design; (ii) high usability, low visual design; (iii) low usability, high visual design, and (iv) low usability, low visual design. The following dependent variables were evaluated: interaction characteristics (to measure performance); instrumental qualities (to measure perceived usability); non-instrumental qualities (to measure visual design); emotional reactions (to measure subjective feelings, motor expression, and physiological reaction); consequences (to measure overall judgment and ranking of stimuli).

The results of study 2 showed that perceptions of ease of use and visual design values were mutually exclusive in the sense that they were independently affected by the different conditions of the system properties. Moreover, the stimuli affected emotional responses such as subjective feelings, physiological reactions and motor expressions respectively.

The perceived high-quality usability version of the system properties was valued more than the perceived high-quality visual design. Therefore, the perception of instrumental quality (e.g. usability) had a stronger impact on system properties than the perception of non-instrumental quality (e.g. visual design quality). It was concluded that emotions, usability and visual design had an impact on overall user experience.

LIMITATION OF THE CUE MODEL

The stimuli used in Study 2 were not concrete portable audio players. Moreover, it becomes imperative to re-assess an extension of the CUE Model in other interactive domains using real prototypes/systems, other than simulations. Mahlke (2008) suggests that additional research needs to be done to investigate "design principles and patterns" that will provide better understanding when designing for non-instrumental aspects. The construct of the non-instrumental quality considered in the CUE Model was *visual design* while *haptic* and *acoustic* dimensions did not form part of the scope of the project. Consequently, symbolic and motivational aspects were not part of the study either. Hence, the CUE model needs further validation for contemporary application to tablet devices; in addition to make it more generalizable, it will be worthwhile revisiting aspects of non-instrumental qualities pertaining to touch-screen gestures. The limitations highlight that there is a potential need to investigate *motivational* qualities for instance, to focus on the hedonic qualities in tablet games building on the CUE Model to devise a new framework for player experience to fully unfold the concepts of user experience.

Another relevant variable that is essential to examine is the temporal aspects to explore the "dynamics of user experience" over time (Ermi & Mäyrä, 2005). This is because user experience may be dissimilar if the product/system is being used over a shorter vs. longer period of time, or for the first time as compared to repeatedly using the same product/system (Fenko, Schifferstein, & Hekkert, 2010; Karapanos, Zimmerman, Forlizzi, & Martens, 2009; Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, & Sinnelä, 2011). The temporal effect of user experience is an emerging area within experience design.

2.7.2 SENSORY CHALLENGE IMAGINATIVE MODEL

The SCI framework (Sensory, Challenge, Imaginative) is related to the idea of immersion in digital game (Ermi & Mäyrä, 2005). The SCI framework (figure 2.5) was devised by observing game-playing children and their non-player parents. The authors conducted in-depth interviews with young players, whereby themes related to game immersion, including game culture, personal and social experiences were found. Of the three immersion components, "sensory immersion" is what players sense when they discern the visual layer of the game interface, whereas "challenge-based immersion" is the usage of

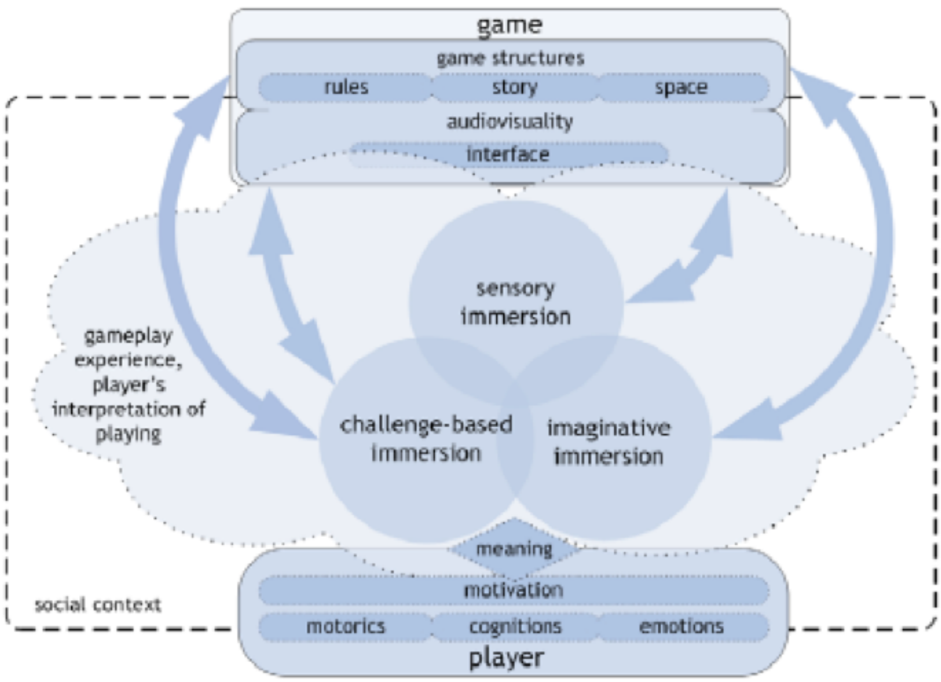

Figure 2.5. The Sensory, Challenge, Imaginative Model (Ermi & Mäyrä, 2005)

motor and cognitive skills in gameplay, equated to active participation, which is analogous to skills and challenge levels (Csikszentmihalyi, 1997).

Imaginative immersion is what carries the player away to a *fantasyland*, gets the player fully immersed into the game, if the game interface, game mechanics and gameplay are properly crafted. This is analogous to the feelings of empathy and atmosphere as described by Nacke & Lindley (2009).

2.7.3 PIFF (PRESENCE, INVOLVEMENT, FLOW, FRAMEWORK)

PIFF *ver2* (Presence Involvement Flow Framework) is a statistically validated 15 sub-items tool devised to understand and evaluate conscious experience (Takatalo, 2011). The PIFF2 framework (figure 2.6) was developed with the aim to study experiences in Virtual Environments such as digital games, and this approach could be used for any human-technology interaction situation.

The *experiential cycle* forms the basis of this theory, linking psychology with the environment. The PIFF2 instrument is a subjective questionnaire that can be used to measure stable phenomena related to user experience; its validity is proven by the fact that similar data were obtained from participant to participant across several experiments. On the other hand, physiological instruments provide accurate data but at times, the instrument may not detect the richness of game playing experience for valence-arousal space. Therefore, a subjective questionnaire is an appropriate tool for capturing multidimensional experiences in a complex human-technology interaction environment.

PIFF2 was developed from a quantitative study of 2182 participants who played 320 games, in different settings (home, online, offline, lab). The main components of PIFF2 such as *presence, involvement and flow* were analyzed using multivariate measurements. Ultimately, eight subcomponents were obtained from the *presence and involvement* category.

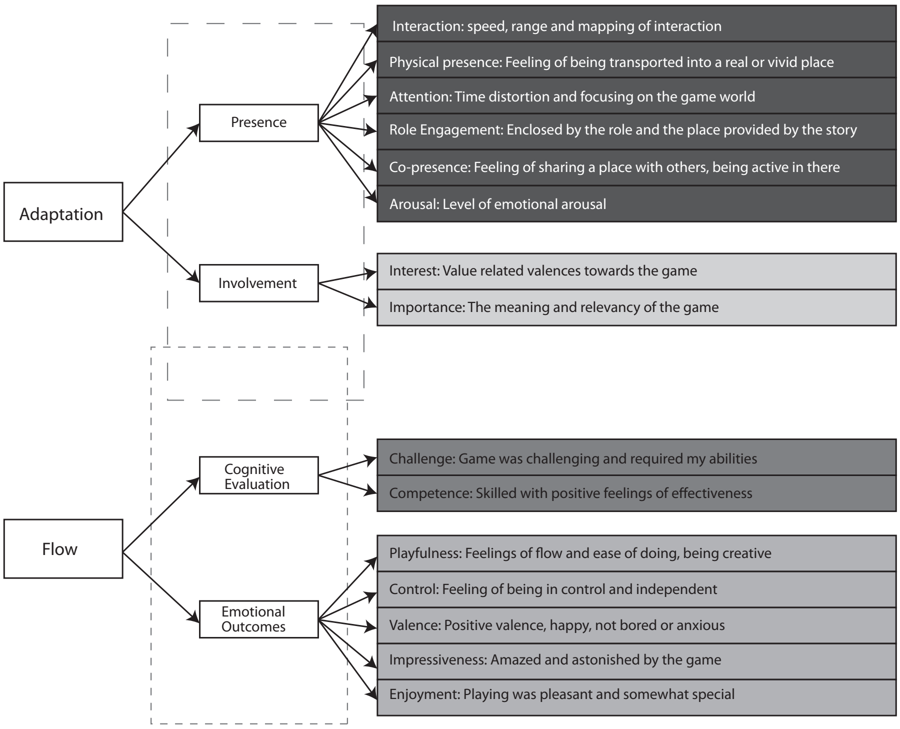

Figure 2.6 Presence Involvement Flow Framework (Takatalo, 2011)

2.7.4 PLAYABILITY

Playability is a property that defines player experience. From a design perspective, the following three elements - game mechanics, narrative and interactivity, are used to verify playability in games (González Sánchez & Vela, 2014). The concept of playability ensures that engagement, motivation and entertainment are present in a game. Playability is defined as the extent to which a player can reach targeted goals effectively and efficiently, including fun and satisfaction, in a gaming situation (González Sánchez & Vela, 2014). The playability model, validated using a case study, is also known as *facets of playability* and consists of the following six attributes: *intrinsic, mechanical, interactive, artistic, interpersonal and interpersonal* (González Sánchez et al., 2012). The *facets of playability* instrument have been developed to detect the degree of player experience in digital games. In other words, to increase playability, Kiili, Ketamo, Koivisto, & Finn (2014) pointed out that continuous interactive visual feedback is an essential ingredient in tablet games to motivate players.

Hence, in order to design user-centered experience products, it is essential to thoroughly understand how components such as emotional experiences, visual design and hedonic quality affect user experience. Users make choices. It is basically these components, which influence why users prefer certain products over others (Thuring & Mahlke, 2007). The new player experience framework in this thesis is built upon the CUE model (Malhke, 2008) in the context of tablet gaming. The CUE model explains how instrumental and non-instrumental qualities of a product, along with emotional elicitations, influence user experience, and the overall judgment one makes upon product interaction. In the new PX framework, there are two new components that have been investigated, *channels of experience* and *game enjoyment*. Their relations to emotional outcomes and player experience have been further examined for game developers and researchers to have a deeper understanding how these components give rise to game enjoyment, directly or indirectly. The *Three Levels of Processing Theory* (Norman, 2004) describes how users process emotions. This emotional theory has been appropriately adapted to this new PX framework, considering the three levels of emotions namely *visceral, behavioral* and *reflective*. During gameplay, a variety of emotions are elicited in a continuous manner. Emotions therefore play an essential role in game player experience.

2.8 Research Gaps

The concepts of instrumental qualities (usability, functionality) and non- instrumental qualities (beauty and hedonic) have been extensively discussed by HCI researchers, yet the findings of the following studies revealed methodological and theoretical inconsistencies (Hassenzahl & Monk, 2010). The concept of aesthetics has become an important topic among HCI researchers lately as it forms an integral part of user experience. In the study "What is Beautiful is Usable" (Tractinsky et al., 2000), the researchers found that the relationship between perceived usability and perceived visual design was strongly correlated. The findings of this study were in line with the Automated Teller Machine (ATM) experiment on perceived visual design and usability, conducted by Kurosu & Kashimura (1995). Sauer and Sonderegger (2009) conducted a study in which participants were asked to execute simulated mobile phones on a computer screen echoed the results of Tractinsky et al. (2000). This might have been the cause of a halo effect. We cannot categorically deny the variability in usability ratings confounded by the visual design of the product to be impacted by minor alteration of the system properties.

Furthermore, Hassenzahl (2004) conducted a experimental study on MP3 skin players, and no relationship was found between "beauty and perceived usability". Mahlke (2008) revealed from the 3 studies he conducted on interactive systems that instrumental and non-instrumental qualities were perceived independently. The differences might have arisen from how the units of analysis were considered in those studies. A unit of analysis can either be the participants or the stimuli. Participants might have been sampled randomly but the stimuli were chosen based on preferences to represent different groups. While only one type of product was utilized as a stimulus in the above studies, the studies claimed that they were generalizable to other interactive products.

Furthermore, Mahlke and Lindgaard (2007) led two studies using portable audio players to examine the correlation between perceptions of instrumental and non-instrumental qualities. Two versions of the portable audio players were simulated by varying the level of usability (low and high) and visual design (low and high). The findings showcased that the variations of usability and design had independent effects on emotions. Mahlke and Lindgaard (2007) recommended that the impact of perceived visual design on emotions required further probing. The researchers warned that challenges such as the "inter individual differences of aesthetics judgments" with respect to visual design in human technology interaction were prevalent that needed attention (Mahlke & Lindgaard, 2007). Clearly a gap and inconsistency exist between *perception of usability and aesthetic qualities* in interactive systems, based on the above literature reviews.

Despite the fact that the validity of the CUE Model (Mahlke, 2008) was constructed based on three empirical studies, a key weakness is that the researchers made use of simulated mobile phones on screen for the participants to evaluate. This might have reduced the authenticity and validity of emotional reactions like visceral and behavioral responses (Wrigley, 2011). Thus, it was important to improve the validity of data collection, by reflecting on the contemporary application of iOS technology to devise the tablet games in this study for use on real iPads (Retina). Earlier work has shown that the effect of product aesthetics on task performance is dependent on the kind of prototype such as paper, computer screen simulation, or real product (Sauer & Sonderegger, 2009). For instance, users tend to be more forgiving of a low aesthetic quality product when it is a paper prototype than a real product (Nielsen, 1990; Hall, 1999; Sauer et al., 2008).

Moreover, hedonic attributes influence the perception of visual design (Van Schaik & Ling, 2008; Hassenzahl, 2004). A few studies consider visual design (beauty) a subset of hedonic quality (Diefenbach, Kolb, & Hassenzahl, 2014), while other studies show that there is an overlap between visual design and hedonic (Van Schaik, Hassenzahl & Ling, 2012). One important question that arises is to explore whether visual design attributes influence perceived hedonic quality, and hedonic attributes can in turn influence perception of visual design quality, thereby creating a cycle in the beholder's mind. Diefenbach, Kolb, & Hassenzahl (2014) recommended that a clearer notion and position of hedonic needs to be determined in future research given the fact that many studies indicated a dichotomous relationship between pragmatic and hedonic, while others assumed hedonic to be a subset of usability, coining the term "hedonic usability" (Hertzum, 2010); other groups of researchers considered "usability and functionality" to be the result of a "hedonic experience" (Stelmaszewska, Fields, & Blandford, 2004). For example, Diefenbach et. al (2014) further point out that 20% of 151 literature articles reviewed on hedonic topics consider beauty to be a subsidiary of hedonic experience. They assume there is an association between hedonic experience and visual design, yet they do not make an explicit statement about the different levels and subsets of qualities.

Each individual has a distinct level of perception of beauty. The 'Centrality of Visual Product Aesthetics" (CVPA) scale can measure the degree of visual design quality an individual account for a product (Bloch, Brunel, & Arnold, 2003). By profiling the background characteristics of participants, accurate results pertaining to visual design appraisal can be obtained. Hartmann, Sutcliffe, and De Angeli (2007) explain that it is necessary to study the behavior of both "aesthetically-sensitive and non-aesthetically sensitive" users, specifically if the goal is to examine multi-grades of visual complexity in user interfaces. This in fact responds to the idea of taking into account "inter-individual differences of aesthetic judgments" in the research questions, as visual design perception depends heavily on the background of the user (Mahlke & Lindgaard, 2007).

2.9 Chapter Summary

This chapter has outlined the technological shift towards the adoption of touch screens, which in turn popularized mobile gaming. This is a turning point of a disruptive technology, as the demand for tablets has now surpassed those of PC (Cortimiglia, Germán, & Seben, 2013). High resolution tablets, along with high processing power, make them a suitable platform for socialization, entertainment and information. Research on motivation (e.g. Technology Acceptance Model) within the HCI area has proven that both functionality and visual elements affect users' motivation and behavior that in turn affect usability (Davis, 1989; Lee, Song, Ryu, Kim, & Kwon, 2015). Several factors such as visual appeal, perceived ease of use, convenience, and escapism have eased the adoption of mobile games (Okazaki, Skapa, & Grande, 2008). A user perceives two main attributes of quality in a product: *pragmatic* and *hedonic quality* (Hassenzahl, 2001; Van Schaik, 2008); pragmatic quality has a utilitarian purpose whereas hedonic quality is associated with the derivation of pleasure and enjoyment during product use.

However, there are a number of shortcomings from current literature that were identified for the focus of this thesis and which are examined further in subsequent chapters. First, the lack of research in tablet gaming on the relationship between variation of visual design quality and the perception of usability. Second, the lack of research on the effect of a variation of visual design quality on emotional responses (valence and arousal). Third, the lack of research between variation of visual design (low and high) and perception of hedonic quality. Fourth, the lack of research on the effect of users' characteristics on game enjoyment. Fifth, the lack of research on other channels of experience (boredom, apathy and anxiety) besides *flow*. The next chapter 3 focuses on the analyses of gaps giving rise to the development of research questions and corresponding hypotheses.

Chapter 3

DEVELOPMENT OF RESEARCH OBJECTIVES

3.1 Introduction

The previous Chapter 2 reviewed literature pertinent components of user experience. Six research gaps were identified from extant literature that led to the development of research objectives and corresponding hypotheses in Chapter 3. The current chapter introduces the components of a new conceptual player experience (PX) framework. It then describes the role of each component in the framework, which provides the basis for discussing the emergence of the five research questions giving rise to six hypotheses.

3.2 Research Gaps

The section presents and discusses the six research gaps deliberated from the literature review.

3.2.1 Gap#1: Lack of research in tablet gaming on the relationship between a variation of visual design quality (low and high) and perception of usability.

The notion of aesthetics is considered a crucial topic in the field of HCI nowadays, as it forms part and parcel of user experience. Research in HCI has shown inconsistencies on how users perceive usability and visual design in products. In "*What is Beautiful is Usable*," (Tractinsky, Katz, & Ikar, 2000), the researchers found that the two variables *perceived visual design* and *perceived usability* were strongly correlated. These findings of this study were in line with the findings of the Automated Teller Machine (ATM) experiment in

Japan, where Kurosu and Kashimura (1995) revealed that the visual design qualities of a product influenced the product's usability was perceived by end-users. Furthermore, Sauer and Sonderegger (2010) conducted a study in which participants were asked to make use of simulated mobile phones on a computer screen; the results echoed the results of Tractinsky et al. (2000), which again indicated a correlation between perceived visual design and usability. This study showed that participants who utilized highly appealing cellphones rated the products to be highly usable. It is not certain if this may be the cause of a *halo* effect. It is a phenomenon presented by Edward Thorndike in 1920 which can lead to potential biases in a user's judgments; it can shift positive or negative judgments based on an attribute to another non-related attribute (Nielsen & Cardello, 2013).

However, another set of studies has found no relationship between visual design and usability. When Hassenzahl (2004) conducted a study on MP3 skin players, he did not find any relation between these two qualities. Mahlke and Lindgaard (2007) conducted two studies using portable audio players to determine whether perceptions of usability and visual design quality were related. Two different versions of the portable audio players by varying the level of usability and visual design were simulated to obtain four conditions. The findings disclosed that the variations of usability and visual design attributes in the products had independent effects on perception of usability and visual design, respectively, but did not influence each other.

However, the failure to find a relationship between visual design and usability in these studies might have resulted from a methodological shortcoming in how the sample units were defined. A sample unit can be either the participants or the stimuli. Participants might have been sampled randomly, but the stimuli were chosen based on preferences to represent different groups. Because only one type of product was utilized as a stimulus – MP3 skin players (Hassenzahl, 2004) and mobile phones (Mahlke, 2008) – in these studies, it is unclear whether their findings are generalizable to the domain of tablet gaming.

In order to fill this knowledge gap, this thesis will investigate the impact of visual design quality on the perception of game usability in the context of tablet gaming. Participants will be chosen at random to consolidate the external validity of my study, and participants will be randomly assigned to treatment groups to increase the internal validity of the study. Two different types of tablet games will be examined so that the results may be generalized for a broader set of applications.

3.2.2 Gap#2: Lack of research on the effect of a variation of visual design quality (low and high) on emotional responses in tablet gaming.

The two emotion dimensions are *arousal* and *valence*. They both play an important part in gaming behavior (Ravaja et al., 2006, Lazarro, 2004, Grodal, 2000). Arousal refers to the intensity of the emotion (e.g. calm to excited) whereas valence refers to hedonic aspect (pleasure to displeasure). The emotional elicitation during gameplay provides game researchers and developers with deeper insight of a player's behavior (Ravaja & Kivikangas, 2008). This in turn assist designers to depict a particular digital game that is meant to elicit the right kind of emotional response from the user (Lazarro, 2004). Often, players are deliberately engaged in games that may elicit negative emotions such as fear or frustration (Salen & Zimmerman, 2004). Research has shown that both positive and negative emotional responses are contributory factors for game experience (Järvinen, 2008; Hazlett, 2006).

Visual elements in interactive products have the potential to elicit emotions and affective responses in end-users (Silvennoinen, Vogel & Kuala, 2014, Thuring & Mahlke, 2007; Cai and Xu, 2011). From the influential works of Lavie and Tractinsky (2004), two dimensions for measuring visual design were devised, known as *classical* and *expressive* aesthetics. *Classical aesthetics* pertains to "orderly and design clarity"; *expressive aesthetics* has to do with *originality, creativity and sophistication* of the design. The *expressive aesthetic* dimension is related to the emotional judgment of beauty (Tractinsky & Lowengart, 2007). Visual design is related to affect, mood, emotion, and feeling, and acts as a connection between a product and a user's emotion. (Zhang, 2009). For example, game visual elements, by virtue of their visceral nature, influence a player to make certain decisions during gameplay, and to some extent exercise some controls over the player (Carr, 2012).

Surprisingly, the effects of visual design on emotions have been examined in only a few studies: in the domain of portable audio players (Thuring & Mahlke, 2007) and online shopping (Cai & Xu, 2011; Porat & Tractinsky, 2012). For instance, it is shown that both dimensions of visual design, *classical* and *expressive*, have an effect on shopping enjoyment, whereas the *expressive* dimension is more pertinent to shopping a hedonic product online (Cai & Xu, 2011).

Thuring and Mahlke (2007) observed that visual design of the portable audio players had an influence on the participants' subjective self-reports of valence and arousal, whereas this did not affect the psychophysiological elicitations (in Tuch, 2011). As described in section 2.6, the portable audio players which was rated low in terms of visual design quality also received lower positive valence and higher arousal appraisals. Furthermore, Mahlke (2008) recommended to further study the effect of perceived visual design on emotional responses of user experience as it has always been a challenge to overcome the inter-individual's differences that may lead to inaccurate results.

Mahlke (2008, p. 4) has noted that while these studies show the way perceived visual design are relevant for emotional user reactions and for the consequences of user experience, "the relation of perceived visual design and emotional aspects of user experience have to be studied further." Researchers echo complaints that "modern design has placed too much emphasis on performance issues, and not enough on emotional aspects such as pleasure, fun, and excitement that are related to aesthetics" (Hassenzahl, 2003; Tractinsky, 2006).

To fill this knowledge gap, an examination of the effect of visual design quality on emotional responses in the domain of tablet games, using two different types of game genres, is proposed.

3.2.3 Gap#3: Lack of research between variation of visual design (low and high) and perception of hedonic quality.

The concept of hedonic quality is constructed on a certain bundle of attributes such as *stimulation, evocation* and *identity* (Hassenzahl, 2003). According to Carr (2012), the concept aesthetic interaction appeal in games has received less attention. Lim, Lee and Kim (2011) proposed a new concept of user-interactivity with interactive products that is invisible and dynamic, but which can be experienced, termed as an interactive attribute. The latter is a novel interaction design approach served to enhance the concept of aesthetic interaction in products. It consists of the following attributes: "*concurrency, continuity, predictability, movement range, movement speed, approximatively, and response speed*" (Lim et al., 2007). From this theory, the interaction styles most relevant to the game interaction are *movement speed, movement range, and response speed*. For example, interaction styles such as *swipe, tap and point* (Lee, Song, Ryu, Kim, & Kwon, 2015) for the touch screen are devised in each level of the tablet games, which provide a basis for hedonic attribute in this thesis.

One proposal is that hedonic attributes influence the perception of visual design (Monk & Hassenzahl 2008; Schaik & Ling, 2008). For instance, the fluency theory predicts that if a person has to judge the beauty of an object, the viewer will use the hedonic response as a shortcut for the judgment of beauty (Reber, Schwarz, & Winkielman, 2004). Another proposal is that there is an overlap between visual design and hedonic quality (Van Schaik, Hassenzahl, & Ling, 2012). On the other hand, visual design is considered to be a subset of hedonic quality (Diefenbach, Kolb, & Hassenzahl, 2014). There is support for this view in the literature: Diefenbach et al. (2014) further point out that 20% of 151 articles reviewed on hedonic topics consider "beauty" (visual design quality) to be a subset of hedonic quality.

The above discussion reveals the inconsistencies that prevail between perception of hedonic quality and visual design. Therefore, to fill the knowledge gap in the area of digital gaming, the association between perception of hedonic quality and visual design need to be further examined.

3.2.4 Gap#4: Lack of research on the effect of users' characteristics on game enjoyment.

Veryzer and Hutchinson (1998) argue that aesthetic response factors cannot be generalized as the experience can be both subjective and objective in nature. A researcher cannot predict how two individuals will react when exposed to the same stimuli. In fact, there is the potential for one individual to have an opposite reaction in comparison to another individual's aesthetic response. (Palmer, Schloss, & Sammartino, 2013). In General, individual differences in aesthetic judgments is a fundamental problem for the field (Hartmann, Sutcliffe, & De Angeli, 2007; Mahlke & Lindgaard, 2007). In particular, do players who possess higher affinity for visual design derive more enjoyment interacting with a game interface that has a high visual design appeal? In order to address the inter-individual differences of people's judgment of visual design quality in products, it is necessary to compare the level of enjoyment derived from a tablet game from users who have low and high affinity to visual design quality in products. For this reason, when evaluating the visual design aspects of the interface, the 'Centrality of Visual Product Aesthetics" (CVPA) scale is utilized to screen the degree of visual design quality an individual account for a product (Bloch, Brunel & Arnold, 2003). This will fill the knowledge gap by investigating whether game enjoyment depends on the level of affinity for visual design.

3.2.5 Gap#5: Lack of research on other channels of experience (boredom, apathy, and anxiety) besides flow.

Flow state is described when the player is fully absorbed in an activity as the game challenge matches player's skills; this leads to optimal level of game enjoyment of the player (Csikzentmihalyi, 1990; Csikzentmihalyi & Hunter, 2003). This implies that *flow* leads to a positive player experience. However, little is known about player behavior and experience for those transiting into the other channels of experience, besides *flow*.

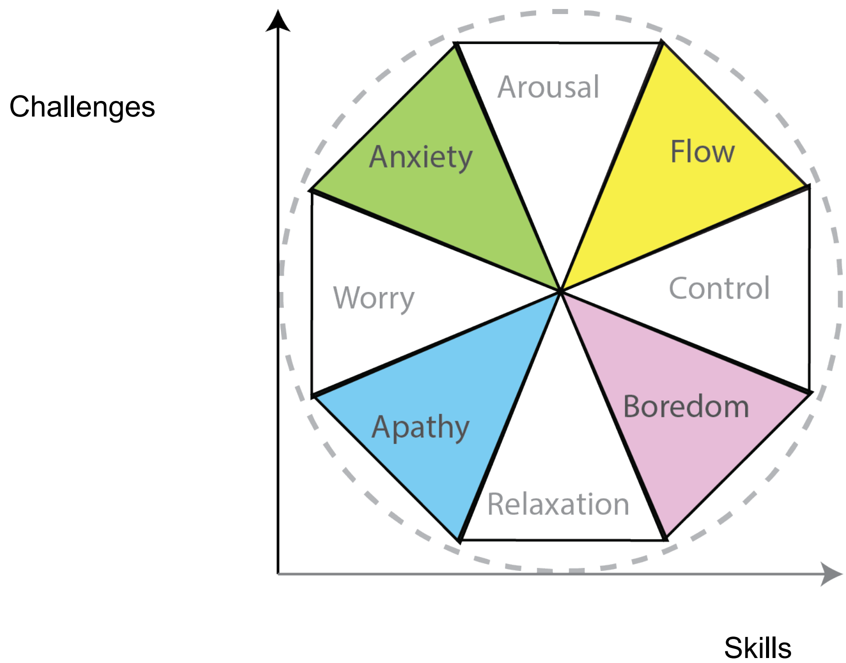

Figure 3.1 Channels of Experience (Nakamura & Csikzentmihalyi, 2009)

It is therefore noteworthy to compare the level of game enjoyment and to examine if enjoyment is still derived by participants in the other channels of experience. Research in gaming has always been centered around the idea of *flow* (Sweetser & Wyeth, 2005; Chen, 2007; Cowley, Charles, Black & Hickey, 2008), while other channels such as boredom, anxiety, and apathy (figure 3.1) have remained unexplored (Takatalo & Häkkinnen, 2014). *Flow* is defined as the state of "optimal experience" when a user's skill level is equated to the challenging activity. If that challenge exceeds the user's skill set, this gives rise to *anxiety* (Chen, 2007). *Boredom* normally occurs when the skill set is deemed medium and the challenge is low. *Apathy* is the condition of low skill set and low challenge.

Larson and Csikszentmihalyi (2014) presented their research on Experience Sampling Method (EMS) using self-report to study how people feel, what do they do and think in their daily lives. The theory of EMS includes necessary dimensions to assess the challenge and skill channels, and hence the concept of user experience in games (Takatalo, Nyman, & Laaksonen, 2008). Surprisingly, it is revealed that the boredom channel is a product of *high sense of control, satisfaction, positive affect and enjoyment* (Takatalo & Häkkinnen, 2014). The latter add that anxiety channel consists of concentration, creativity, and partly arousal.

This study makes use of post-test self-reports concerning challenge and skills to measure the *channels of experience* as participants transition into at the *behavioral level*. These will be used to assign participants into the following groups: *flow, apathy, anxiety, and boredom*.

3.3 Development of a conceptual Player Experience framework

Extending the discussion on the gaps highlighted in the previous section (Section 3.2), this section outlines a player experience (PX) framework, and the relevance of each component, developed to address the gaps in the literature. The framework is subsequently used to highlight the research questions which are set out in the following section (Section 3.4).

This theoretical framework for PX, relates to tablet gaming and illustrates possible relationships among the following variables listed below.

- *perception of usability*
- *perception of hedonic quality*
- *perception of visual design quality*
- *emotions* (visceral level)
- *channels of experience* (behavioral level)
- *player experience* (reflective level)
- *game enjoyment*.

The thesis has two broad aims:

First, the aim is to construct two types of tablet games with a variation of visual design quality for use as experimental stimuli.

Second, the aim is to examine how low and high visual design quality of tablet game user interfaces influence the components of PX framework, and to statistically validate the framework.

This section provides an overview of the PX components from a user-centric perspective, followed by a description of the PX research framework. It is important to note that a product has two facets, instrumental quality and non-instrumental quality (Mahlke, 2008). Instrumental quality denotes the usability, functionality, practicality, and utility of a product. Non-instrumental quality refers to the visual design and hedonic quality in general. The framework outlines the theoretical relations between user perceptions and visual design quality in tablet games. Each component is now elaborated in turn.

Perception of Usability: The perception of usability component is illustrated in the PX framework in relation to visual design quality. The goal of usability is to promote efficiency, effectiveness, and learnability (Shneiderman et al., 2016). Pragmatic quality refers to the instrumental aspects of a product (Hassenzahl, 2004). Instrumental quality is a broad term encompassing functionality, usability, utility, practicality features (Mahlke, 2008). These attributes become more apparent to the user when interacting with the product, in this case the game user interface, which is defined as the *perception of usability*. Usability has the following goals: efficiency, effectiveness, and learnability. The emphasis is on task related activities (Diefenbach, Kolb, & Hassenzahl, 2014). The Technology Acceptance Model illuminates that both perceived usefulness and perceived ease of use can be used to determine the intention to use a product (Davis et al., 1989). This definition indicates that perceived usefulness is concerned with utility whereas perceived ease of use denotes usability. According to González Sánchez and Gutiérrez Vela (2014), one attribute that designates player experience in games is playability, which can be applied during the design or evaluation phase to understand how players feel during the gameplay (see Section 2.8, Chapter 2). Playability has been initially equated to game usability (Federoff, 2002). It is clear that perception of game usability alone cannot be the sole dimension to measure player experience in digital games (Fernandez, 2008; González-Sánchez, J., Padilla-Zea, N., Vela, F.L.G., 2009; Isbister & Schaffer, 2008; Nacke, Drahen & Gobel, 2010). Van Schaik and Ling (2011) mentioned that besides usability, a user experience model incorporates aspects of aesthetic experience. that Hence, hedonic aspects must be considered to obtain a holistic evaluation of player experience and enjoyment.

Perception of Hedonic Quality: A relationship between perceptions of visual design and hedonic quality exists, as described in section 3.2 under Research Gap#3. Visual design attribute when evaluated from a user's perspective connotes the perception of visual design quality. Non-instrumental quality is another facet of a product or system denoted by hedonic quality, visual design quality, and emotional responses, which aim to enhance experiential feelings of product use (Lallemand, Gronier, & Koenig, 2015). In addition, Van Shaik and Ling (2011) explain that "beauty" (perception of visual design) is affected by hedonic quality only. Furthermore, perception of hedonic quality (non-instrumental quality) is assumed to be independent of the perception of usability (instrumental quality) component and its position in relation to visual design quality is depicted in the PX framework. This assumption is based on Mahlke's (2008) research work such that usability and visual design independently affect user experience. Hence, perceptions of usability and hedonic quality are postulated to occur independently in this framework. Hedonic quality is composed of three dimensions: *stimulation*, *evocation*, and *identification*

(Hassenzahl, 2004; Hassenzahl & Monk, 2010). In this thesis, the focus of hedonic quality is limited to "*stimulation*" since it is linked to motivation and interaction. For instance, we play games to satisfy our inner-needs (Salen & Zimmerman, 2004); gameplay is governed by intrinsic motivation, which is influenced by challenge, fantasy, curiosity and control (Malone, 1981). Furthermore, HCI practitioners have linked user experience to components beyond usefulness and usability to include hedonic, visual design, emotions, and "experiential" technology-interaction (Desmet & Hekkert, 2007; Forlizzi & Ford, 2000; Hassenzahl & Tractinsky, 2006).

Positive *hedonic quality* supports *pleasure* and *satisfaction* in a product (Hassenzahl et al., 2010) and for this reason *perception of positive hedonic quality* is said to be connected with positive emotions (Marković, 2012). *Pleasure* and *satisfaction* experienced by players form part of the *perception of hedonic quality.* As described in the previous chapter, emotion has two dimensions - valence and arousal. Valence (which occurs along the x-axis) is analogous to the *perception of hedonic quality* and it ranges from pleasure to displeasure whereas arousal (which occurs along the y-axis) ranges from calm to excited in Russell's (1980) Circumplex model.

Emotion: The PX framework illustrates the *emotion* component at three different levels – *visceral, behavioral* and *reflective* (Norman, 2004), as described in Section 2.5, refer to figure 2.2. The two main constructs of emotional responses that are measured are valence and arousal. A deeper analysis of emotion, namely *behavioral* and *reflective* levels are showcased in the framework. When a user interacts with the digital game interface, the perceptions of usability, visual design and hedonic quality give rise to emotional responses during game interaction (Mahlke 2008; Huisman et al., 2013). It is through emotion that these qualities ultimately affect player experience and game enjoyment. Emotions are reactions to events (game interaction) that are relevant to the concerns of the individual (Frijda, 1986; Desmet, 2002). Hassenzahl (2003) also views emotion to be an outcome of product perceptions. Affective processing begins at the visceral level in our minds, the stage when one makes rapid judgement of a stimulus. When the user is exposed to the game interface, visceral responses occur automatically; these are immediate reactions based on perceptual features of the game interface. The information passes from the visceral to the behavioral level, which is still not a conscious level. That is why the player can allow his fingers to play freely on the touch screen while reflecting upon the higher-order structure of a game strategy for instance. Norman (2004) explains that bottom-up processes, from visceral to behavioral and reflective levels are controlled by perception whereas the top-down approach is operated by thought processes. The behavioral level is connected to the reflective level. Information from the reflective level can bias the behavioral level to take necessary action. Critically, information from the behavioral level feeds back to the visceral level (see figure 2.2). The process works in a loop. During game interaction, "behavioral pleasure" occurs when the information is transmitted to the user, a state theoretically described as the *channels of experience*.

Behavioral level: The theoretical framework in this thesis proposes that the behavioral level is the critical waystation as a player's mind transits from the visceral level, to attain the reflective level, as indicated in figure 3.2. When the user is exposed to the game interface, visceral responses occur; these are immediate reactions based on perceptual features of the game interface. Norman (2004) suggests that visceral responses, which include emotional responses, are followed by *behavioral level* responses which take place during game play, a reaction to usability and functionality of the game features. This is where a player's expectations are considered, as we can obtain a confirmation or denial of those expectations (Don Norman, email communication, Feb 2014). In a digital game context, the player faces certain challenges to win the game, and based on the ratio of challenges to skills that is self-reported by the participant in a questionnaire, the player transits into one of the 8 sub-channels of experience: *control, boredom, relaxation, apathy, worry, anxiety, arousal, or flow* (Nakamura & Csikzentmihalyi, 2002; Reese, 2010). *Channels of experience* are self-perceptions of an affective experience from which we infer players' states (Reese, 2010). The behavioral level is mapped onto *channels of experience* as shown in the framework. The *channels of experience* are the affective state of the player and can be positive or negative. Each condition of the channels of experience is a measure of the ratio of challenge to skill that the user reports (Larson & Csikszentmihalyi, 2014; Reese, 2010). For example, a high challenge and high skill level reported by the user gives rise to *flow*, which is positive. Conversely, low challenge and low skill causes apathy, which is negative (Table 3.1).

Flow	High Skill and High Challenge
Apathy	Low Skill and Low Challenge
Boredom	Medium Skill and Low Challenge
Arousal	Medium Skill and High Challenge
Anxiety	Low Skill and High Challenge
Worry	Low Skill and Medium Challenge
Relaxation	High Skill and Medium Challenge
Control	High Skill and Medium Challenge

Table 3.1: Channels of Experience (Csikszentmihalyi & Jeremy, 2003)

Player experience: This component is indirectly related to usability, visual design, hedonic quality of the game user interface. As illustrated in the framework, the reflective level is mapped onto player experience, as they are both equivalent to an overall perceptive evaluation of the interface. The third level of emotional processing, the *reflective level,* is a conscious one. It provides meaning to the gameplay as well as an overall impression of the game user interaction. This gives rise to *player experience* and ultimately the user makes a self-assessment of the *pleasure and satisfaction* derived from the game interaction. The player appraises the game based on its narrative, mechanics, gameplay and user interface. Player experience is defined as a consequence of all the interaction experiences between the game elements and the player. Poels, De Kort, & IJsselsteijn (2007) observed that the concept of player experience "*has been studied in a fragmented way*" because it lacks a solid definition.

Game enjoyment: In the PX framework, game enjoyment is positioned relative to player experience (reflective level) and behavioral level and linked to the other components indirectly. Game enjoyment is a product of both emotional reaction and cognitive evaluation, which is entailed from a pleasurable experience (Vorderer, Klimmt, & Ritterfeld, 2004). The researchers further add that enjoyment can be described as the gratification that ensues when one is in control of an interactive game situation. In addition, user experience designer John Ferrara (April 07, 2011) explains the idea of game enjoyment emerges at the end of the player experience when all the components of the PX framework operate harmoniously with each other. Gajadhar, de Kort and IJsselsteijn (2008) relate game enjoyment to positive affect, competence, challenge and frustration. Admittedly, player experience is not only a function of positive emotions (Hazlett, 2006), but it comprises of a combination of negative emotions that build up during a challenging game activity (Keeker et al., 2004). This means that both positive and negative emotions are key ingredients in generating necessary player experience. According to the PX framework, it is posited that the final outcome is *game enjoyment*, as it is followed by a holistic interpretation of the player experience at the reflective level. Evidently, the player makes an overall judgment of gameplay activity prior to arriving at game enjoyment through a comprehensive reflection of the perceptions of usability, visual design, hedonic quality, and visceral responses, including the channels of experience.

Figure 3.2 illustrates the conceptual PX framework based on the above theoretical inferences discussed for each individual component connected to user experience design.

3.4 Development of Research Objectives and Hypotheses

In this section, the research objectives and hypotheses are developed based on the theoretical inferences proposed in the development of the PX framework, as summarized in figure 3.2. The research gaps identified in Section 3.2 form the bases of the development of research objectives and hypotheses.

Research Objective 1

The demonstrated gaps in current user experience research as discussed in Section 3.2.1 led to the first research objective:

- To examine if the level of visual design quality (low or high) in game user interfaces affects perception of usability, as illustrated by H1 in figure 3.2.

The first hypothesis is

H1: High visual design quality game user interfaces are perceived to be more usable.

Research Objective 2

The identified gaps in extant literature as discussed in Section 3.2.2 led to the second research objective:

- To examine the impact of visual design quality (low and high) of two types of tablet game interfaces on emotional responses (arousal and valence), as illustrated by H2 and H3 respectively in figure 3.2, which gave rise to two hypotheses below.

The second hypothesis is

H2: Participants experience a higher level of arousal in the high visual design quality game user interface of the Hard-Fun Key.

The third hypothesis is

H3: Participants experience a higher level of valence in the high visual design quality game user interface of the Easy-Fun Key

Research Objective 3

The demonstrated gaps in extant literature as discussed in Section 3.2.3 led to the third research objective:

- To examine the impact of visual design quality (low and high) of two types of tablet game interfaces on the perception of hedonic quality, as illustrated by H4 in figure 3.2.

The fourth hypothesis is

H4: High visual design quality of tablet game interfaces has an effect on the perception of hedonic quality

Research Objective 4

The demonstrated gaps in extant literature as discussed in Section 3.2.4 led to the fourth research objective:

- To examine if user characteristics can influence game enjoyment, as shown by H5 in figure 3.2. The fifth hypothesis is:

H5: Participants who are more sensitive to visual design quality (high CVPA) in user interfaces derive more game enjoyment with the high visual design version.

Research Objective 5

The identified gaps in extant literature as discussed in Section 3.2.5 led to the fifth research objective:

- To compare the level of game enjoyment derived by participants in each channel of experience (flow, apathy, arousal, boredom), as illustrated by H6 in figure 3.2.

The sixth hypothesis is:

H6: Participants in the flow channel derive a relatively greater level of game enjoyment.

3.5 Description of the PX framework

The framework (figure 3.2) below posits visual design quality of game user interfaces has an influence on the perception of usability (H1), emotional responses (arousal and valence represented by H2 and H3 respectively), and hedonic quality (H4). It also proposes that user characteristics such as CVPA level of participants may have an impact on game enjoyment level (H5). In addition, it is speculated that game enjoyment may be influenced by the channels of experience (H6).

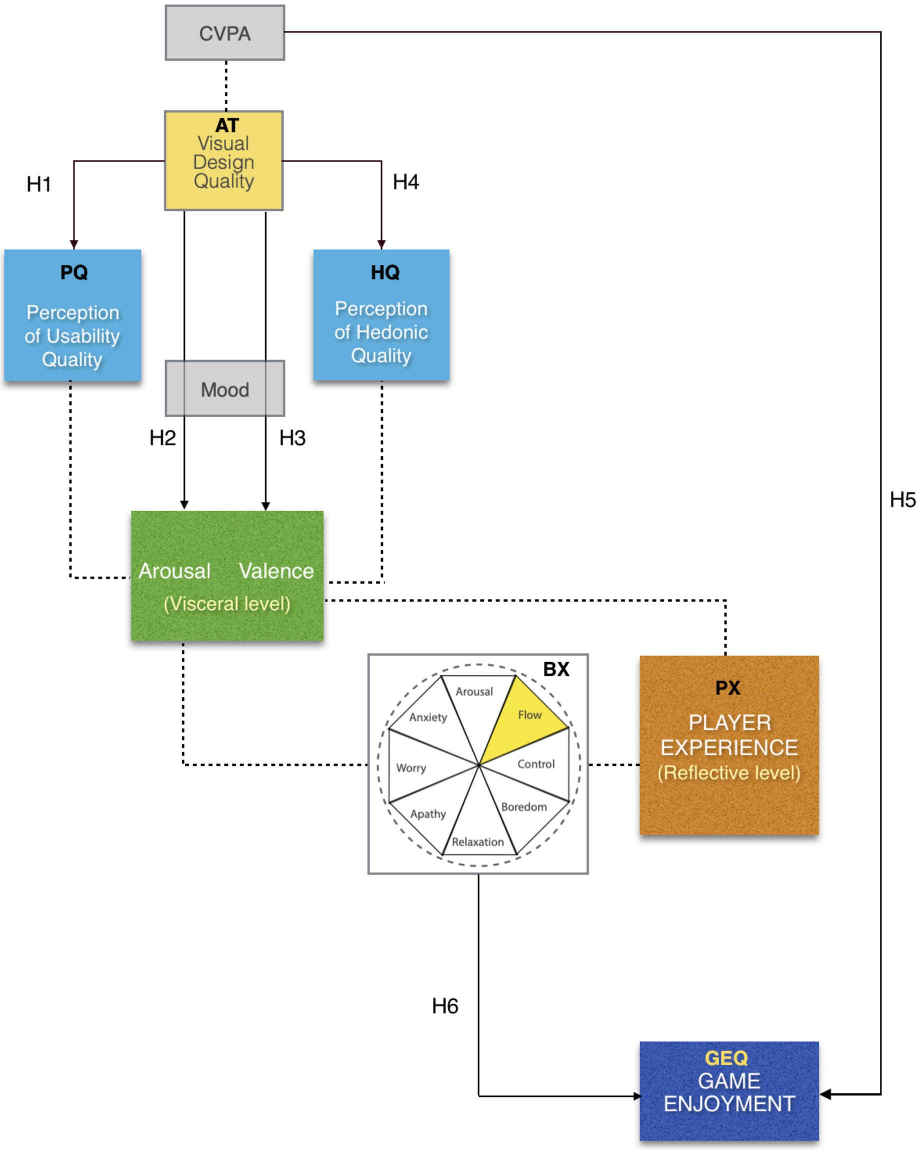

Figure 3.2 Conceptual Framework for Player Experience Design

3.6 Chapter Summary

In summary, five major research gaps from literature review have been identified that form the basis of the research objectives. From the identification of research gaps, a conceptual PX framework in the domain of tablet gaming is depicted using the following components: visual design quality, perception of usability, perception of hedonic quality, emotion, channels of experience, player experience and game enjoyment. Consequently, six hypotheses emerged from the research objectives so as to validate the PX Design framework. In order to address the hypotheses, a Design-Oriented approach is adopted, as it enables to design and develop the game prototypes for use as stimuli in a true experimental condition. The creations of the tablet game applications are essential to achieve the required visual design manipulation of the game stimuli. A description of the methodological approach including the research design, experimental design, and survey instruments are provided in the subsequent Chapter 4. The design and development of the game prototypes are set out in Chapter 5

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter describes the research methodology adopted to examine a player experience design framework. The chapter begins by summarizing the research questions developed in Chapter 3. It sets out with the philosophical worldview that informed the development of this thesis. It then outlines the application of the design-oriented research approach in the creation process of the two types of tablet games. The mixed methods research approach adopted is then described, followed by a discussion of the sampling frame and data collection process for each phase of the research. Finally, the validity and reliability of the research design is considered. The chapter ends with a deliberation about the limitations of the research design, followed by a chapter summary.

4.2 Research Questions

Research questions emerged from the knowledge gaps in extant literature on components of user experience which led to the development of a conceptual player experience design framework (figure 3.2). A summary of the research questions and hypotheses are:

Research Question #1

How do variations of visual design quality of game user interfaces affect a game participant's perceived game usability?

Research Question #2

How does a variation of visual design quality of two types of tablet game interfaces affect emotional responses (valence and arousal) of game participants?

Research Question #3

How does a variation of visual design quality of tablet game interfaces affect a game participant's perception of hedonic quality?

Research Question #4

Do game participants with high CVPA[1] characteristics (Bloch et al., 2003) derive more game enjoyment when they interact with the high visual design quality tablet game interfaces?

Research Question #5

Do game participants experience a higher level of game enjoyment in flow channel as compared to the other channels of experience such as apathy, boredom, and relaxation?

4.3 Research Design

The research design of the Design Oriented Research approach (as discussed in section 4.4) are theory, practice, and evaluation, as represented in figure 4.1.

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[1] Individuals with High CVPA ratings possess higher affinity to visual design in products (Bloch et al., 2003)

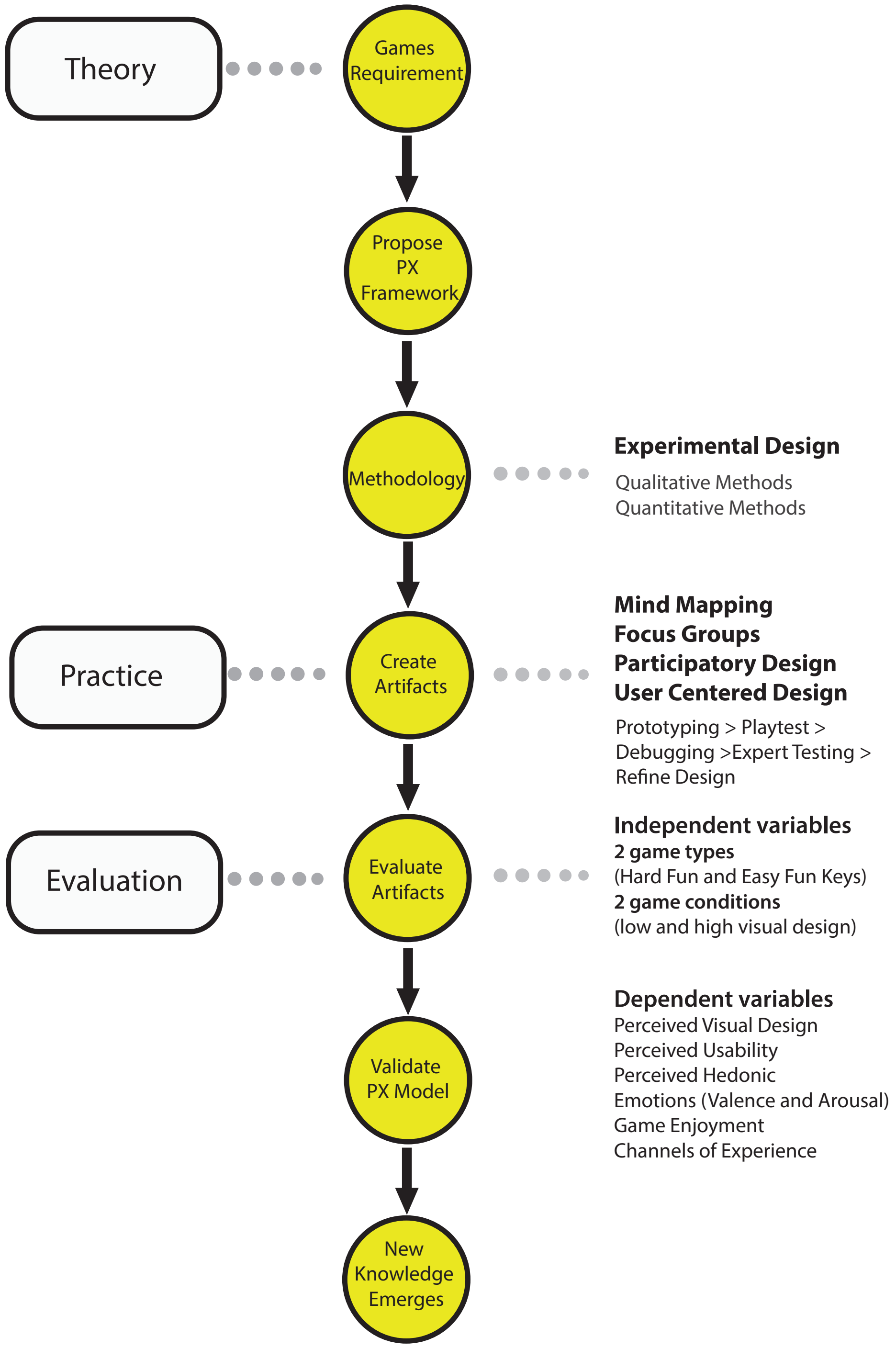

Figure 4.1 Overview of the Research Design

According to Creswell (2014), the philosophical approach to research (figure 4.2) informs the research design and design methods. The philosophical "worldview" therefore guides the research practice and influences the way knowledge is reviewed and interpreted (Guba, 1990; Mertens, 2015; Teddlie and Tashakkori, 2009).

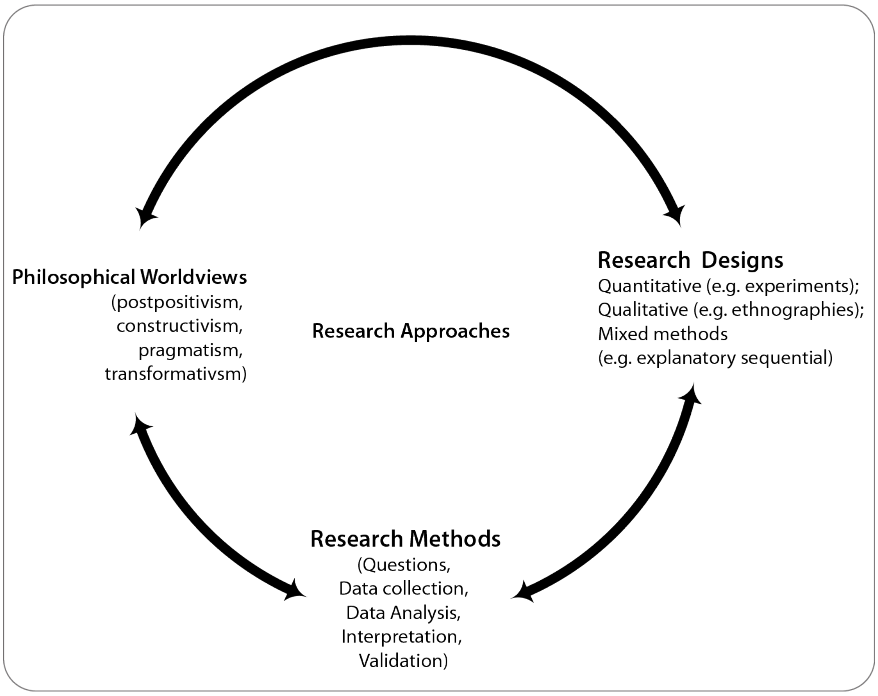

Figure 4.2. Research Framework by Creswell (2014)

Table 4.1 summarizes the four main worldviews namely *Post-positivism, Constructivism, Transformativism, and Pragmatism* (Cresswell, 2014). This thesis follows the pragmatism worldview based on the following evaluation criteria:

- *Instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem* (Creswell, 2003, p.12).
- *Researchers have a freedom of choice. They are "free" to choose the methods, techniques, and procedures of research that best meet their needs and purposes (*Creswell, 2003, p.12).

- *Human inquiry (how we interact with our environments) is regarded as scientific inquiry and experimental* (Johnson & Onwuegbuzie, 2004, p.18).

Postpositivism	**Constructivism**
• Determination • Reductionism • Empirical observation and measurement • Theory verification	• Understanding • Multiple participant meanings • Social and historical construction • Theory generation
Transformative	**Pragmatism**
• Political • Power and Justice oriented • Collaborative • Change-oriented	• Consequences of actions • Problem-centered • Pluralistic • Real-world practice oriented

Table 4.1 Four Philosophical Worldviews (Creswell, 2014)

The challenge is that the researcher needs to understand and apply different methods and approaches in a coherent mix (Johnson & Onwuegbuzie, 2004). Mixed methods research (Tashakkori & Teddlie, 2003) combine methods to complement each other into a single study (Johnson & Onwuegbuzie, 2004). For example, the design-oriented research methodology presented a sequential path of practice (phase 1) followed by scientific inquiry research (phase 2), which is the essence of pragmatism. Creswell's (2014) "worldview" provided the necessary rationale to adopt the pragmatism approach to address the player experience design framework developed in figure 3.2. The decision to choose the mixed-methods research approach was based on the complexity of the project, which was to construct tablet games, create two variations of visual design qualities, and to use those games conditions as stimuli for an empirical evaluation and validation of a player experience design framework (figure 3.2). These methods were used to respond to the objectives in this thesis sequentially (Leech & Onwuegbuzie, 2009). Research design is the choice of methods the investigator makes for collecting and analyzing data, along with the reasons that justify those choices (Bryman, 2015). The research adopted a survey method, focusing on both exploratory (the "why") and confirmatory (the "what or how") research questions to address the research framework and hypotheses developed in Chapter 3.

In phase 1 of the thesis, an inductive logic was applied to a tablet game design and development process (described in detail in chapter 5) which outlines the approaches utilized to make use of the design-oriented research approach. This phase of research development was therefore aligned with exploratory sequential mixed methods (Creswell, 2014) since it comprised qualitative techniques. For example, the design-oriented research design was considered appropriate as it enabled the development of two types of tablet games using a rapid iterative prototyping technique, followed by empirical evaluation of the game artefacts. The incorporated mixed methods comprised mind-mapping and focus groups in an iterative approach to prototyping and usability testing during the game design process. In addition, a participatory design method was implemented in the game prototyping process whereby the researcher assumed the role of a designer, who worked in collaboration with a game developer. Participatory design technique draws on a diverse and rich set of ideas from participants with different backgrounds such as graphic designers, developers, game players, and the researcher (Simonsen & Robertson, 2013). The technique differs to a User Centered Design (UCD) approach where the focus is on the needs of the end-user during product design and development (Karat, 1997). In this research, PD was considered appropriate because the focus was on the prospective end-user was actively involved in the tablet game design processes,

In phase 2, a mixed methods design was also adopted comprising two major components – quantitative and qualitative survey methods used in conjunction with an experiment based on the games developed in phase 1. To evaluate the player experience design framework in phase 2, a dominant quantitative method (e.g. survey) followed by qualitative method (open-ended survey) was adopted. The advantage of employing a structured survey-based approach was that it established consistency and uniformity throughout the data collecting process as all participants receive the same questions that could be reflected upon. The goal of administering the structured survey following a period of gameplay using the games designed was to capture rich data, complementing the quantitative method surveys (Migiro & Magangi, 2011), thereby allowing the participants to reflect on the game mechanics, game interface and gameplay that influenced their experiences in both types of games and conditions.

The triangulation and complementary methods of data collection helped to increase reliability of the findings of the study (Denzin, 1978; Onwuegbuzie & Leech, 2005). The combination of methods provided deeper insights to address the research questions. The use of mixed methods enabled the researcher to address the weaknesses in each specific method. Open-ended questions were used in the second phase to allow respondents to explain the reasons for their choices in the quantitative survey. Another reason was to collect richer data by allowing respondents to mention topics, aspects etc. that had not been covered in the survey. The main challenges when dealing with mixed-methods, apart from the lengthy period of time and extensive resources as in this study, could be conflicting results garnered by each method. In this situation, the investigator should judiciously delve deeper into the analysis, or gather and analyze additional data to reach a right conclusion. This could also be an opportunity for future research. Mixed-methods research has the ability to extract finer research outcomes (Powell et al., 2008).

A flowchart of the methodology summary is illustrated below (figure 4.3).

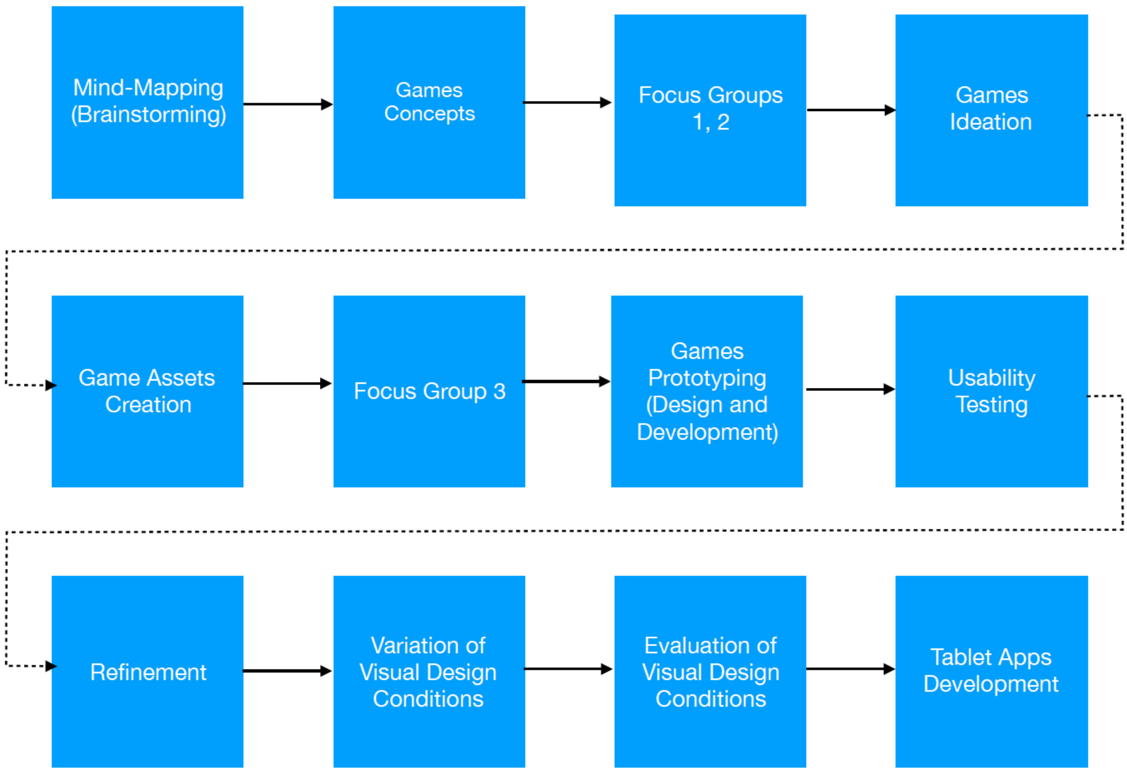

Figure 4.3 Summary of the methodology

4.4 Phase 1 - Design-Oriented Research

The research adopted a design-oriented approach. Drawing on Fallman (2004, 2005), design-oriented research, focuses on the artefact producing the final outcome contributing to new knowledge and attainable by means of research and development (Fallman, 2005). The artefact produced in a design-oriented research approach itself is not regarded as new knowledge but is used as a creative tool or stimulus to realize the research objectives from which a new theory may emerge. Fallman (2004), argues the design-oriented research approach is concerned with the generation of new knowledge to study human behavior and user experience, rather than the artefacts (Fallman, 2004). Therefore, it was aligned with the scope of this thesis given that new knowledge emerged following the evaluation of the game artefacts by participants. In this context, the game artefacts were produced to serve as stimuli to respond to the hypotheses and to study the proposed player experience design framework (figure 3.2). The emergent evaluation of games can in turn be used to inform future designs.

Next, two major creative practice methodologies are discussed showing resemblance to the concepts of design-oriented research and research-oriented approach. In aligning the design-oriented approach with design research methodologies such as practice-based research and practice-led research (Makela & Nimkulrat, 2018; Candy, 2011), the distinction between the two approaches was determined to be in the roles of the practitioner as researcher. In practice-based research, the role played by the practitioner is more "dominant" than the researcher since the focus is geared on practice, as the research undertaken by the practitioner-researcher is mainly based on practice. In contrast, in practice-led research, both the practitioner and researcher roles are proportionately equivalent as research forms an integral part of practice. In the case of practice-led research approach, the goal is to make use of an artefact, which is not the final outcome of the research, but is used for documenting (sketches, diaries, etc.) and reflecting on the process of the making. It has also been stipulated that the artefact-making process may not be necessary in practice-led research; the research outcome can be identified in terms of a framework, model or guidelines (Candy & Edmonds, 2018). On the other hand, practice-based research is defined as an original investigation that constructs new knowledge, partially by practice and through the outcomes of that practice (Candy, 2011). The artefacts play a pivotal role in new knowledge generation and reflection on the outcomes of that practice. Practice-based research is concerned primarily with generating new knowledge that contributes to our understanding of a phenomenon or experience including the role of a system or artefact in that experience.

This definition overlaps with the notions of design-oriented research as it takes into account human experiences in its evaluation process. Therefore, in a practice-based research situation, the goal is to develop a new artefact from which new knowledge can be gleaned. Thus, the design-oriented research approach is conceptually similar but technically different from practice-based research methodology. At a broader level, the design-oriented research approach has characteristics inherent in practice-led research but they differ technically (Nimkulrat, 2007). In this study, design-oriented research methodology was adopted to inform the development of tablet game artefacts so as to address the proposed research framework (figure 3.2) and the hypotheses (section 3.4). The considerations for adopting design-oriented research were:

- the research questions were pre-determined; they were not formulated during the game design and development process;

- it allowed for the creation and modification of the game artefacts to answer the needs of the research objectives;
- the roles of the game artefacts were not the primary outcomes as the goal of the thesis was to generate new knowledge after responding to a series of research questions.

Based on the above considerations, design-oriented research was considered to adequately respond to the goals of the research study through the lens of a practitioner-researcher. In addition, the approach adopted draws on the researcher's experience as a game designer (Abras, Maloney-Krichmar, & Preece, 2004; Norman & Draper, 1986; Pratt & Nunes, 2012) for developing the tablet games, in addition to the incorporation of practitioner reflective practices, as described by Schon (1983).

4.4.1 Game Artefacts

Reflecting the design-oriented research methodology, game artefacts were created using a well-established design process by applying relevant techniques and user testing. The practitioner-researcher employed personal reflection-in-action based on technical experiences of the creation process in an effort to combine practice and scientific inquiry. The approach begins with a conceptual player experience design framework, with a set of pre-defined objectives, consisting of corresponding research questions. Scientific inquiry aided in formulating the necessary hypotheses to devise mixed-methods research using the dominant-less dominant design typology described by Tashakkori and Teddlie (1998) as in (as cited in Parylo, 2012) with a quantitative dominant design to collect and analyze the data and respond to the objectives of the research study. The creation of the tablet game artefacts plays a key role in the experimental design process to test the hypotheses. The knowledge contribution in terms of a theoretical model emerges during that process, separately from the game artefacts (i.e., by using the games artefacts as a vehicle).

The rationale behind adopting a design-oriented research approach was to create artefacts (tablet games) for serving as stimuli and to modify game user interfaces into a low and high visual design quality. Only after devising the tablet games was it possible to use them as response-stimuli for the pre-defined research questions and hypotheses in this study. This approach takes the following route: theory – practice – empirical evaluation – new theory (player experience design model).

The design and development of the games artefacts was both novel and creative. Their novelty was drawn "directly on the practitioner's practice, applying knowledge, experience, skills and a sense of creative enquiry" (Candy & Edmonds, 2012: p. 284). The game narrative, visuals, interface design, and elements were skillfully crafted through the lens of a (reflective) creative practitioner. Nevertheless, these artefacts were the outcome of a systematic and creative process. Additionally, game theories, Gestalt theories and Design principles informed the practice of the game making process, to which two main components of creativity were applied – divergent and convergent thinking (Guilford, 1968; Schneiderman et al., 2017). As such, a transformation of ideas rendered the game depiction unique and creative (Amabile, 1983). Hence, designing and developing the tablet games were preliminary to investigate the hypotheses of this thesis.

The theoretical player experience design model emerging from this research is unique to the study itself. The design-oriented research methodology holds the potential to be replicated by other game design researchers to generate other theories. The flexibility of the design-oriented research approach allows a practitioner-researcher to choose unique procedures of gathering data by combining different methods and techniques. The game making process, referred to as reflective practice, undergoes a series of rigorous mind-mapping techniques, focus groups, and user centered design principles.

4.4.2 Mind-Mapping Technique

Researchers have identified several idea generation techniques such as sketching, storyboarding, expert opinion, reflection, documenting, collaboration, critique, incubation, and brainstorming (Herring, Jones, & Bailey, 2009). The preliminary stage of the game design process began with a brainstorming technique known as mind-mapping (Buzan & Buzan, 2010; Malycha & Maier, 2012). Mind-mapping was used to trigger their thought processes by coalescing their knowledge in a systematic way to develop new ideas (Davies, 2011; Nesbit & Adescope, 2006).

Due to the complexity of the mind-mapping procedure and in order to use cognitive resources effectively (Runco, 2014), the research participants (two game players and three student designers) were provided with the necessary descriptions of the mind-mapping process, along with the goals of the tasks.

While planning the research, decisions such as resources, time frame to build the game, and age group of audience who play tablet games were considered. Participants were required to brainstorm using the keywords: “space-shooter” and “tablet game.” A “space-shooter” game type was chosen since it was relevant to the Hard-Fun Key characteristics; the Easy Fun Key was an extension of the Hard-Fun Key game narrative. The iPad was chosen as platform for a number of reasons: due to its popularity for playing games; high performance features such as high screen resolution, gaming technology capabilities and open source framework available for game developers that makes it effective to develop and test. The design goals were for each game type to convey the relevant emotions through the designs of user interaction. The unavailability of the haptic vibration touch gesture feature in iPads was circumvented by a variety of other touch gestures as discussed in chapter 5, section 5.3.3.1. In addition, the challenge was to create a composition in a real time 2.5D game environment that is dynamic as the player constantly moves through the game interface based on his actions, thereby continually generating new sets of visual structure.

There was no time restriction during the mind-mapping process as it has been shown that time pressure can have a negative impact on the creative outcome, compromising the cognitive processes (Amabile et al., 2002). Norman (2004) explains that the generation of positive emotions can stimulate curiosity and promote creativity. Admittedly, a conducive environment was created in which there was no judgment for giving a right or wrong answer.

Visualization techniques such as mind-mapping organically generate association between keywords. The mind mapping procedure was conducted as follows. First, a central idea or node (space shooter or tablet game) was written down as a focal point on the whiteboard. Participants depicted an individual mind-map. They had to think about a related and meaningful idea to the central node in order to branch out ideas. Participants made use of word associations to generate specific examples of different keyword categories while evoking their mental models (Malycha & Maier, 2017). Thus, other nodes were added to the mind-map diagram as the process unfolded to encourage as many associations as possible. Upon task completion, participants were requested to identify the most useful or intriguing words and connections. Color-coding the key nodes proved to be an expedient way to draw necessary associations and connotations. The keywords from the mind-map diagram were in fact the seeds for design inspiration and game narrative development.

Following the mind-mapping session, each participant summarized their concepts into a brief for the game story. A summary of keywords provided in Appendix 5.2 formed the bases for transforming these ideas into concrete examples. Focus groups were conducted to further conceptualize the ideas of the tablet games in terms of game classification and design.

4.4.3 Focus Groups for Concept Testing

A focus group is a resourceful and cost-effective means to gather data from participants (Kruger & Casey, 2000). The keywords generated from the mind-mapping exercises swere used in the focus groups to discuss game design, mechanics and story. To obtain a diversity of ideas and opinions, the researcher recruited six research participants through a convenience sample for a focus group which met on three separate occasions for 2 hours each over an eight-week period, as recommended by the following researchers, Johnson & Christensen, 2004; Krueger, 2000; Onwuegbuzie, Dickinson, Leech, & Zoran, 2009. The six participants volunteered to take part in a series of three focus groups comprising of two game developers, two student designers, two casual mobile game players while the researcher moderated the discussions.

Focus groups were used to discuss and shape ideas generated for the two types of tablets games: a Hard Fun Key (Mission Mars) and an Easy Fun Key (Mars Explorer). It is posited that three to six different groups are required to obtain data saturation (Krueger, 1994; Morgan, 1997). The same group met on three different occasions to seamlessly reach a final decision (Onwuegbuzie et al., 2009). Sections 5.3.2, 5.3.3, and 5.3.4 showcase the main discussions of the three focus groups and their outcomes are discussed in sections 5.3.2.1, 5.3.3.1, and 5.3.4.1 respectively.

The group dynamics was continuously monitored, to ensure smooth interaction among participants, aligned with Jiao, Collins, & Onwuegbuzie (2008). For example, all participants were given an equal amount of time to speak. The researcher initiated necessary discussions and took notes throughout all the sessions.

4.4.4 User Centered Design Principle

The user centered design (UCD) principle was adopted in the design and development of the two tablet games. UCD is defined as the "active involvement of users for a clear understanding of user and task requirements, iterative design and evaluation, and a multi-disciplinary approach." (Vredenburg, Mao, Smith, & Carey, 2002, p. 472). Applying UCD methods in interactive design enhances its usefulness and usability. The concept of UCD has been extended from traditional usability engineering principles to incorporate aspects of user experience design. Users are involved in the design process at all levels to influence the design space, as UCD philosophy places users at the heart of the design process (Rubin & Chisnell, 2008) due to their contributions to a more effective, efficient and safer product (Preece, Rogers & Sharp, 2015).

Figure 4.4 below exemplifies the UCD principles undertaken in this study from designing, prototyping, evaluating, until product is deployed. The process starts with defining requirements, design, evaluation (iterate back to design), implementation, and deployment. UCD methods that are generally used comprised *iterative design*, *usability evaluation*, *informal expert review*, and *task analysis* (Vredenburg, Mao, Smith, & Carey, 2002). A formative evaluation approach ensures that important design features and functionality of the game artefacts can be improved iteratively, following user-testing.

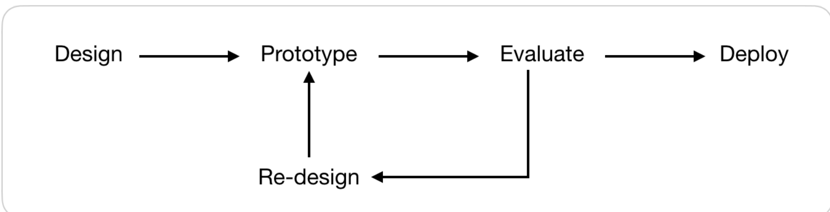

Figure 4.4 Prototyping Diagram (Dix, Finlay, Abowd, & Beale, 2004)

4.5 Mixed Methods

Phase 2 adopted the mixed methods sequential research design (Teddlie & Tashakkori, 2009). The following sequential research structure was devised:

- A preliminary survey to evaluate the skills and expertise of research participants (Section 4.5.1)
- Baseline evaluation of mood of participants (Section 4.5.2).
- Survey to quantitatively evaluate (i) perception of hedonic quality, (ii) perception of visual design, (iii) game enjoyment, (iv) emotional responses, and (v) flow during and after gameplay experiments (Section 4.5.3).
- Survey to qualitatively evaluate player experience of game participants post gameplay (Section 4.5.4)

The design of each component of the sequential approach adopted is discussed below.

4.5.1 Preliminary Survey

A preliminary survey was designed to evaluate the skills and expertise of research participants. A screening questionnaire was developed to assess participants' eligibility for the study. This comprised items for age, gender, number of hours of game-play per week, digital game experience (none, novice, intermediate, expert). Participants with intermediate and expert skills only were chosen since novices were presumed to add confounding factors such as inaptitude of touch screen interaction and/or tablet gaming, as per the inclusion and exclusion theory (Salkind, 2010). The procedure was carried out within a research laboratory environment located in a US comprehensive university campus over a period of ten weeks.

4.5.2 Baseline Mood State Evaluation

When participants arrived in the lab, the research protocols were communicated. They were requested then to relax for 10 minutes to help neutralize their baseline emotional states.

Participants' baseline emotions were measured using the multidimensional mood state questionnaire (Steyer, Schwenkmezger, Notz & Eid, 1997). The original multidimensional mood instrument is made up of three constructs, valence (good vs. bad, GB), arousal (awake vs. tired, AT) and calmness (calm vs. nervous, CN), and altogether it contains a list of 24 adjectives that characterize different moods. The only two constructs relevant to this current study are "good-bad", analogous to valence; "awake-tired" is analogous to the arousal dimension. Examples of "good-bad" items are content, bad, great, uncomfortable, superb, good, unhappy, discontent, happy, wonderful. Examples of "awake-tired" are rested, worn-out, tired, energetic, highly activated, sleepy, alert, fresh, exhausted, wide awake.

4.5.3 Quantitative Survey Instruments

Alongside the experiments, six different validated survey instruments were used to quantitatively evaluate (i) perception of hedonic quality, (ii) perception of visual design, (iii) game enjoyment, (iv) emotional responses, (v) channels of experience and, (vi) player experience during gameplay. The survey instruments were administered during and following gameplay (Appendix 4.5). In order to ensuring accuracy in emotional response data collection, they were collected during gameplay as demonstrated in a study by

Mandryk and Atkins (2007), as emotional elicitation occurs for a brief period to time (Levenson, 1992). Measuring it at the end of the gameplay would have forced participants to recollect how they felt a while ago during gameplay interaction, which would not be reliable. Data for each dependent variable were collected using self-report questionnaires. All the above instruments were digitally created using Google Forms and uploaded online on Google Sites for each of administering and collection purposes. Participants could switch from gameplay to fill the questionnaires with ease on the iPad. A description of the instruments related to the hypotheses are provided below.

Table 4.2 below lists the validated instruments adapted in whole or in part, from other researchers to collect data to respond to the research questions. Relevant constructs from existing instruments were chosen mainly because they served to measure the dependent variables with accuracy. Moreover, they had been empirically tested and validated in several HCI studies. In this section, the development of the survey instruments used to collect data are discussed. Instruments are administered at different phases of the study as recommended by the researchers (Ary, Jacobs, Razavieh, & Sorensen , 2009); Creswell & Creswell, 2018):

(i) **Pre-experiment survey instrument** -- used prior to the experiment before the game stimuli are applied.
(ii) **Experiment survey instrument**--used during the experiment, while the game stimuli are being applied.
(iii) **Post-experiment survey instrument**--used at the end of the experiment, after the game stimuli have been applied.

Dependent Variables	Instruments
▪ Perceived ease of use ▪ Perceived usefulness	Attrakdiff2 Questionnaire ▪ Pragmatic (PQ)
▪ Perceived Visual Design ▪ Perceived Hedonic	Attrakdiff2 Questionnaire ▪ Design (AT) ▪ Hedonic (HQ-S)
▪ Arousal and Valence	▪ Self-Assessment Manikin
▪ Game Enjoyment	▪ Game Experience Questionnaire
▪ Player Experience	▪ PIFF2 Questionnaire
▪ Flow	▪ Flow (GEQ sub-section)

Table 4.2 Summary of Survey Instruments

4.5.3.1 Pre-experiment Survey Instruments

In this true experimental design study, the hypothesized independent variable, visual design, was manipulated into low and high quality. In order to measure the effect of the independent dependent variable on the dependent variables, it was essential to consider the baseline emotion (mood) of the participants prior to the study to examine if that variable changes during the course of the study. Not every participant who arrives in the lab has the same standard emotional level. The baseline emotion was captured using the shorter version of the Multidimensional Mood Questionnaire (Steyer, Schwenkmezger, Notz, & Eid, 1997) prior to the experiment.

A shorter version of the questionnaire of 5 items was administered in this study related to valence (good +, unhappy -, discontent -, happy +, wonderful ++.) and 5 items related to arousal (sleepy-, alert+, fresh+, exhausted-, wide awake++.) The instrument is balanced by equal number of –ve (negative) and +ve (positive) signs. The participants were asked to carefully indicate by checking the corresponding scale that best represented their mood status at that moment, as shown in Table 4.3 below.

Right now, I am feeling

Valence	Definitely not (1)	Not (2)	Not really (3)	A little (4)	Very much (5)	Extremely (6)
Good			X			
Unhappy						
Discontent						
Happy						
Wonderful						
Arousal	Definitely not (1)	Not (2)	Not really (3)	A little (4)	Very much (5)	Extremely (6)
Sleepy		X				
Alert						
Fresh						
Exhausted						
Wide Awake						

Table 4.3 Multidimensional Mood Questionnaire (Steyer et al., 1997)

The original MDBF instrument is made up of three constructs, valence (good vs. bad, GB), arousal (awake vs. tired, AT) and calmness (calm vs. nervous, CN), and altogether it contains a list of 24 adjectives that characterize different moods. The only two constructs relevant to this current study were "good-bad", analogous to valence; "awake-tired" was related to the arousal dimension. Examples of "good-bad" items are content, bad, great, uncomfortable, superb, good, unhappy, discontent, happy, wonderful. Examples of "awake-tired" are rested, worn-out, tired, energetic, highly activated, sleepy, alert, fresh, exhausted, wide awake.

4.5.3.2 Measurement of Emotions using self-reports

Different methods have been used to measure emotions. The Component Process Model of Emotion (figure 4.5) is composed of subjective feelings, behavioral tendencies, cognitive appraisals, motor expressions and physiological responses (Scherer, 1984). According to this theory, an individual reacts to a stimulus through all these channels. Subjective feelings consist of verbal and non-verbal responses. There are challenges in measuring emotional responses as they are experienced continuously, and an emotion can repeat itself (Moors, Ellsworth, Scherer, & Frijda, 2013). The notion of "efference" illuminates that the emotion phenomenon is so complex that one component may not have established a response, yet it has already started to affect the subsequent components (Scherer, 2009; Scherer, 2015).

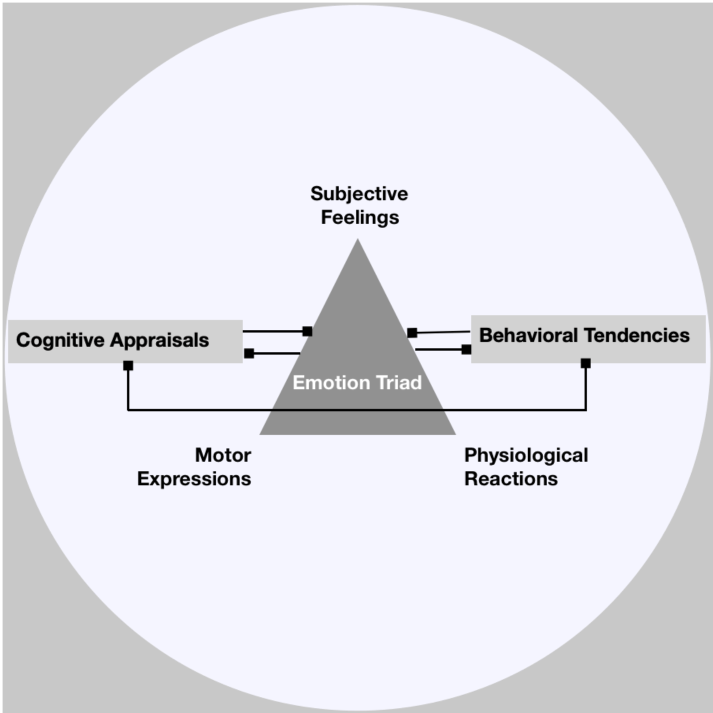

Figure 4.5 Component Process Model (Scherer, 1984)

Desmet (2002) explains that self-report verbal tools, comprising of rating scales, are beneficial in the sense that they can be used to measure mixed emotions, and can also measure specific emotion within a range of emotions. On the other hand, verbal tools may be difficult to translate for use across cultures. Non-verbal tools are made up of "pictograms," which replace words to denote emotional responses, such as *LEMtool* (Susagroup, 2010), prEmo (Desmet, 2002), and *Self-Assessment Manikin* (SAM) (Bradley & Lang, 1994). The SAM tool is based on the theoretical work of Russell (1980), which consists of three dimensions: valence, arousal and dominance (figure 4.6). SAM is a self-report measure with a 9-ratings scale interval. It measures subjective emotional responses of users from three distinct categories – valence, arousal, and dominance. The valence dimension indicates the hedonic quality of an affective experience, ranging from displeasure to pleasure. The arousal represents the degree of "activation" during emotional occurrence, ranging from calm to excited (Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006).

To summarize, emotions are important in the sense that they shape the perception, reactions, attention and thoughts of an individual, preparing him/her to make decisions (Madeira, Arriaga, Adriao, Lopes, & Esteves, 2013). Arousal dimension provides the researcher with an indication about the degree of excitement, whereas the valence dimension provides a cue ranging from the pleasure to displeasure a player may experience during gameplay.

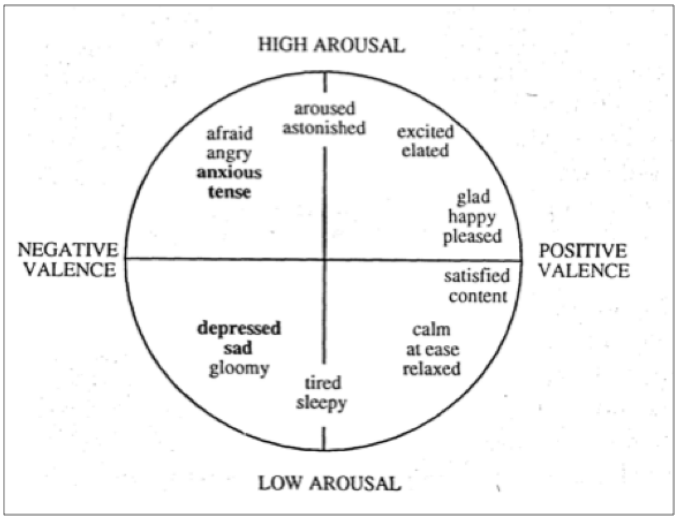

Figure 4.6 Valence vs. Arousal Circumplex Model (Russell, 1980)

4.5.3.3 Experiment Survey Instruments

The two instruments administered during the experiment were (i) Self-Assessment Manikin (Bradley & Lang, 1994) to measure emotional responses (related to hypotheses H2 and H3), and (ii) Challenge-Skills Questionnaire (Nakamura & Csikszentmihalyi, (2009) to measure Channels of Experience, related to hypothesis H6: *Players who experience flow during gameplay will derive a greater level of game enjoyment.*

(i) The valence and arousal constructs of the Self-Assessment Manikin questionnaire (SAM) were administered during the experiment (gameplay) at 5-minute intervals; participants were advised to pause the game and self-report their current emotional states. Participants rated their emotional states by selecting the appropriate manikin, or the space between adjacent manikins. The advantage of this technique simulates real-time data collection as the participants could easily recall their emotional feelings at that point in time. The mean value of the data collected at different intervals were considered.

The SAM is a validated non-verbal instrument intended to measure users' emotions. According to Bradley and Lang (1994), the SAM's instrument ratings for both valence and arousal are in line in terms of reliability and validity with the Semantic Differential Scale devised by Mehrabian and Russell (1974). The advantage of non-verbal measures is that they can be used cross-culturally without the need for translation for better accuracy (Desmet, 2018). This instrument has been employed successfully in several studies (Mahlke, 2007; Schifferstein, Talke & Oudshoorn, 2011). The tool is based on bi-polar dimensions – two opposite adjectives, can be administered quickly and completed at a faster pace, and is appropriate for both adults and children (Lang, 1985). It measures subjective emotional responses of users from three distinct categories –valence, arousal, and dominance. Only two dimensions namely valence and arousal were relevant to this thesis in order to determine emotional responses. The displeasure to pleasure scale measures valence (Figure 4.7a) whereas the calm to excited scale measures arousal (Figure 4.7b) in a participant.

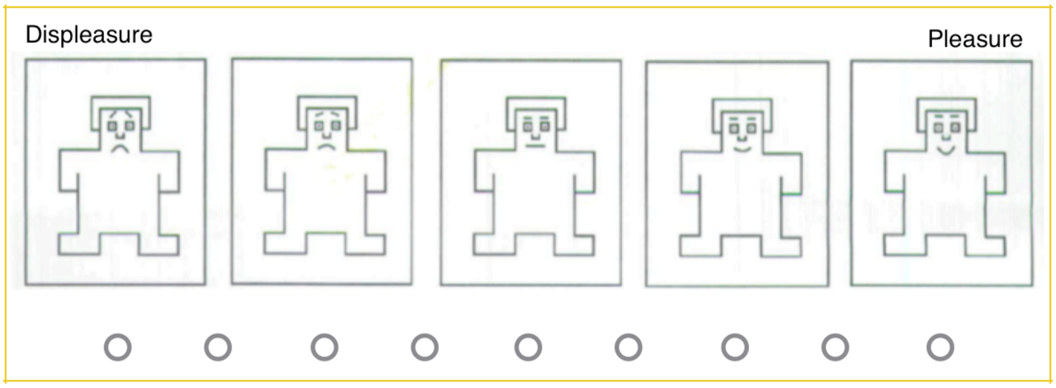

Figure 4.7a SAM Valence (Bradley & Lang, 1994)

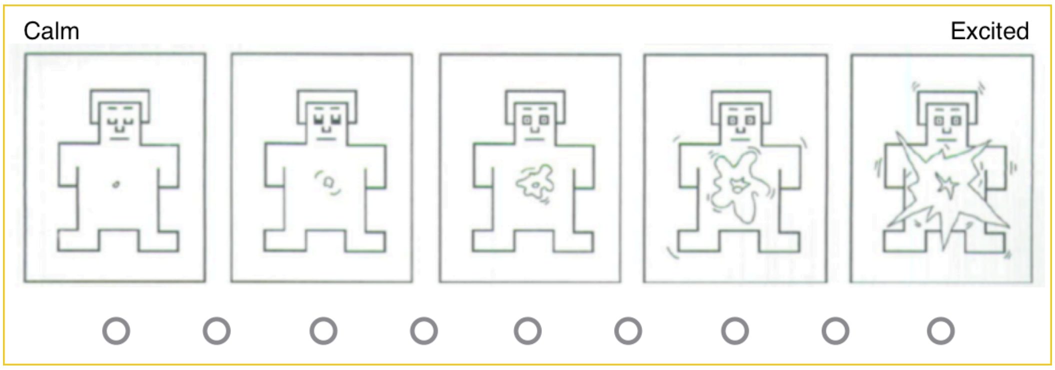

Figure 4.7b SAM Arousal (Bradley & Lang, 1994)

Research Question #2 examined whether a variation of visual design quality of two types of tablet game interfaces affect emotional responses (valence and arousal) of game participants.

H2: *Participants experience a higher level of arousal on the high visual design quality game user interface of the Hard-Fun Key.*

H3: *Participants experience a higher level of valence on the high visual design quality game user interface of the Easy-Fun Key.*

The survey instrument used to measure flow was the "challenge-skills" questionnaire related to hypothesis H6. A player can experience any of the following states during gameplay: flow, apathy, anxiety, relaxation, depending on the level of skills they exert and challenge encountered. This research question seeks to compare the degree of enjoyment research participants derive in each of the states or channels of experience. The channel of experience in which a participant transited was based on the self-reported data using the challenge and skills questionnaire (Hektner, Schmidt, & Csikszentmihalyi, 2007). For example, a *high skill-high challenge* self-report data corresponds to flow; a *low skill-low challenge* data corresponds to apathy, as shown in Table 4.4 below.

Channels of Experience	Characteristics
Flow	High skill and High challenge
Apathy	Low skill and Low challenge
Anxiety	Low skill and High challenge
Relaxation	High skill and Low challenge

Table 4.4 Channels of Experience (Csikszentmihalyi & Jeremy, 2003)

The challenge-skills instrument adapted in this thesis was based on the two constructs: How challenging is the game activity? How skillful are you at the game? The instrument has been derived from the Experience Sampling Method (ESM) to assess flow experience of participants in their daily real life (Larson & Csikszentmihalyi, 2014). The challenge-skills questionnaire was administered to the participants during gameplay at 5-minute intervals to self-report their challenge and skills level instantaneously. Participants were requested to pause the game, and to rate how challenging the game was and their level of skill at that moment. Data were gathered during the test session to simulate real-time recording.

The four channels of experience as shown in Table 4.5 were measured using a self-report tool with the two constructs: challenge and skills (Hektner, Schmidt, & Csikszentmihalyi, 2007), on a rating scale of 1–9 (extremely low to extremely high). The self-report questionnaire known as the Experience Sampling Form (ESF), has a high validity and reliability, the internal consistency has Cronbach's alpha of 0.94 (Moneta & Csikszentmihalyi, 1996). The two constructs *challenge* and *skills* have high reliability to assess *flow* and other channels of experience such as *apathy, anxiety, and relaxation*, that are self-reported (Csikszentmihalyi & Csikszentmihalyi, 1988a; Reese 2010).

4.5.3.4 Post-experiment Survey Instruments

Attrakdiff ver2 questionnaire (Hassenzahl, Burmester & Koller, 2003) is a validated 28 items instrument with four sub-scales used to measure:

(a) perceived pragmatic quality (PQ), Cronbach's alpha=0.88,

(b) attractiveness (AT), Cronbach's alpha=0.91,

(c) hedonic quality-stimulation (HQ-S), Cronbach's alpha=0.78,

(d) hedonic quality-identity (HQ-I), Cronbach's alpha=0.77, of a product

The instrument has been extensively utilized to study perception of usability, hedonic and visual design in products (Hamborg, Hulsmann & Kaspar, 2014; Christou, 2012; Hassenzahl & Monk, 2010).

Research Question #1 examined if the visual design quality level (low and high) of game user interfaces affect the perception of game usability. In order to respond to hypothesis H1: *High visual design quality game user interfaces are perceived to be more usable*, participants were requested to report perceived ease of use (usability) of the game interfaces following game play. Participants were also asked to self-report their perceived visual design quality and their perceived hedonic quality of the game user interfaces to examine hypothesis H3.

The PQ construct of AttrakDiff (Table 4.5) has a high internal consistency, Cronbach's Alpha= 0.88 (Isleifsdottir & Larusdottir, 2008). It captures perceived usability consisting of seven bi-polar items (technical-human; complicated-simple; impractical-practical; cumbersome-straightforward; unpredictable-predictable; confusing-clearly structured; unruly-manageable).

	Extremely	Moderately	Fairly	Neutral	Fairly	Moderately	Extremely	
Technical								Human
Complicated								Simple
Impractical		X						Practical
Cumbersome								Straightforward
Unpredictable								Predictable
Confusing								Clearly Structured
Unruly								Manageable

Table 4.5 Pragmatic Quality (PQ) Questionnaire (Hassenzahl, Burmester & Koller, 2003)

The AT construct of AttrakDiff (Table 4.6) has a high internal consistency, with Cronbach's Alpha greater than 0.91; this instrument measures perceived visual design of the user interface. It consists of six bipolar items such as (unpleasant - pleasant; ugly - attractive; disagreeable - likeable; rejecting - inviting; bad - good; repelling - appealing) on a rating scale.

	Extremely	Moderately	Fairly	Neutral	Fairly	Moderately	Extremely	
Unpleasant					X			Pleasant
Ugly								Attractive
Disagreeable								Likeable
Rejecting								Inviting
Bad								Good
Repelling								Attractive

Table 4.6 Visual Design Questionnaire (AT) (Hassenzahl, Burmester & Koller, 2003)

Research Question #3 examined the impact of visual design quality of tablet game interfaces on the perception of hedonic quality. In order to respond to hypothesis H4: *High visual design quality of tablet game interfaces has an effect on the perception of hedonic quality*, research participants were requested to complete the hedonic quality-stimulation (HQ-S) questionnaire.

HQ-S, Cronbach's alpha=0.78, has seven bipolar items used to evaluate perceived hedonic quality-stimulation as follow: *conventional-inventive; unimaginative-creative; cautious-bold; conservative-innovative; dull-captivating; undemanding-challenging; ordinary-novel* as shown in Table 4.7.

	Extremely	Moderately	Fairly	Neutral	Fairly	Moderately	Extremely	
Conventional								Inventive
Unimaginative								Creative
Cautious								Bold
Conservative							X	Innovative
Dull								Captivating
Undemanding								Challenging
Ordinary								Novel

Table 4.7 Hedonic Quality (Stimulation) (Hassenzahl, Burmester & Koller, 2003)

Stimulation explains how the product affects "proliferation of knowledge and skills" (Hassenzahl & Monk, 2010). This implies that the most relevant hedonic component that pertains to digital games in this study is "stimulation" which includes type of interaction, emotive responses and motivation. For instance, the "dull-captivating" item reflects the interaction aspect; "unimaginable-creative" and "cautious-bold" concern emotive responses; "conventional-inventive" and "conservative-innovative" refer to motivation. Hence, the seven bi-polar items of the HQ-S tool is used to gather data to examine perceived hedonic quality.

Research Question #4 examined if participants with higher affinity to visual design would derive more game enjoyment in the high visual design quality condition. In order to test hypothesis H5: *Participants who are more sensitive to visual design quality in user interfaces will derive more enjoyment in the high visual design version of the tablet games*, participants were first screened into two groups – those with low and high sensitivity towards visual design in user interfaces, using the (CVPA) Centrality of Visual Product Designs questionnaire (Bloch, Brunel & Arnold, 2003). The instrument consists of three domains:

- *value*: relates to the "perceived value that is assigned to product appearances,"
- *acumen*: the ability to "understand and evaluate a product design,"

- *response intensity*: signifies the "level of response to visual design aspects of products" (Bloch, Brunel & Arnold, 2003, p. 552).

The *value* construct has four items, each on a 5 Likert Scale: strongly disagree, Agree, neutral, disagree and strongly disagree. The items are: (i) Owning products that have superior designs makes me feel good about myself. (ii) I enjoy seeing displays of products that have superior designs. (iii) A product's design is a source of pleasure for me (iv) Beautiful product designs make our world a better place to live.

Similarly, the *acumen* construct consists of four items: *(i) Being able to see subtle differences in product designs is one skill that I have developed over time. (ii) I see things in a product's design that other people tend to pass over. (iii) I have the ability to imagine how a product will fit in with designs of other things I already own. (iv) I have a pretty good idea of what makes one product look better than its competitors.*

The *response* construct contains three items: *(i) Sometimes the way a product looks seems to reach out and grab my attention (ii) If a product's design really "speaks" to me, I feel that I must buy it. (iii) When I see a product that has a really great design, I feel a strong urge to buy it.*

The employment of all the three domains of the CVPA instrument in this thesis provides an accurate measure of the degree of sensitivity to visual design quality. Higher scores on the CVPA indicated that an individual was more sensitive to the visual design of game user interface. A compilation of the mean value of the Likert-scale score from each group items (value, acumen and response) in the CVPA questionnaire was carried out to obtain a final CVPA score for every participant. Bloch, Brunel & Arnold (2003) demonstrated that the internal consistency of the CVPA scales were substantially high as the Cronbach's alphas fell in the range 0.86 to 0.96 and therefore was an instrument of high reliability.

While the CVPA instrument was used to screen participants into two groups: low and high affinity to visual design in products, the Game Experience Questionnaire (IJsselsteijn, Poels, & de Kort, 2008) was used to determine the game enjoyment level from each group. The original GEQ is a validated instrument consisting of three modules: (i) the core questionnaire (ii) the social presence module (iii) the post-game module. The original GEQ is intended to measure user experience; it is supposed to be administered immediately after the game session has been completed. The core module has seven components: *immersion, flow, competence, positive-negative affect, tension, and challenge*. For instance, the core module is a 33-item long questionnaire that has a five-level rating scale: 0: not at all; 1: slightly; 2: moderately; 3: fairly; 4: extremely.

As shown in Table 4.9 below, four out of seven constructs were adapted from the GEQ (IJsselsteijn, Poels, & Kort, 2008) to measure game enjoyment: ***flow*** (Cronbach's Alpha=0.866), ***positive affect*** (Cronbach's Alpha=0.797), ***negative affect*** (Cronbach's Alpha=0.712), and ***challenge*** (Cronbach's Alpha=0.745) to measure game enjoyment from the two groups of participants interacting with the two game conditions (low and high visual design quality). An overview of the adapted GEQ instrument used is shown in

Table 4.8, with five level of rating scale: **0**: *not at all*; **1**: *slightly*; **2**: *moderately*; **3**: *fairly*; **4**: *extremely*

Constructs	Items	Extremely	Fairly	Moderately	Slightly	Not at all
Flow	*I lost track of time.*					
	I was deeply concentrated in the game.					
	I lost connection with the outside world.					
	I forgot everything around me.					
Positive-Affect	*I felt content.*		X			
	I thought it was fun.					
	I felt good.					
	I enjoyed it.					
Negative-Affect	*I felt bored.*					
	It gave me a bad mood.					
	I thought about other things					
	I found it tiresome.					
Challenge	*I felt challenged.*					
	I had to put a lot of effort into it.					
	I felt time pressure.					
	I thought it was hard.					

Table 4.8 Game Experience Questionnaire (IJsselsteijn, Poels, & de Kort, 2008)

Research Question #5 determined if participants experienced a relatively greater level of player experience in the flow channel as compared to the other channels of experience such as *apathy, arousal,* and *boredom*. To respond to hypothesis H6: *Players who experience flow during gameplay will derive a greater level of game enjoyment*, the first step was to stratify participants into four different groups: flow, apathy, boredom, and arousal, based on their self-report using the challenge-skill questionnaire. In order to measure player experience of the participants, four constructs namely *presence, involvement, emotional outcomes and cognitive evaluation* were adapted from PIFF2 instrument (Takatalo, Hakkinen, Kaistinen, & Nyman, 2010) to evaluate player experience. PIFF2 consists of two main dimensions, *adaptation* and *flow*. *Adaptation* is further divided into *presence* and *involvement*. *Presence* refers to the interaction, attention, arousal, physical presence and engagement of game players. *Involvement* refers to importance and interest. *Flow* is defined as a component of *emotional* outcomes and *cognitive* evaluation. Cognitive evaluation is connected to *challenge* and *competence*. Emotional outcomes comprise of *valence, enjoyment, playfulness, control, and impressi*veness.

PIFF2 was primarily developed for virtual reality environment and for multiple players. In this thesis, the 15 items of PIFF2 have been adapted in the context of tablet gaming to measure player experience. Therefore, the items were changed in the original instrument to render the questionnaire more meaningful for the single player and pertinent to tablet gaming environment as shown in Table 4.9 below. The 5-level rating scale was applied to the new questionnaire ranging from *strongly agree, agree, neutral*, *disagree,* to *strongly disagree.* It was administered upon the completion of each game condition.

ADAPTATION	CONCEPT	ITEMS
Presence	Role engagement	The game was engaging
	Attention	My attention was focused on gameplay
	Co-presence	~~Not Applicable in a single player game~~
	Arousal	I felt stimulated during gameplay
	Physical Presence	I felt being transported to the game world
Involvement	Interest	The game was exciting
	Importance	I am attached to this type of game
FLOW		
Cognitive Evaluation	Competence	I felt competent playing the game
	Challenge	Playing the game was challenging
	Interaction	The touchscreen interaction responded quickly to my actions.
Emotional Outcome	Valence	I felt happy with the gameplay
	Impressiveness	The game elicited authentic feelings
	Enjoyment	I enjoyed playing the game
	Playfulness	The game was imaginative
	Control	I was in control of the game

Table 4.9 Adaptation from PIFF (Takatalo, Hakkinen, Kaistinen, & Nyman, 2010)

The 15-items PIFF2 questionnaire was derived using factor analysis from 2,182 research participants (Takatalo, Hakkinen, Kaistinen, & Nyman, 2010). The internal consistencies, known as Tarkkonen's rho (Vehkalahti, Puntanen & Tarkkonen, 2010) of the sub-components (items) varied between 0.7 and 0.89; values above 0.70 denote that the measuring tool produces stable and consistent results, meaning the instrument has high reliability factor.

4.5.4 Qualitative Survey Instrument

A post completion survey was designed to assess player experience of game participants using a structured questionnaire containing two open-ended questions. Results obtained were used to elaborate and substantiate on findings from other instruments (Beck, 2005; Creswell, 2011). This triangulation of methods helped in comparing quantitative and qualitative data to effectively validate conclusions (Migiro & Magangi, 2011). Participants were requested to respond to three open ended questions.

- *Which aspects/elements/features of the low visual design game made gameplay gratifying?*
- *Which aspects/elements/features of the high visual design game made gameplay challenging?*
- *Which of the two games is more pleasurable to play? and Why?*

The essence of the open-ended questions sought to understand if players found any value in the low visual design game version and to describe any challenges they encountered while playing the high visual design version. The next section discusses the reliability and validity of the study.

4.6 Scales

A reliable instrument survey is constructed so as to produce accurate responses. For instance, the response received for an item question in a Likert Scale depends on the "number of categories presented, the verbal and numeric labels assigned to the scales, the order and layout in which the categories are presented" (Christian, Dillman, & Smyth, 2008). Any scale is prone to systematic errors; participants may overstress their preferred attributes or neglect the unfavorable one's. Another source of error, known as "acquiescence," is prevalent in Likert Scales containing only positively worded-items (Friborg, Martinussen, & Rosenvinge, 2006). In order to reduce the systematic errors in Likert Scales, bipolar ordinal scales are used that measure both direction and level (e.g. "strong agree" – "agree" – "neither agree nor disagree" – "disagree" – "strongly disagree"). In this case, the direction is "agree or disagree," and the level is denoted by "strongly." Krosnick & Fabrigar (1997) argued that scale with a number of categories ranging from five to seven have been found to be reliable and valid; this is the optimum level of categories to reduce a respondent's cognitive load. In other words, the number of categories should be broad enough to accommodate the entire continuum of possible responses, but at the same time it must not be short to challenge the respondent from choosing the right answer. In addition, Saris and Kronick (2000) have found that construct of specific scales tend to reduce acquiescence response bias and cognitive load. Evidently, the items in the above instruments reflect the usage of construct specific scales (e.g. "My attention was focused on gameplay" rather than stating "Part of my attention was focused on gameplay"). Another consideration is to select category labels so that all the verbal labels are conceptually equal distant apart relative to either category, and the scales are balanced with an equal number of positive and negative categories (Dillman, Smyth, & Christina, 2009). The above guidelines were followed in the construction of the above instruments in order to reduce measurement error.

Semantic Differential makes use of bipolar scales with adjectives opposite in meaning, aims to measure the reaction of a participant when he is exposed to a stimulus. They are deemed to be simple and economical means of gathering data on participants' reactions (Heise, 1970). Semantic Differential method (Osgood et al., 1957) has been mostly employed in a wide range of research studies to measure attitudes and perceptions, and this method has proven useful in the study of design attributes (Hsu, Chuang, & Chang, 2000; Hassenzahl, 2003). In order to ensure the reliability and validity of semantic differential scale, ambiguous words are avoided (Fowler, 2014).

4.7 Sampling Frame

Sampling designs have two constituents: sampling scheme and the sample size. The sampling scheme represents the action plan in selecting units (e.g., people, groups, events) while the sample size indicates the number of units selected for the study (Migiro & Magangi, 2011). In the mixed methods design adopted, both sampling scheme and sample size have been considered for the qualitative and quantitative phases of the study. The sampling approach taken to the design of the games is outlined in Chapter 5 alongside the explanation of how the games have been developed and so is quickly summarized in this section.

This research has used a sampling approach in two different ways:

In phase I, a *maximum variation sampling* scheme (non-probabilistic sampling) to devise the games. The maximum variation sampling is a type of purposive sample scheme in which individuals possessing a range of different backgrounds are selected for inquiry purposes (Sandelowski, 1995). This is justified since multiple stances and viewpoints of the participants representing the intricacy of the real world were required for the investigation (Creswell, 2002).

In phase 2, a purposive convenience recruitment technique, which is a non-probability sampling method, was used in gathering data for both the quantitative and qualitative methods (Blackstone, 2012), followed by a simple random sampling into each game condition to validate the game designs using the experiments and survey instruments.

Phase I

In phase I, participants' characteristics required varied backgrounds and expertise in game play aligning with the maximum variation sampling scheme, referred to as the inclusion criteria (Salkind, 2010). The mind-mapping session was conducted prior to the focus groups. The mind-mapping session consisted of three student designers and two game players from the university campus, who were invited as participants, with the goal to generate novel ideas and feature-sets; common themes and aspects were chosen from the mind-map keywords for discussion in the subsequent focus group sessions.

Requisite knowledge in a mobile environment and technology were mandatory for participating in the focus groups and collaborative inquiry sessions for this phase. Specific skills and competencies were required, as it was important to draw from the individual background experience of participants (Hayward, Simpson & Wood, 2004). A purposive sampling scheme was therefore used to recruit participants for the focus groups. The selection of the participants was informed by their common interests in tablet gaming (Krueger, 2000). Based on review of literature, it was determined to include experienced game players, student game designers, and game developers with game programming background in the sampling frame for the focus groups.

A summary of the samples recruited is shown in Table 4.10.

Methods	Participants
Mind Mapping	3 student designers, 2 mobile game players.
Focus Group (all three sessions)	2 game developers, 2 student designers, 2 casual mobile game players.
Observation and Diary notes	Practitioner-researcher

Table 4.10 Sample recruited for Phase 1

Phase 2

In phase 2, 111 participants were recruited using a purposive convenience technique. According to Blackstone (2012), purposive sampling technique is based upon a broader range of criteria or confined to a few specifics. Participants recruited from the purposive sampling strategy included specific criteria as reported in the screening questionnaire based on the “intermediate and expert” level of the participants. These data-rich responses help the researcher identify possible patterns while analyzing the quantitative data. Given research constraints (time and resources), university students were selected using a convenience recruitment method as they were deemed to fit the required age descriptor 18-29 years and representative of the target game player population. This age group accounts for 29% of video game players population in the USA, according to a report (Statista, 2018); the average age of a male game player is 33 years old in the US (ESA, 2017). The participants were screened based on moderate to high touch screen game play experience.

4.7.1 Sample Size

Phase I

In qualitative research, sample size may be dependent on the "types of data collection methods used, and heterogeneity of the population" (Ritchie, Lewis, & Gillian., 2003, p.84). Other groups of researchers explain that the concept of saturation is vague to determine sample size prior to gathering data (Guest, Bunce & Johnson, 2006; Dey, 1999). The key characteristic leading to saturation in qualitative research adopted in the mind-mapping session was based on the theory "from the words of key informants to the voice of the other sample members" (Onwuegbuzie & Leech, 2007, p.107). It is common practice for qualitative researchers to work with a small sub-sample, known as "key informants," who are representative of the actual sample of participants. The data garnered from those participants can be generalized to the larger representative group. The relevant sampling units are the "words" and the "participants."

Focus groups should normally comprise of 6-12 individuals (Johnson & Christensen, 2004) and Langford, Schoenfeld, & Izzo (2002) recommends 6-10 participants. Krueger (2000) explains that in a focus group of larger than 12 individuals can restrict each participant to provide their valuable perspectives, and also can be difficult for the moderator to manage. In this thesis, three separate focus groups with the same 6 participants were conducted until data saturation point was reached as ideas became congruent (Morgan, 1997).

Phase 2

During the second phase of the data collection process, quantitative methods were utilized using validated survey questionnaires, followed by a structured open-ended questionnaire at the end of gameplay. G*Power analysis (figure 4.8) was used to determine the sample size to ensure robustness of the results, thereby avoiding Type II errors (Faul, Erdfelder, & Buchner, 2009). Statistical applications such as the G*Power can be used to determine the sample size of the convenience samples required in order to detect significant effects in the population, known as power calculation (Faul, Erdfelder, Lang, & Buchner, 2007). Statistical power is defined as the probability of rejecting a null hypothesis when the alternative hypothesis holds true (Greene, 2000). Power is generally kept at 0.90 or above to achieve robustness in a study and defined as the probability to detect an effect if in case an effect occurs in a test (High, 2000). A higher power requires a larger sample size (Lenth, 2001). In this study, a priori approach was taken to calculate the sample size in order to attain the target statistical power (Myoung Park, 2008, p. 7). According to Cohen (1988), a small effect size ranges between 0.2 and 0.3 indicates a real effect in the sample. Alpha-value, also known as the significance level in hypothesis testing, relates to Type I error, which is the probability of rejecting the null hypothesis when it is true (Field, 2009). The standard value of 0.05 is used because it is important to keep the probability (5%) of making a Type I error low, and also because it is the conventional value in social science research. With an effect size estimate of 0.25 and an alpha level 0.05, the minimum sample size required for this study is 106 for performing a mixed ANOVA (within and in-between subjects tests), as illustrated in Table 4.11 below.

		Visual Design Quality	
		Low Design	**High Design**
Fun Keys	Easy Fun Key (Group A)	57 (10 min)	57 (10 min)
	Hard Fun Key (Group B)	55 (15 min)	55 (15 min)

Table 4.11: Experimental Design (2x2 factorial design between Fun Keys and Visual Design Quality)

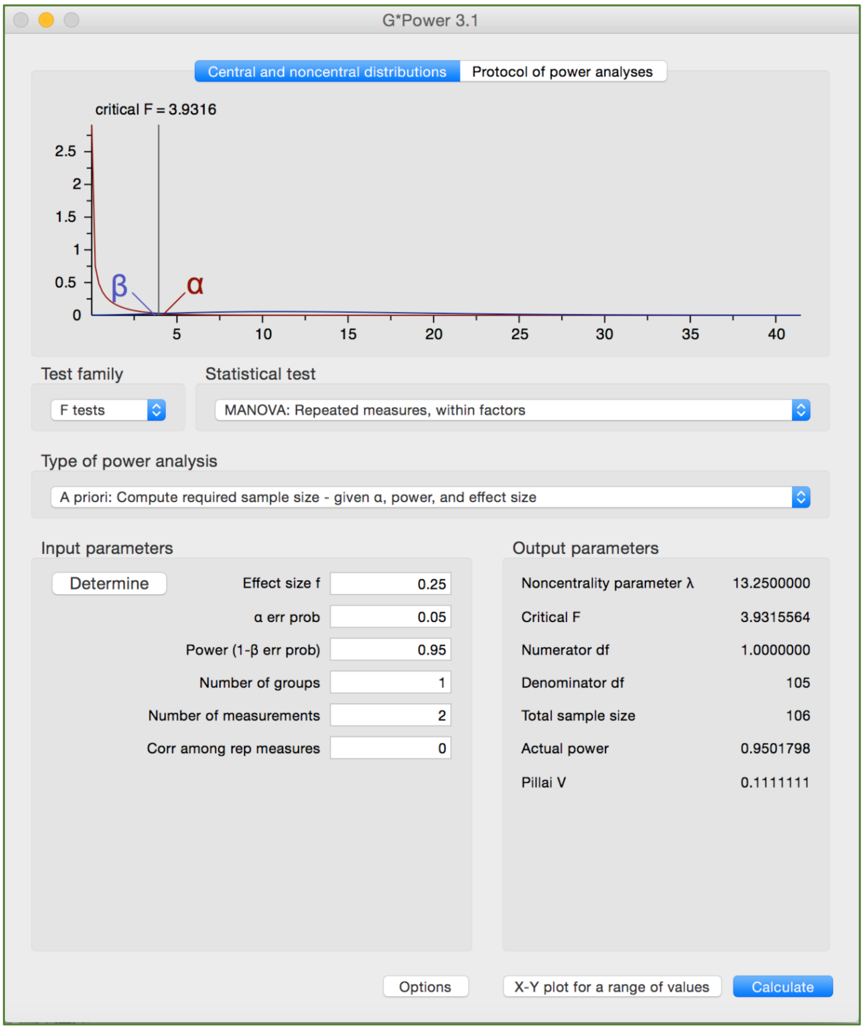

Figure 4.8 G-Power Analysis (Faul, Erdfelder, & Buchner, 2009)

4.7.2 Data Collection and Research Timescale

Chapter 5 outlines the processes adopted to develop the stimuli used in the research, and how these reflected the requirement to test the research hypotheses. This section explains the data collection process and the research design timescale. It also emphasizes on how the games were used as stimuli in the following experimental design:

A total sample of 111 participants (18–35 years) were recruited across campus through posters and flyers from a large comprehensive university in the southern United States. Data collection were carried out over a period of 10 weeks to attain the required number of participations. On arrival in the lab, the investigator read the important information contained in the participant info sheet (Appendix 4.1). The procedures of the experiments were communicated to the participants. They were handed a consent form to read and sign (Appendix 4.2). They were required to complete a preliminary survey which assessed their baseline mood state. They were then given an iPad Air Generation 2 on which they were instructed to play the two different versions of the same game for approximately 30 mins. During the gameplay experiment, participants completed a series of pre-test and post-test questionnaires. Following the experiments, they completed three questions in an open-ended questionnaire.

56 participants played both versions of the Easy-Fun Key and 55 participants played both versions of the Hard-Fun Key Game. A participant was randomly assigned to play either the low design or high design quality of a particular game type. The same participant played the low and the high design version of the same game category, with a 5-minute break in-between each game condition.

Each game play activity was divided into two sessions. In the first session, a participant played one version (low or high visual design quality) of the Hard-Fun game for a duration of 15 minutes, completed the required post-experiment surveys. The individual then switched to the other version of the Hard-Fun game in session 2, for another 15 minutes and took the post-experiment surveys. Two experiment surveys were administered during game play. The above procedure was repeated while collecting data for the Easy Fun Game, except that the duration of each game session was 10 minutes. As shown in Table 4.11 above, the assignment of a participant to either game condition was counter-balanced; this implied that everyone did not start with the same game condition. The same participant was tested twice in two different controlled game conditions. The duration of the study lasted for 60 minutes per participant on average.

Research ethics approval was obtained from De Montfort University (Appendix 4.3). Data were collected using United States' Institutional Review Board (IRB) code of practice in relation to anonymity and data protection (Appendix 4.4). The identity of each participant was anonymized on the questionnaire and its subsequent entry into Microsoft Excel sheets. Data were password protected on the researcher's computer and all the printed materials were kept in a locked cabinet at all times.

4.8 Reliability and Validity

The reliability and validity of each survey instrument are discussed at length in the above sections 4.5.3.1, 4.5.3.2, 4.5.3.3 and 4.5.3.4. Reliability is of twofold – internal test reliability and test-retest reliability. The internal test reliability of a questionnaire ensures that there is consistency among the question-items. The test-retest reliability implies that similar results are obtained when the researcher repeats the data collection process with the same participant on two separate occasions (Carmines & Zeller, 1979).

Reliability is a term used to define consistent measurement (Bollen, 1989), or the stability of replicating the measurement under different conditions in which the same results should be expected. It is important to note that reliable measures are not necessarily valid (Nunnaly, 1978). When it comes to the idea of reliability in qualitative research, key ideas for conducting a sound study emerges as trustworthiness (Glaser & Strauss, 1967), consistency (Hammersley, 1992; Robson, 2002), and dependability of evidence (Lincoln & Guba, 1985).

However, to ensure **reliability** of the research design, participants were randomly assigned to each game condition. The research design was robust in the sense that internal checks were carried out to ensure the quality of data gathered was consistent and within the context, and was interpreted with appropriateness. In order to generate data from participants, a systematic approach was undertaken from well-established participatory design methods, in which potential users and designers work together on the same platform (Halskov & Hansen, 2015). During phase 1, the participants in both the focus groups and the mind-mapping sessions were given sufficient time to cover necessary ground in order to showcase their experiences. Furthermore, the moderator provided all the necessary information about the research process to keep all participants apprised of the design and research process, in line with Ritchie & Lewis (2003).

The tablet games were designed using guidelines from the Principles of Design, including Gestalt theories, and were developed iteratively using a user-centered method approach, to ensure reliability, and pre-tested with users and designers at several phases by debugging the games that would have otherwise given rise to errors and usability issues. Rigorous game testing and troubleshooting with different users and developers significantly increased the reliability of the tablet game prototypes functionality and usability.

It is important to use a valid and reliable instrument to capture data with accuracy. ***Construct validity*** is concerned with a measuring tool that measures what the researcher expects to measure (Cronbach & Meehl, 1955; Rudestam & Newton, 2007; Field, 2009). The construct validity of an experiment is demonstrated by the content analysis of the qualitative data, and the ANOVA tests providing evidence of mean differences between two groups (Brown, 2000). In order to improve construct validity of the experimental study, a pilot test session was run prior to starting the actual experiment with participants.

According to Baker (1994), in order to conduct a pilot study, a sample size of 10-20% of the actual sample size of the main study is adequate. This ensured all the research protocols were followed. A pilot study enables researchers to conduct a preliminary analysis through a small-scale study of the actual study (Polit, Beck, & Hungler, 2001, p. 467), which is usually performed to pre-test the research instruments (Baker, 1994). It serves to give an indication if the research methods, design and survey of the study are valid. The goal is to perform a test-run to ensure that the research plan is as outlined so as to provide an accurate and reliable data. The goal is to ensure good research design in the final study. It provides an opportunity to work through issues or weaknesses that may arise in the actual study.

Face validity is based on judgment (Bailey, 1994), and is considered a weak practice of validity (Trochim, 2001). The advantage of face validity is that the researcher develops an understanding how prospective participants construe and respond to the items in the questionnaires (Devon et al., 2007). It is common practice to invite lay-persons to review the instruments for instructions, grammar, punctuations, wordings, and comprehensibility (Schultz & Whitney, 2005). In this thesis, a pilot study was carried out with three volunteer students to verify if:

1. instructions (research protocols, instruments) were clear and comprehensible;
2. the tools, game stimuli for capturing relevant data were in working conditions.
3. the wordings of each item questionnaire were correctly spelt.
4. the steps of conducting the experiments were aligned with the research instructions.

Internal validity is another category of validity defined as the level to which the results are due to the independent variable rather than to other confounding factors (Cook & Campbell, 1979). The following precautions were taken to control the internal validity of the study: (i) "testing and history" – there was a consistent 10 minutes break in between the test of the two different game conditions by each participant, and no specific events occurred in between the tests that would have influenced the participants (ii) "instrumentation" – the same instruments were used throughout for collecting data for both Fun Keys. (iii) "selection of subjects" – even though a convenience sample was chosen for the study, each participant was randomly assigned to each game condition to counter-attack against the threat of affecting the internal validity. The sample size was based on the research design by using a statistical calculation of the G-Power analysis (see figure 4.8) software which predicted the minimum number of subjects required to obtaining *power* in the research design; in this way, *Type II errors* (also known as false negative, or the error of not rejecting a null hypothesis when the alternative hypothesis is true) were minimized or eliminated. In other words, this is the error that occurs if the researcher fails to accept the alternative hypothesis when the research design does not have enough *power*. ***External validity*** is defined as the degree to which the results of a study can be generalized to a broader population (Cook & Campbell, 1979). External validity is discussed in the following section.

4.8.1 Generalizability

New results in a research study are normally domain specific. It is important to determine if these results are generalizable to other domains. In a quantitative research, the idea of external validity is key because the researcher should be able to explain the extent to which the results of the study, is generalizable to a broader population from the chosen sample frame. It is evident that no research study can be fully valid externally as several factors must be taken into consideration.

The purposive convenience sample recruited for this study could be a threat on external validity. For example, as the sample frame was drawn from a purposive convenience sample, it may not be representative of the target population. But in order to maximize generalizability, the participants were randomly assigned to game condition in the true experimental condition. The groups were equivalent in each condition in terms of number and gender, to reduce individual differences. A consideration while choosing the sample frame was the age group chosen for this tablet game study was between 18 and 34 years old, which account for 34% of the mobile game players in the US alone. In addition, it is important to emphasize on the way the study was operationalized in terms of constructs and methods. For instance, two different tablet game genres were used to make the research design more robust, so that the external validity of the findings could be improved. The application of mixed-methods research, as compared to a single-method research has proven to reduce the threat of construct validity, and external validity. Otherwise, generalizations could be only applicable to a single method study. For example, the methodology of this thesis was consolidated by a series of qualitative methods such as mind-mapping, focus groups, user centered design principles of prototyping, followed by quantitative methods. And for each dependent variable, specific validated instrument was utilized for data collection, and rigorous statistical techniques were applied to analyze the data. Since the research design was a within-subjects test, whereby the same participants played both game qualities, the carry-over effects were minimized by requesting each one to take a break in between each treatment. Consequently, experimenter effects were reduced by following the same formal experimental procedure for each participant. Hence, the results from this study may be generalizable to other interactive domains and to the actual population at large.

4.9 Chapter Summary

The adoption of *design-oriented research* approach provided the necessary rationale how theory was integrated into the practice of games creation process in phase 1. Relevant tools (mind-mapping, user centered design principles) and methods (focus groups and participatory design) were applied at different juncture of the research study to formalize the research. Mixed methods research approach employed necessitated qualitative methods in the game design process, and quantitative methods in validating the player experience design framework. Specific instruments were used to measure the continuous dependent variables at different stages of the data gathering process: pre-test, during the test, and post-test. The reliability of the instruments and validity of the research study were substantiated, and essential research limitations were indicated. The following chapter 5 describes the game design and development processes for use as stimuli in this study.

CHAPTER 5

GAME DESIGN AND DEVELOPMENT

5.1 Introduction

The chapter is divided into four main parts: game design process (section 5.2), game conception (section 5.3), games prototypes creation (section 5.4), and games evaluation (section 5.5). It begins with a description of the design and development of two types of tablet games, using a *design-oriented research* approach to address the research objectives outlined in Chapter 3. Each game user interface is rendered into two visual design qualities for testing the hypotheses. It then describes the conceptualization of the two tablet games, beginning with ideation followed by a series of three focus groups. The game design and development process adopt a user centric design principle by elaborating on game assets creation and prototyping. The final part explicates how the alpha and beta versions of the game prototypes are tested, refined, and converted into *builds* (real game apps) for uploading onto Apple's *iTunes Connect.* To test the hypotheses, the games are then evaluated by participants on an iPad using mixed methods (quantitative dominant).

5.2 Best Practice Approaches to Game Design

This section highlights the approaches used to game design and development. For the research, two tablet games were developed in two different formats representing high and low visual quality interfaces. The games were called *Mission Mars* and *Mars Explorer*. The following sections discuss the principles of the design approaches adopted in the game development stages.

Warr and O'Neill (2005) defines the *design cycle* as a composition of three main levels: *idea generation*, *implementation* and *evaluation*. Idea generation also known as ideation is a process for generating novel ideas or concepts during a design process, akin to divergent thinking (Power, 2011; Runco, 1988; Runco, 2014), which is also linked to creative problem solving (Titus, 2000). The idea generation process is also dependent on intrinsic drive (Couger, 1995; Amabile, 1983). An idea can be a visual or abstract representation of our thoughts. One of the techniques used for *idea generation* was mind-mapping, as elaborated in section 5.2.1. In this study, during the *implementation* stage, the game prototypes were developed as discussed in section 5.4 followed by game prototypes user testing in section 5.5 which forms part of the *evaluation* process.

At the micro-level, the following game design practices were rigorously implemented, as described by Adams (2013), Winn (2009), and Bates (2004). The process began by choosing the appropriate gaming platform (e.g. iPad) to build the iOS games. Feedback was implemented into the games through the head up display to retain players' attention. As explained under game mechanics section below, game rewards proved to be an essential component to motivate and involve the players (Salen & Zimmerman, 2004). Furthermore, the structure of game levels allowed players to progress through gradual challenges throughout gameplay, which was implemented in the *Mission Mars* game. The constant feedback and rewards induced player focus on game actions. The game design was simplified by the use of metaphorical objects familiar to end-users in the games to enhance game engagement level. Subsequently, *Spritekit* framework[1] from the Apple was used to develop the tablet games, in conjunction with rapid prototyping and iterative testing, as deliberated by Ushaw et al. (2015).

As discussed in section 4.4.4 of the methodology chapter, the user centered design approach was applied throughout the game creation process. The sequence of rapid iterative testing in this study started with design requirements, followed by devising prototypes, evaluation, implementation, play testing, refinement and evaluation, and deployment. During iterative prototyping, the designer usually receives feedback from participants to enable the iterative design cycle of the product (Leonidis, Antona, & Stephanidis, 2012). Testing the game prototypes at different stages of production allowed the researcher to detect functional issues, usability problems, and other technical issues, prior to the implementation phase (Preece & Maloney-Krichar, 2003).

Out of the three approaches to iterative design and prototyping proposed by Dix et al. (2004), the evolutionary prototyping approach was applied. The initial prototype was not rejected but evolved until the desired final stage was reached, following constant modification and refinement during the process. In this approach, the stakeholders can focus their effort more efficiently in the multiple development stages. Based on the literature review in Chapter 2, and subsequent development of research questions, it was

[1] The SpriteKit framework is used to create high-performance 2D games. It supports custom OpenGL ES shaders and lighting, integration with SceneKit, advanced new physics effects, and animations. (Scolastici and Nolte, 2013)

determined that the most appropriate approach to address the aims and objectives of this thesis was to build necessary emotional experiences in each game prototype; the most suitable approach to achieve this was to adopt Lazzaro's (2004) Four Keys to Fun theory, which is discussed in the next section.

5.2.1 Four Keys to Fun Game Theory

Lazzaro's (2004) Four Keys to Fun game theory describes four different types of fun in a game, namely Hard Fun, Easy Fun, People Factor and Serious Fun (figure 5.1). For the scope of this research, two popular game types for mobile devices from the Four Keys to Fun theory were considered: *Hard Fun Key* (action game) and *Easy Fun Key* (adventure game). These two Fun Keys games are characterized by the types of emotional elicitations intended from players.

5.2.1.1 Hard Fun Key

The concept of Hard Fun Key was applied to the *Mission Mars* game. Meeting challenges and "overcoming obstacles" are the main reasons for game play (Lazzaro, 2004). The emotions elicited from a player in a Hard-Fun game category are "fiero" and "frustrations" corresponding to the challenges and rewards associated with the game. A player has to accomplish specific goals. For example, a Hard-Fun game focuses on beating opponents, gauging ability and skills or winning the game using specific strategies rather than sheer luck.

5.2.1.2 Easy Fun Key

The concept of Easy Fun Key was applied to the *Mars Explorer* game. The goal of an Easy Fun game is to elicit an appreciation for curiosity, awe, wonder, and surprise from the player, as depicted in figure 5.1. The player does not necessarily play to win but to discover the game as the emphasis is on exploring the game activities. According to the Self-Determination theory in the context of gaming, it is postulated that one plays to satisfy psychological needs for competence, autonomy, and relatedness (Ryan, Rigby, & Przybylski, 2006).

In order to design the feature sets for each game type, it was essential to primarily explore their characteristics, *game interface, game play*, and *game mechanics* (Federoff, 2002), as elaborated in the following sections below.

5.2.2 Game Play

Game play is the process by which a player wins a game, surpassing obstacles designed and incorporated into the game through interaction design. It incorporates rules, challenges, and mechanics (Hagen, 2012). Game play consists of the important decisions a player makes to address game challenges to win the game (Federoff, 2002). In line with Lindley (2002), for game play to occur, participants are required to understand the game rules but in order to successfully play the game, it is not necessary to memorize all the rules. Gaming interaction is analogous to the *dynamic-interactive* (varying) taxonomy in line with the concept outlined in Candy and Edmonds (2011) as no outcome of the user interaction can be predicted. Participants interact with game prototypes during the evaluation process and the outcome of the game activity is always random and unpredictable, referred to as emergent experiences (Seevinck, Edmonds, & Candy, 2012). The game play for *Mission Mars* is described in section 5.4.2 and for *Mars Explorer,* it is indicated in section 5.4.3.

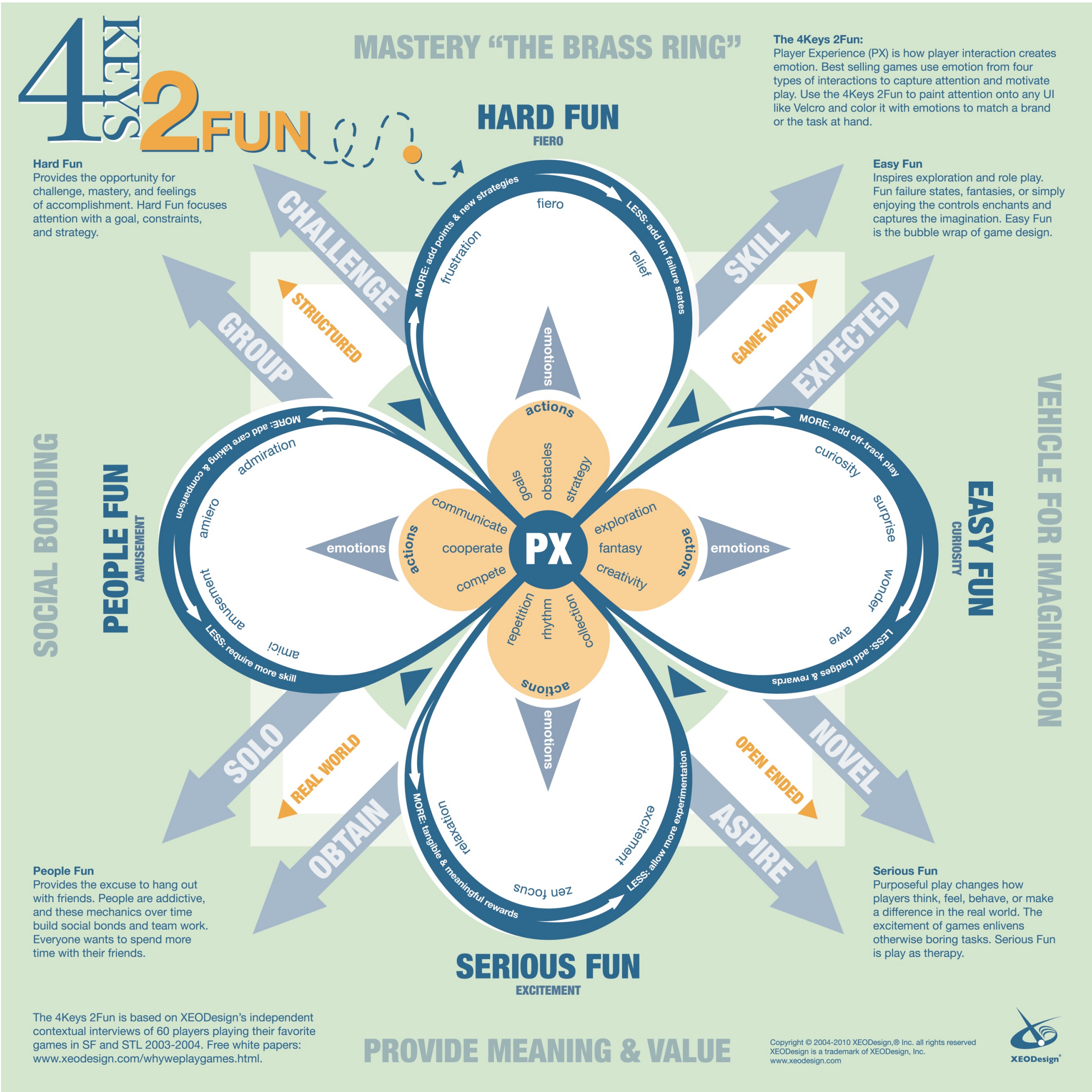

Figure 5.1 Four Keys to Fun Theory (Lazzaro, 2004)

5.2.3 Game Mechanics

Järvinen (2008, p. 254) defines game mechanics as "a means to guide the player into particular behavior by constraining the space of possible plans to attain goals." Game mechanics are defined as constructs of rules with the intent to produce gameplay. It is in fact these rules and rewards that characterize gameplay to create a compelling and engaging user experience (Salen & Zimmerman, 2004). The rules and rewards render the game activity challenging, fun, or satisfying, depending on the types of emotional responses the game developer hopes to elicit from the users. A dynamic difficulty adjustment (DDA) component is integrated into the game so that it can adapt to the pace of the player (Chen, 2007). This is achieved by game programming logic statements that monitor the score and the motion of the objects on screen. If the player wins too often, the game dynamically becomes more challenging, and vice-versa. The game should not be easy to win, nor too difficult so that it frustrates the player; the DDA component therefore helps maintain a balance promoting player experience (Hunicke, 2005). The game mechanics for *Mission Mars* are described in section 5.4.2 and for *Mars Explorer*, it is indicated in section 5.4.3.

5.2.4 Game Interface

The game user interface is the main point of interaction between the player and the device. The user interface affects gameplay as it defines how the player interacts with the game and accomplishes the goals presented herein. A well-designed user interface can stimulate gameplay with simple mechanics, by meeting the players' expectations. Game motivation increases as a player recognizes he can fulfill necessary action as envisaged.

Michailidou, Harper, and Bechhofer (2008) observed a strong correlation between visual complexity and structure as well as design elements, such as organization, cleanliness, and attractiveness in websites. Both visual complexity and prototypicality have an impact on design judgment. Visual complexity is defined by how convoluted the visual design looks; prototypicality is a mental model defined by the representation of a product that can fit under a specific category (Tuch, Presslaber, Stocklin, Opwis, & Bargas-Avila, 2012). Information from low visual complexity and high prototypicality interfaces is processed more rapidly and favored by end-users (Winkielman et al., 2006). Graphics have always been used to enrich the visual design of user interfaces (Noiwan & Norcio, 2006), so that end-users can focus their attention on the intended signifiers (Shneiderman et al., 2016). However, incorrectly designed graphics may cause unnecessary cognitive overload for the users as they decipher the connotations (Wang & Emurian, 2005).

In order to achieve the high level of user interface sophistication, essential elements and principles of design need to be followed. Designers adhere to the overarching elements and principles of design while creating user interfaces that convey equilibrium of structural design elements. The different laws that govern the principles of design are: *balance*, *proportion*, *rhythm*, *emphasis*, and *unity*. The elements of design are *line, shape, size, space, color, texture, value.* Researchers have empirically shown that attributes such as color, balance (symmetry or asymmetry and grouping), order, simplicity, complexity, and novelty have an effect on the design appraisal of user interfaces (Moshagen & Thielsch, 2010; Lavie & Tractinsky, 2004).

Meeting the above principles would result in a high-quality visual design for game interfaces, which is the expected objective for game designers. The aims and hypotheses of the thesis required the research study to vary the visual experimental design of the game user interfaces into a lower and higher visual design condition respectively (see Methodology Chapter, Table 4.2). Therefore, two visual design conditions were created for each game type to respond to the research gaps indicated in chapter 3, section 3.2.

5.2.5 Visual Design Renditions

To achieve a lower visual design quality (LQ) condition of the game interfaces, the visual structure was manipulated to affect layout balance graphics texture in addition to modifying the color and contrast between visual elements and their environment; game assets were rendered without impeding the usability attributes similar to the experimental work conducted by the following researchers: (Tuch, Roth, Hornbaek, Opwis, & Bargas-Avila, 2012; Wong, Khong, & Thwaites, 2010; Mahlke, 2008).

The creation of the game user interfaces with higher visual design followed again the core design guidelines and principles. For example, the laws such as balance, rhythm, and hierarchy were applied to arrange game elements as both symmetrical and asymmetrical layout can give rise to balance in a design layout, according to the principles of design. The position of the head-up display in both game types and conditions were unchanged for research participants to avoid premature perceptual biases leaning towards a specific design condition, as discussed in Brave and Nass (2003), and Kahnerman (2017). For both game types, the higher visual design version (HQ) of the game environment and assets were rendered using an analogous color scheme with high contrast and high-resolution image quality (figures 5.2a and 5.3a).

Vertical symmetry was applied to the Hard-Fun Key high visual quality game design (Mission Mars HQ) as it was found to affect participants' appraisals and judgments more than horizontal symmetry (Rossi-Arnaud, Pieroni, & Baddeley, 2006; Tuch 2011). Asymmetrical design was adopted for the Easy Fun high visual quality Key (Mars Explorer HQ) to create harmony among the visual elements with a balanced layout. For the low visual quality (LQ) version of each game, the visual design quality of the game interface was modified by *violating the elements and principles of design* (Tuch et al., 2012). This approach is consistent with previous research where visual design elements such as color scheme, graphics texture, and layout were manipulated, without affecting the perceived usability, as demonstrated in Tuch (2012), Wong et al., (2010), and Mahlke, (2008). For example, in order to create a low visual design condition of a website interface, Tuch et al., (2012) modified the background color, texture and ornamental graphical elements, without changing the position of the interactive elements. Ultimately, the approach did not alter usability of the design and therefore, adopting a similar approach, this technique was incorporated into the current game designs.

As elaborated in Appendix 5.4, under Game Scene Design, when the Easy Fun Key (Mars Explorer) game is initialized, it adds the rocks and other scenery objects to the background layer dynamically as per game codes. The game loops through every tile in the map and randomly adds an object if that current tile is empty. In the case of the Easy Fun Key LQ version, the game logic was programmed so that the visual elements would appear on screen by dispersing the visual weight of the game assets, thereby offsetting the informal balance (asymmetrical layout) in addition to the monochromatic color scheme, low bits graphics and low contrast. Indeed, this was rendered in both LQ game types (figures 5.2b and 5.3b). The usability features were not manipulated between the HQ and LQ in each game type as the research objective was to experiment with the visual design condition only. As described in section 5.7 below, user testing was conducted for both conditions to ensure game usability remained unaltered. Game playability attributes were therefore not modified (following Tuch et al., 2012) as the game mechanics and game narrative were unaltered, with the exception that each game type was rendered into a lower and higher visual design version. Ultimately, usability was tested throughout the development stages and findings are reported in Section 5.5.3 below, suffice it to say that it was not found necessary to adopt a different approach to proceed in testing the research hypotheses outlined in the previous chapters.

Figure 5.2a (Mars Explorer) Higher Visual Design Quality Interface

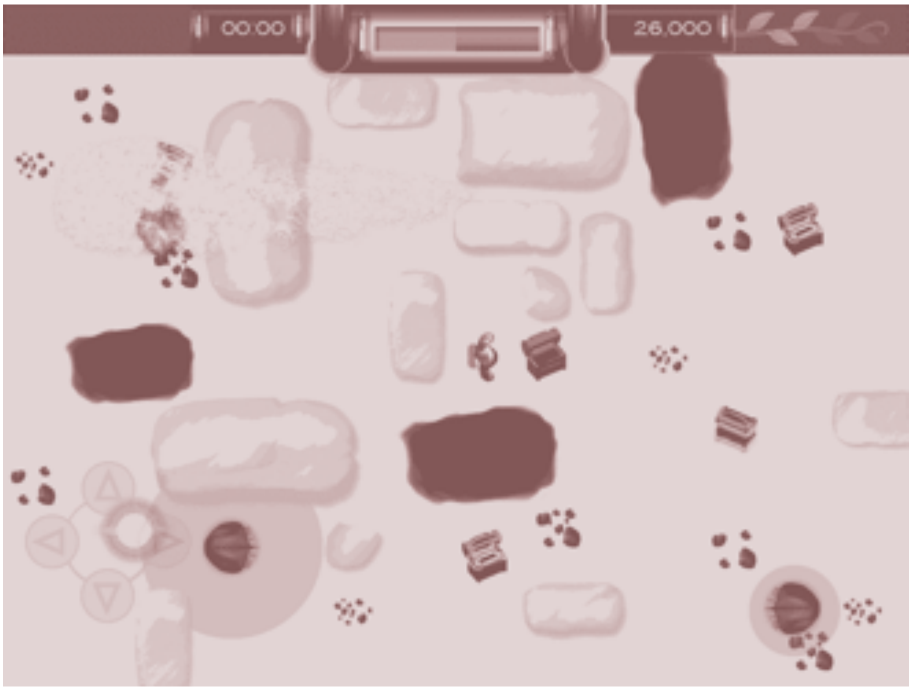

Figure 5.2b (Mars Explorer) Lower Visual design Quality Interface

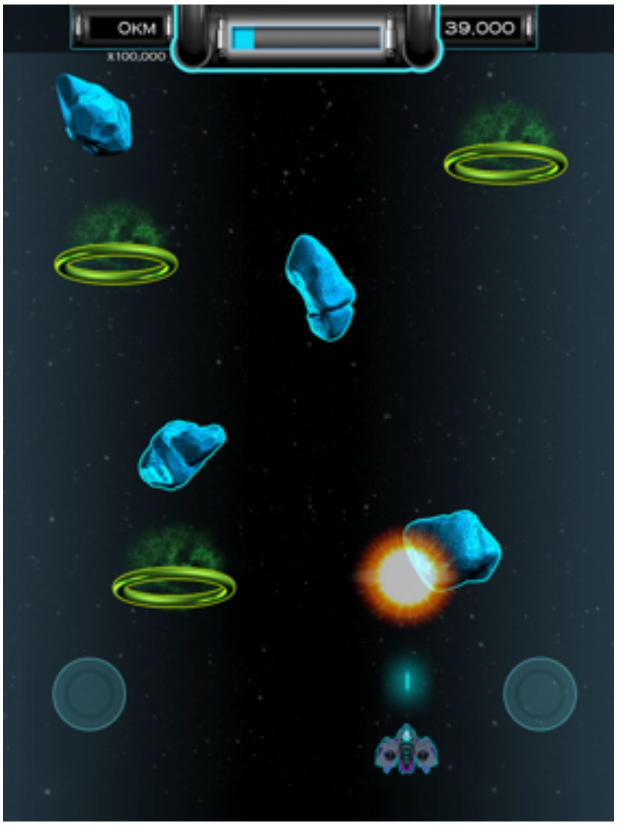

Figure 5.3a (Mission Mars)- Higher Visual Design Quality Interface

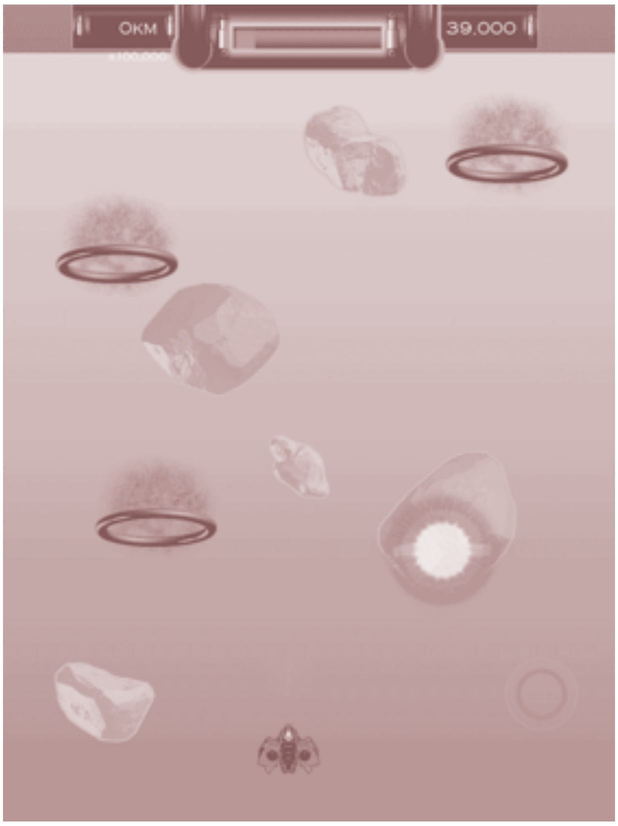

Figure 5.3b (Mission Mars) - Low Visual Design Quality Interface

5.3 Games Conception

This part describes the different stages involved in the tablet games conception, prototyping and games evaluation, summarized in Table 5.1. The conceptual ideas stem from an ideation process developed using mind-mapping technique (see section 4.4.2). This entailed a visit to the Smithsonian National Air and Space Museum and was further developed through the conduct of three series of focus groups to determine the characteristics of the two types of tablet games which were named *Mission Mars* and *Mars Explorer*. The next sections focus on the design processes adopted for the game concepts including game assets and environment through the iterative game development processes outlined in the previous sections of this chapter.

Stage	Process/Method	Dates	Sample
Games Conception			
Game ideation	• Mind-Mapping (see appendix 5.1) • Visit to Smithsonian National Air and Space museum (see section 5.3.1)	April 2013 June 2013	5 Participants
Game narrative ideation	• Focus group 1 (section 5.3.2)	August 2013	6 Participants
Game interface ideation	• Focus Group 1 (section 5.3.2)	August 2013	6 Participants
Game play ideation	• Focus Group 2 (section 5.3.3)	September 2013	6 Participants
Game assets ideation	• Focus Group 2 (section 5.3.3)	September 2013	6 Participants
Game mechanics ideation	• Focus Group 3 (section 5.3.4)	October 2013	6 Participants
Games Prototyping			
Prototyping Game assets	• Iterative usability testing (section 5.4.1)	November 2013	2 Participants Researcher as design practitioner
Games visual design renditions 1.Hard Fun Key-Higher Visual Design Quality	• Design Researcher-Practitioner • Participant observation self-reflections (section 5.2.6)	Jan - April 2014	

2. Hard Fun Key-Lower Visual Design Quality 3. Easy Fun Key-Higher Visual Design Quality 4. Easy Fun Key-Lower Visual Design Quality			
Games design and development	• User Centered Design • Iterative Prototyping • Participatory Design Section 5.4	October 2015–April 2016	2 Participants
Games Evaluation and Usability Testing			
Games Prototypes Visual Design Evaluation	• User Testing (iMac computer interface) Section 5.5.1	October 2015	3 Participants
Games Iterative Usability Testing	• Iterative Game Testing and Debugging Section 5.5.2	May 2016	4 Participants
Games Visual and Usability Evaluation	• User Testing (iPad devices) Section 5.5.3	November 2015–April 2016	3 participants

Table 5.1 Summary of Game Development Process

5.3.1 Games Ideation

The stages entailed to ideate the tablet games:

- Mind-mapping was used to devise a list of keywords and links between them in a focus group session.
- A visit to Smithsonian National Air and Space museum in Washington D.C. was undertaken to collect visual information on space travel and planetary exploration that would inform *Mission to Mars* and *Mars Explorer* games.
- Three different focus groups were conducted to iteratively shape the games concepts, devise feature-sets, discuss the visual styles (e.g., 2D and 2.5D), and understand types of user interaction with the games as they developed.

An example of Mind-Mapping is found in appendix 5.1 and the keywords generated are found in appendix 5.2. The ideas generated from the mind-maps served as a stepping stone to guide the preliminary research phase to shaping the characteristics of the tablet games.

In the concept development phase, tablet game types and visual styles were studied. In order to develop insight and interest in *Mission to Mars* game, the visit to the Space Museums in Washington D.C. provided necessary visual information that was used to develop a 'mood board' of content as a reference for further concept development. Initial ideas pertaining to game scenarios, characters, and assets were sketched out, notes were recorded into a notebook and photographs were taken during the museum visit. Visits focused on understanding the roles of orbiters in Space, and planets of the solar system in a 3D space Data photographs (see figures 5.4a and 5.4b).

The visit was used to enhance the researcher's knowledge-base and understanding of scientific phenomena (Vartiainen & Enkenberg, 2013). Exploring the artefacts displayed in the museum exhibition space enabled a deeper understanding of the design features that could be incorporated into the games. This aligns with the "meaning-making" process of the artefacts that is facilitated by the semiotic resources embedded into the exhibits (Insulander & Selander, 2009). Primary ideas were construed from multi-modal resources such as giant displays, demonstrations, simulations and interactive kiosks. The categorization of artefacts allowed exploration of the collected dataset using a cognitive filtering method (Bell et. al., 2009) to build concepts based on a series of reflective notes.

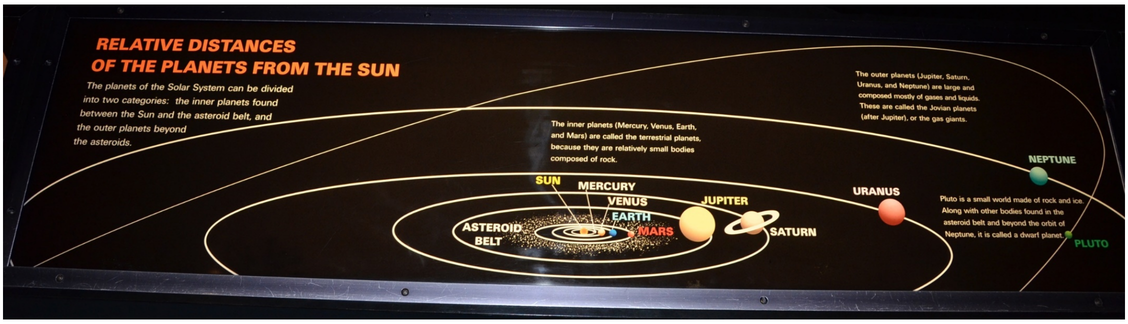

Figure 5.4a Solar system, photograph collected from Smithsonian National Air and Space Museum, Washington D.C

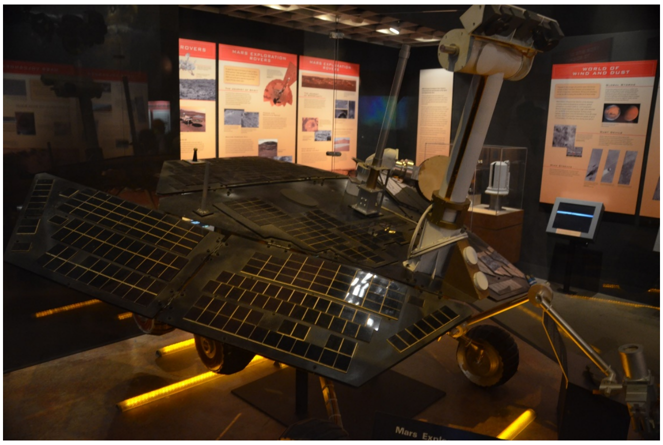

Figure 5.4b Orbiters in space, photograph collected from Smithsonian National Air and Space Museum, Washington D.C

The depiction of the planets, their characteristics, textures and their relative positions in orbits provided the basis for building the games environment, assets, and game characters (see figures 5.4c and 5.4d). The story line of the tablet games ultimately surfaced following a meta-reflection of engagement with the physical artefacts and conceptual models displayed in a 3D space. Meta-reflection is a continuous process of thinking, analyzing, and interpreting information, as put forward by Granville & Dison (2005).

To turn these ideas into concepts, the sketches and notes were initially evaluated through self-reflections, critiques, and were later developed for use in the focus groups.

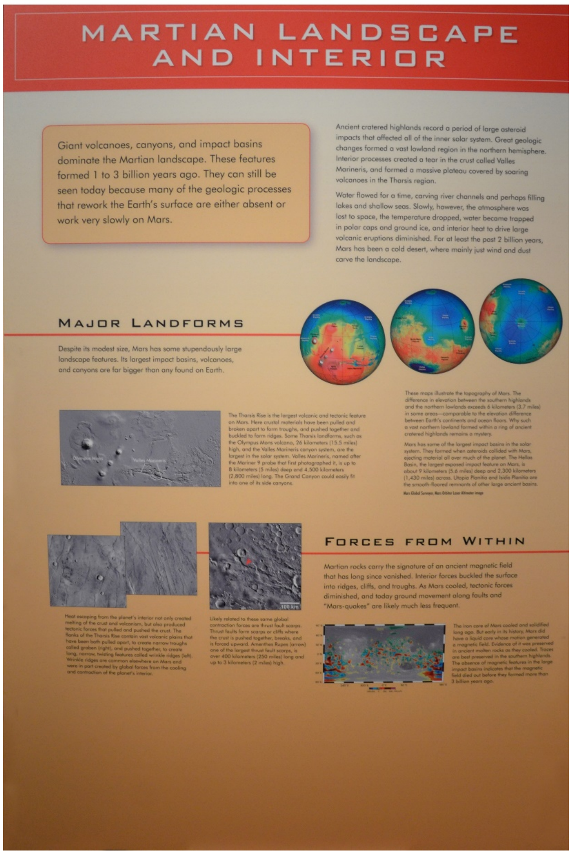

Figure 5.4c Mars Landscape Textures, Smithsonian National Air and Space Museum, Washington D.C

Figure 5.4d Asteroids, Smithsonian National Air and Space Museum, Washington D.C

5.3.2 Focus Group 1

The aim of the focus group was to discuss the game narratives and interfaces. During the first focus group, an engagement question was first asked: "Can you describe your favorite tablet game?" The choice of the device was made due to its easy to use, familiarity, and high-resolution screen. The constraints of the resources were considered during the conversation. For instance, the game had to meet the objectives of the study, including the variation of visual design quality and the timeline for development. A list of popular mobile games along with their artistic styles was elicited from the participants. The key idea revolved around a contemporary 2.5D visual style with scope for rendering into a low and a high visual design condition. The 2.5D visual style is characterized by 2D gameplay and 3D objects rendering without the use of a 3D space.

5.3.2.1 Outcomes of Focus Group 1

Mission Mars

Participants proposed and collaboratively generated the following narrative for Mission Mars: it revolves around a spaceship starting its journey from planet Earth to Mars. On its way, it surmounts multiple obstacles (storms, asteroids, aliens) before reaching planet Mars; the game challenges increase after each level is played. Figure 5.5 depicts a high-level visualization of *Mission Mars* with different game layers. The visualization illustrates the concept of "parallax" scrolling which is a popular technique and visual effect in 2D and 2.5D digital games whereby graphics on topmost layers move relatively faster than farther ones. This visual style makes use of multiple layered background imagery, each object in a layer moving at a relative speed with respect to others so that the illusion of depth is generated. The foreground layer moves at a higher speed than the background, thereby creating an optical illusion in the game user interface.

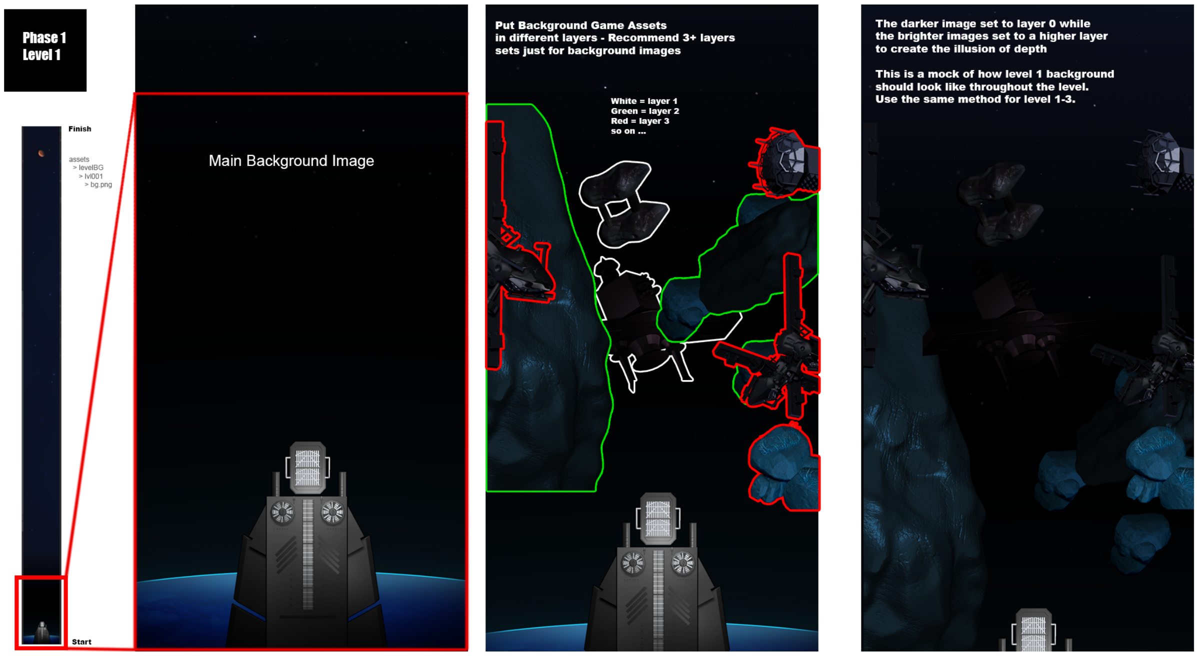

Figure 5.5 Mission Mars Visualization of parallax scrolling

Mars Explorer

For this game, the focus group participants outlined how characters (astronauts) explore the Mars landscape, grow green leaves to support their survival and faces enemies (aliens), and sand storms on the terrain. The participants converged on a storyline in which a character's task is to open treasure chests to collect gold coins. Aliens randomly appear in the treasure chests which can defeat the player. Avoiding the sandstorms and destroying the enemies help the player earn enough points to grow green leaves for survival. A visualization depicting the game story for *Mars Explorer* which ultimately emerged from the refined game discussed in focus group 2 as shown in Figure 5.6.

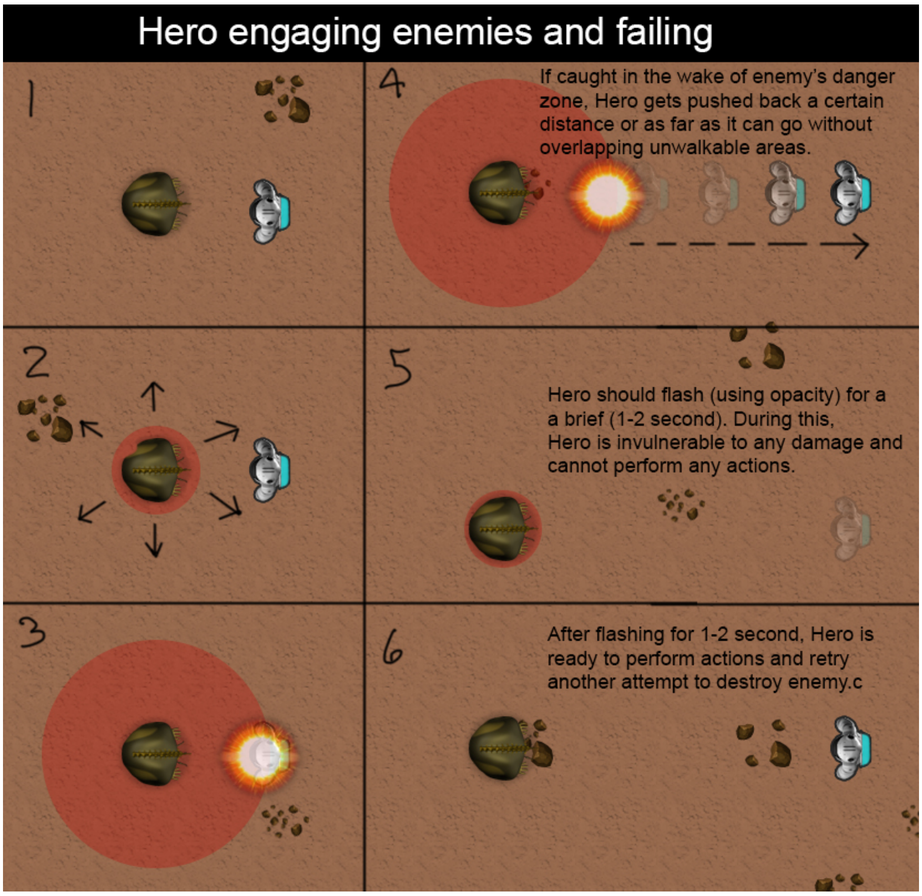

Figure 5.6 Mars Explorer Visualization

5.3.3 Focus Group 2

During this focus group, the following game play questions were raised:

i) How many levels should each Fun Key (Hard Fun and Easy Fun Key) ideally have?

ii) What are the strategies for a player to win the game?

iii) How would a player score or lose points in each level?

iv) What would the visual styles of the game assets look like?

An extract from the National Geographic magazine (Mars, n.d.) describing the Red Planet (Mars) was distributed to each participant to support the game visualization processes.

Mars is a small rocky body once thought to be very Earthlike. Like the other terrestrial planets—Mercury, Venus, and Earth—its surface has been changed by volcanism, impacts from other bodies, movements of its crust, and atmospheric effects such as dust storms. It has polar ice caps that grow and recede with the change of seasons; areas of layered soils near the Martian poles suggest that the planet's climate has changed more than once, perhaps caused by a regular change in the planet's orbit. The Mars atmosphere consists mostly of carbon dioxide, can be processed to release oxygen for life support or propellant use. Periodically, great dust storms engulf the entire planet. The effects of these storms are dramatic, including giant dunes, wind streaks, and wind-carved features. There may be asteroids snared by Mars's gravity.

5.3.3.1 Outcomes of Focus Group 2

This focus group identified the challenges involved during game play are described for each level for the Hard-Fun Key. The game elements and strategies to play both games formed the basis of the discussions. In order to incorporate different types of touch screen gestures (user interaction) and an increasing level of challenges, there was unanimity that a *Mission Mars* game with three levels of challenges would serve the purpose of the research objectives. The creation of interaction models was proposed in the discussion which revolved around user interaction and game actions.

The outcomes of the focus group aligned with Pratt and Nunes (2012) explanation that designers depict interaction models to showcase alternative design solutions for the end-user to better understand how to steer an experience. The researcher depicted gameplay through interaction models as sequences of hand drawn sketches connoting a user's key action during interactivity (figures 5.7a-c). Furthermore, in order to respond to the focus group questions related to the appearance of the game assets, it was necessary to create digital mock-ups, which then became a tool to test the essence of the artefacts with participants.

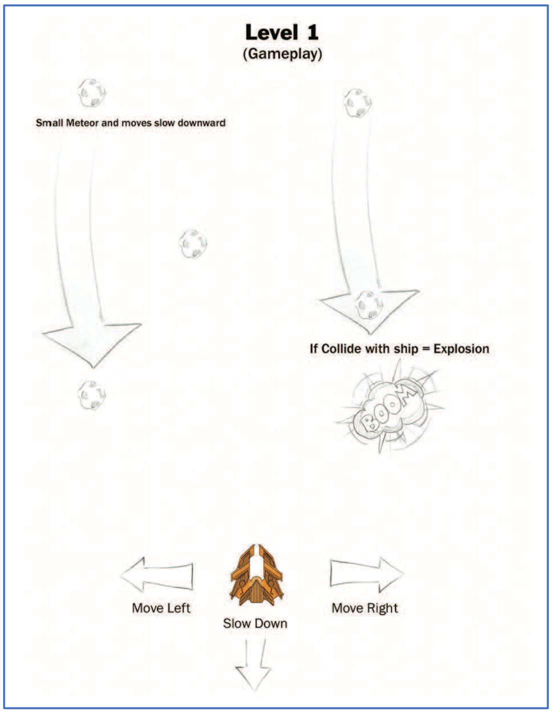

Figure 5.7a Interaction Model Hard Fun Key level 1

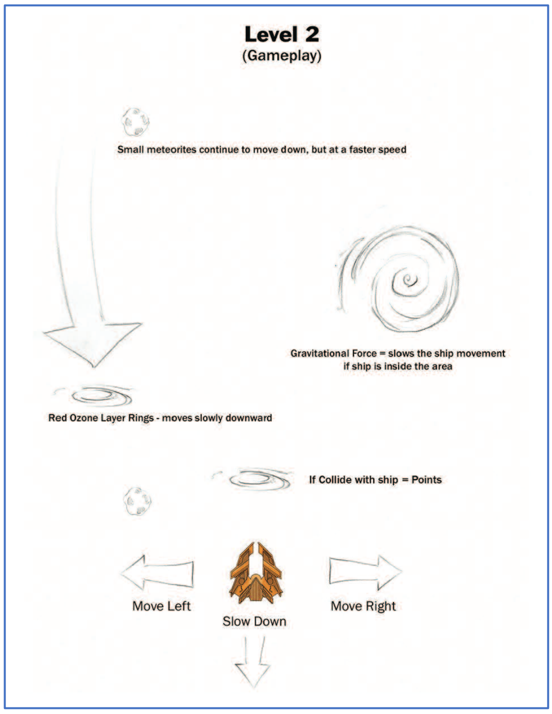

Figure 5.7b Interaction Model Hard Fun Key level 2

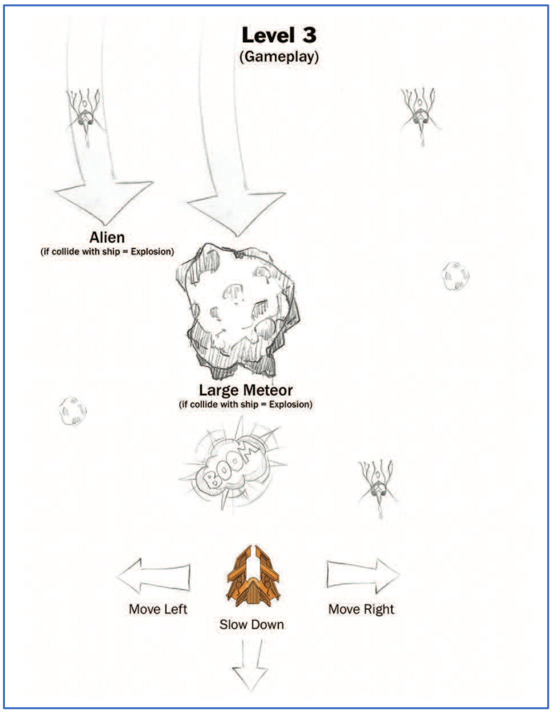

Figure 5.7c Interaction Model Hard Fun Key level 3

These mockups facilitate storytelling to render the idea tangible (Camburn, Viswanathan, Linsey, & Anderson, 2017). The Hard-Fun Key was constrained linearly as the player was able to move from one point to another in a 2D space. The ideas from the sketches were translated into digital game asset prototypes as shown in section 5.3.4.1 below.

Mission Mars

Level 1: The game is played by making use of the tilt function of the *iPad* to navigate the spaceship, and any tap (using either thumb) on screen to fire bullets from the spaceship to destroy meteorites or to avoid being hit by meteorites.

Level 2: The game assets, such as storms and meteorites, travel at greater speed with the addition of red ozone layer rings. The player finger taps on either side of the screen to navigate the spaceship (hero) along the x-axis. The player taps on the spaceship to fire bullets to destroy enemies, red ozone layer rings, and meteorites while avoiding storms which add another level of challenge to gameplay.

Level 3: In addition to the above game assets, more elements such as asteroids, aliens, and ozone rings (green and red) are incorporated. Green ozone rings are included as harmless characters while the player earns points by colliding with the green ozone rings. The score is reduced if the player is attacked by the harmful red ozone rings. The game is played by swiping enemies on the touch screen to destroy them; one touch to the left and or to the right will navigate the spaceship to the left and right respectively. The closer the finger is positioned relative to the spaceship, the faster it moves; by contrast, if the tap on the screen is further away from the spaceship, it will move relatively slower in the respective direction, depending on the position of touch to the spaceship. The player earns points by destroying meteorites, asteroids, and aliens. The player can accumulate bonus points by passing through green ozone rings that appear randomly on screen. A player has three chances to win following an encounter with an enemy. After reaching 1500 points, the player completes the game. In line with the game narrative, the player accumulates enough points to land on planet Mars, embarking on the other game type, Easy Fun Key (Mars Explorer).

Mars Explorer

Similarly, it was determined that gameplay with one level, while incorporating a variety of challenges for the *Mars Explorer* tablet game, would respond to the research objectives. It was speculated a player would take 15 minutes to complete a gameplay. The Easy Fun Key was built along a non-linear environment as the player could move freely along the x and y axes in a 2D space. When the spaceship lands on Mars, the main character (player) starts his exploration. Mars Explorer is represented as a top-down view. Once the spaceship lands on planet Mars, the exploration begins. The player's goal is to successfully grow leafy green salad on Mars for survival. Every time hundred points are scored, a leaf sprouts off the stem; however, the plant will shed a leaf every time hundred points are lost. There is no level in this game. As the (player) astronaut explores Mars, he encounters aliens, falling objects and dust storms. The aim is to find available resources such as metals, precious stones, and ice-water.

The player explores the planet Mars, with the aid of an oxygen tank that becomes depleted over time. The player must ascertain sufficient amount of oxygen level to carry out the mission. By destroying aliens, players earn points, while by opening treasure chests, they accumulate bonus points or can lose points as well. Players are encouraged to play the game more than once in order to reach higher scores every time, or to discover additional resources on the Red Planet. The game ends in one of two ways: when the oxygen level is completely depleted, as reflected by the status score of the head up display or if all the leaves have been shed.

Another thread of discussion of the focus group related to controlling the game sprites, which are the animated game assets that are part of gameplay (e.g. the main character, enemies, bullets.) It was also suggested to include a control to enable left and right-handed players greater access to the gameplay components in both versions to ascertain the usability attributes were the same. The degree of freedom concerning rotation and movement of the main character is provided in Appendix 5.3.

5.3.4 Focus Group 3

This discussion focused on the micro-level details such as game mechanics, which are the constructs of game rules intended to produce gameplay. The following areas were addressed during evaluation of the games in development:

i) What aspects in the games would motivate a player to play the game again?

ii) How does the visual style depiction of assets for each game type reflect congruency along a storyline?

Intra-group data saturation was apparent when no more new items surfaced, as noted in

Onwuegbuzie et al's (2009) study. So, this focus group provided sufficient game prototyping information. The researcher combined the notion of "descriptive counts of categories" and qualitative data annotated during the discussion as recommended in previous studies (Kidd & Marshall, 2000; Morgan, 1993; Silverman, 1985). For example, 5 out of 6 participants agreed that the tilt, tap, and swipe touch interaction gestures would be appropriate to specific levels. The researcher also noted the number of times participants would repeat an idea during the conversations to persuade the other members about their opinions. The outputs from the three focus groups are summarized below.

5.3.4.1 Outcomes of Focus Group 3

Discussion focused on a number of refinements to game functions which were subsequently developed:

- to implement a mechanism to accommodate players with different skill levels. Hence, to motivate the player, the dynamic difficulty adjustment (DDA) component was incorporated into the game, as discussed in section 5.2.4).
- to apply the concept of unpredictability through game programming logic in the game development to prevent players from predicting outcomes of the interaction in a linear manner. This is in line with Sommerer and Mignonneau's (1999) theory of "unpredictability in arts" and also with the theory of dynamic-interactive (varying) systems as proposed by Edmonds (2011).

- the head up display provides instantaneous feedback for players to be aware of their status during gameplay at all the time. The horizontal status bar in the Mission Mars and the leaves icon of the Mars Explorer provided supplementary cues in addition to the scores in each type.

- Short videos were created to demonstrate the actions of the *Mission Mars* game levels for deeper understanding of player interaction (figures 5.8a-5.9e), and to demonstrate the actions of the Mars Explorer game (figures 5.8f-5.9h).

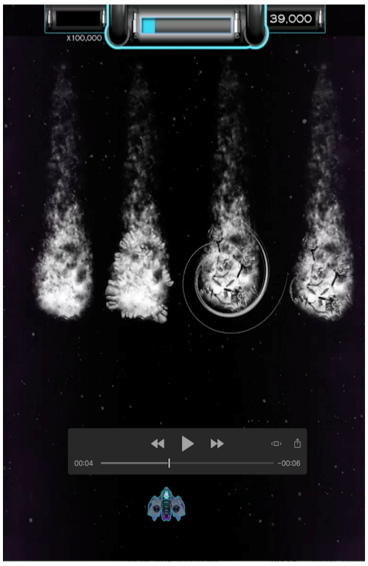

Figure 5.8a Mission Mars - Level 1 Spaceship avoiding storms

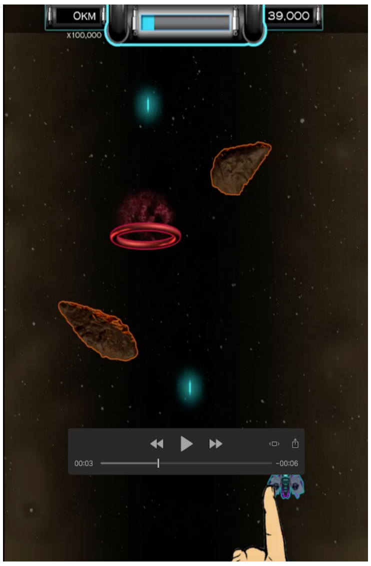

Figure 5.8b Mission Mars - Level 1 Spaceship shooting meteorites and avoiding Red Ozone Rings

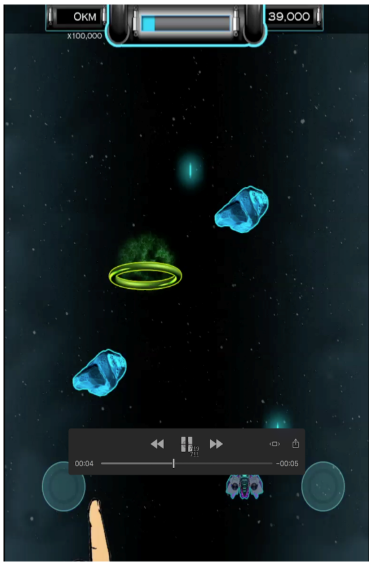

Figure 5.8c Mission Mars - Level 2 Spaceship shooting asteroids and approaching Green Ozone Rings

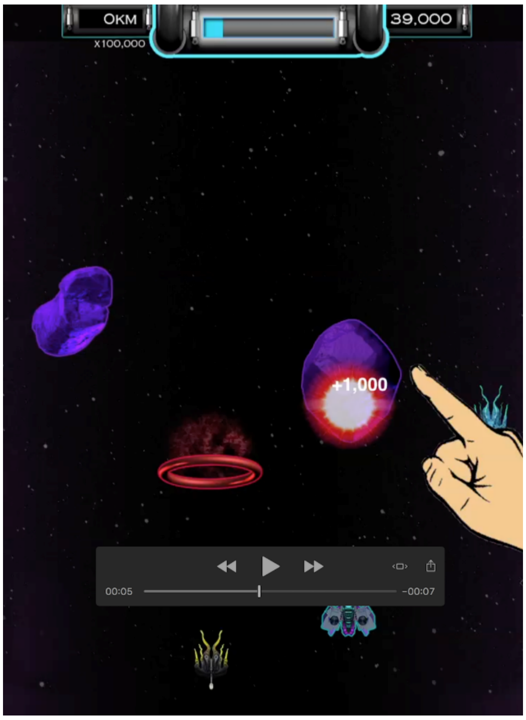

Figure 5.8d Mission Mars - Level 3 Swipe touch screen gesture destroying meteorite

Figure 5.8e Mission Mars - Head Up Display (HUD) all levels completed

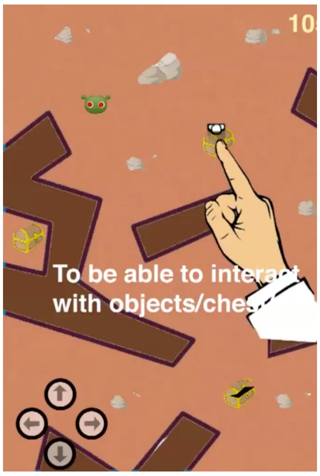

Figure 5.8f Mars Explorer - Player interacts with treasure chest using arrow keys

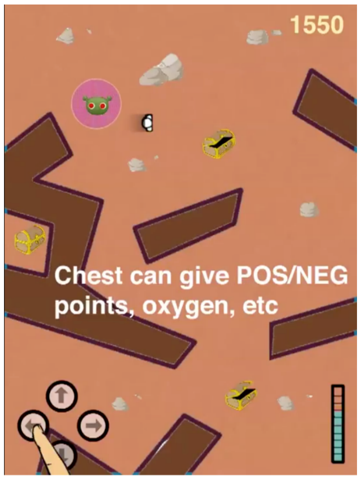

Figure 5.8g Mars Explorer- Chest can either add or deduct points to score

Figure 5.8h Mars Explorer- Player avoiding harmful radiation emitted by alien

Following satisfactory completion of the concept development stage through the focus groups, the next stage was to develop the game prototypes for subsequent usability testing.

5.4 Games Prototypes Creation

The concepts derived from the outcomes of the three focus groups were integrated into the building of tablet game prototypes. The design and development process started with the creation of the higher quality versions of the two games. Following debugging and user testing, the game assets were converted to create the lower quality versions while the game programming logic was kept constant. To create the connection between the two game types, the game narrative of the Hard-Fun Key game flowed seamlessly into the Easy Fun Key game.

The games were created using *SpriteKit* framework with *Xcode* integration using Swift version 2.0 (for iOS tablets). It is important to note it requires special technical, artistic and programming skills and resources to create 3D games. To turn shapes into 3D objects, lighting, textures, and the third dimension was considered. Based on the scope of this thesis, a 2.5D style iOS game was premeditated to respond to the objectives of this research study. A description of the game development is provided in Appendix 5.4, which includes the tools used for development, game scene design, game logic, collision detection, parameters for dynamic difficulty adjustment, and class architecture. Each game prototype was iteratively built using a top-down approach by integrating individual game assets from feature-sets and user interface elements to game mechanics into Xcode7. In order to play-test the beta game applications (apps) with participants, several versions of the *TestFlights* were built for the iPad retina with a screen size 9.7 inches, as it was determined to be the most practical way to invite participants for user testing and debugging. The section below describes the creation of game assets of the higher and lower game interface types.

5.4.1 Game Assets

Game Assets were created in Adobe Photoshop as image bitmaps; game (assets) sprites simulating 3D bitmaps were created using Google Sketchup (figures 5.9a and 5.9b). The objective was to blend 3D objects into a 2D game environment to reach the level of sophistication of a 2.5D visual style tablet games. The high-fidelity prototypes (game assets) resembled the intended final product. The characteristics explored in the prototypes (figures 5.9a and 5.9b) were symbolic connotations, recognition and congruent visual styles.

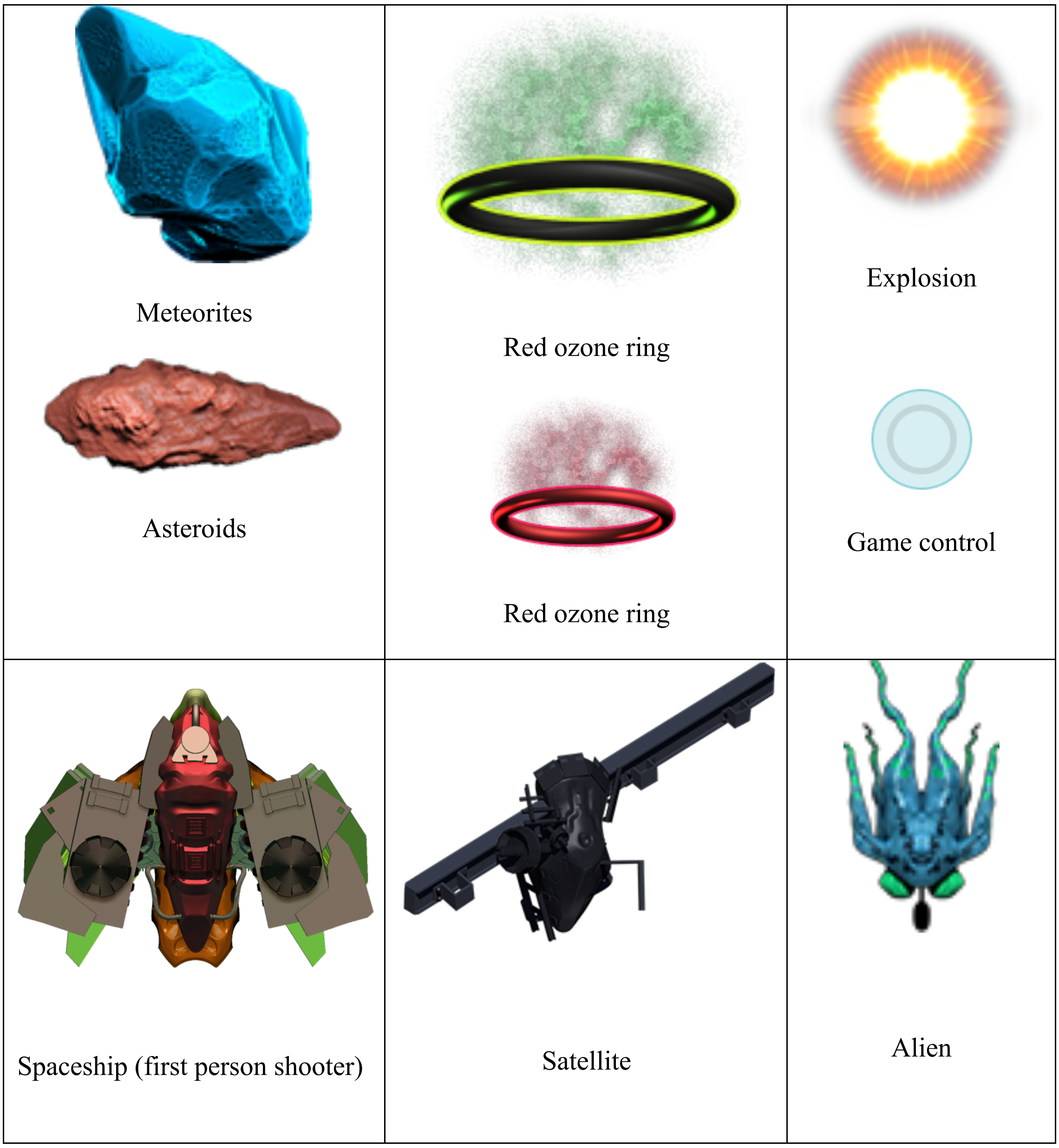

Figure 5.9a. Game assets – Hard Fun Key (HQ)

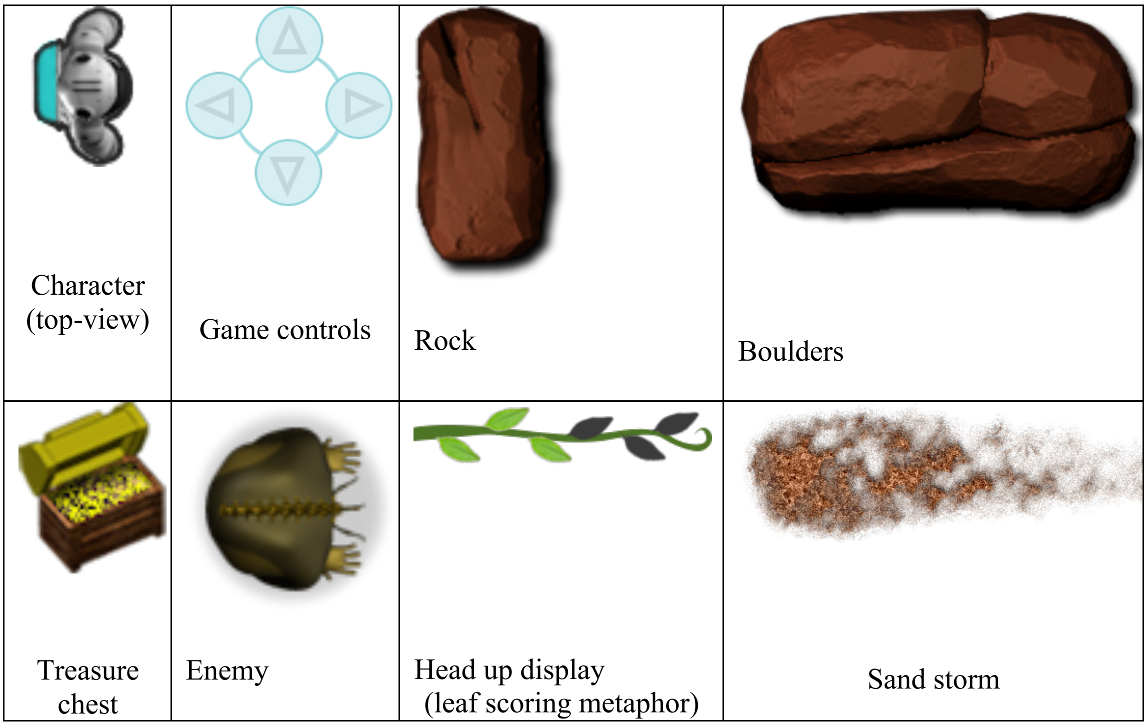

Figure 5.9b. Game assets – Easy Fun Key (HQ)

Using two participants (game players) as objective usability testers working in conjunction with the researcher, the game assets were developed. Following usability testing, the pixel density of the assets was adjusted to the correct size to match the screen resolution of the iPad device. Upon establishing a viability of the higher quality versions of the assets, they were rendered into a monochromatic color scheme for use in the lower quality game versions and again assessed by the usability testers. The game asset prototypes formed an integral part of the user interface elements and were then implemented into the tablet games to test the playability of the functionality and feature-sets.

The following sections discuss the final prototypes which incorporated the feedback from the focus groups and preliminary usability testing.

5.4.2 Mission Mars Game Prototype (Higher Visual Quality)

Reflecting on Gee's (2004) observations that during gameplay the player is constantly engaged in acquiring new literacy, until fully familiarized with the gaming environment, the three game levels were devised for the player to acclimatize to the game environment and assets. The game was designed for levels to start from a less challenging level progressing to more complex ones. In this way, the player acquired more control of the game by becoming more involved and engaged to attain the ultimate goals of a Hard-Fun Key by eliciting pertinent emotions. The 2.5D tablet game was designed to be played in portrait-screen orientation on a tablet. The player, represented by the main character, embarks on a spaceship from Earth and travels to Mars for a space mission. The action game is a third person shooter as the player character is present on-screen within the game environment. The player travels in a spaceship with scrolling background game elements. The head-up display is made up of the score and health bar, which are used to provide feedback to the player at each level. For instance, the health bar provides a graphical cue of the total distance travelled by the spaceship. The following sections summarize the gameplay levels for the higher quality interface design.

Level 1

Figure 5.10a shows the splash screen of the *Mission Mars* game. Using the tablet device's accelerometer (Liu, 2013), the player tilts the iPad sideways to navigate the character horizontally across the screen. On its way from Earth to Mars, the spaceship encounters multiple obstacles, also known as enemies: storms and asteroids. The player taps on either of the two circular targets (thumb controls) on the screen to shoot meteorites. If the spaceship encounters any of the two obstacles when the score is nil, the player loses the game. The goal is to avoid the red ozone rings (figure 5.10b).

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Figure 5.10a Hard Fun Key level 1 splash page

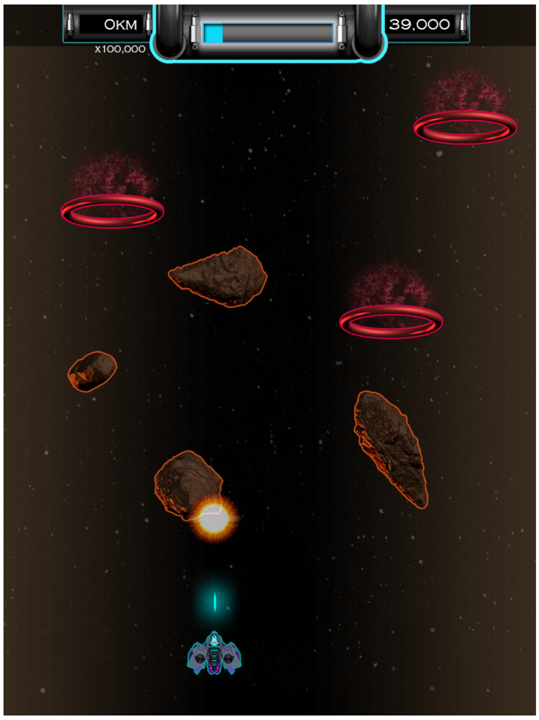

Figure 5.10b Hard Fun Key level 1 gameplay

Health points (HP) are used to visually indicate status on a health bar, are not affected by obstacles, and are directly proportional to the distance that the spaceship has to travel to reach the next level. For instance, the HP level starts at 299 million kilometers, and as the spaceship travels from Earth to Mars, the distance to its next destination, which is Level 2, decreases over time. If the spaceship destroys a meteorite, the player scores 20 points. The spaceship must avoid the storms, otherwise the score decreases if it is hit.

Level 2

The game user interface for level 2 is shown in figures 5.11a and 5.11b. The player taps on either end of the iPad to navigate the spaceship with an elastic motion to the right or left across the screen. The player taps on the spaceship to shoot enemies to score points. Level 2 is relatively more challenging than the previous one as the objects move at a higher speed on screen. The player must avoid red ozone layer rings and asteroids otherwise, if hit, points are deducted, whereas navigating through green ozone layer rings entails bonus score points. The player earns points by destroying the asteroids.

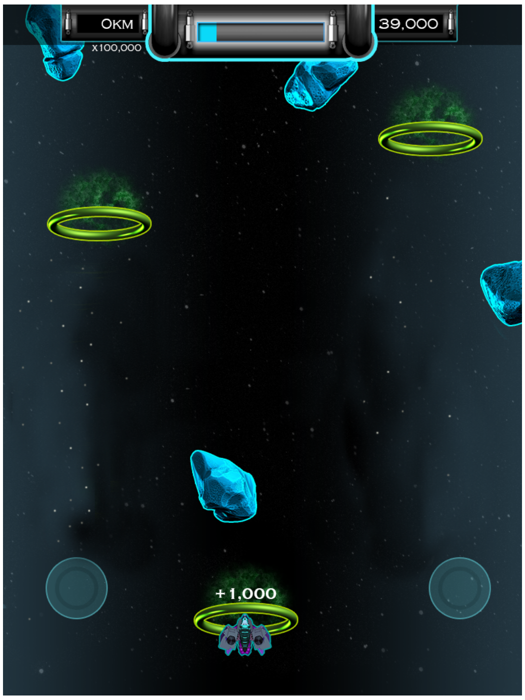

Figure 5.11a Collision with green ozone ring earn bonus points

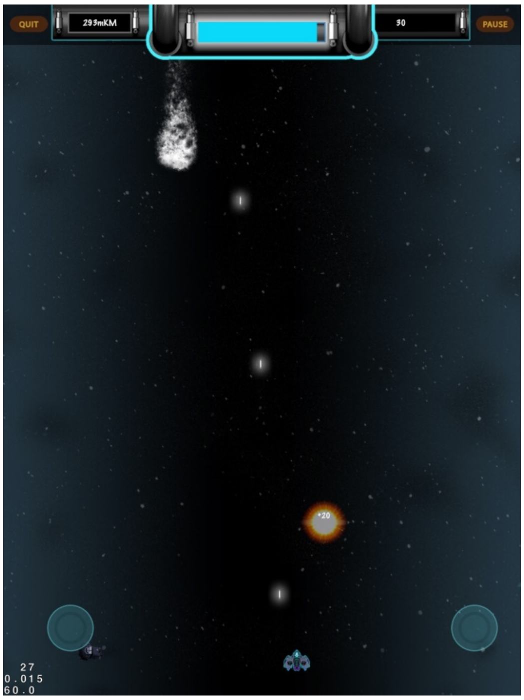

Figure 5.11b Killing enemies to earn points

Level 3

The game user interface for level 3 is shown in figure 5.12a and the screen showing the score when the level has been completed (figure 5.12b). In addition to the above type of interaction, the player swipes an enemy or shoots the asteroids to destroy them. The player can shoot the aliens traveling at high speeds to score points. This level is relatively more challenging due to additional challenges such as aliens, meteorites and red ozone layer rings. In contrast with the red ozone layer rings, the green ozone layer rings entail bonus points. A tap to the left or to the right on screen will navigate the spaceship to the left or right respectively. The closer the tap relative to the spaceship, the subtler is the motion of the spaceship. If the touch is farther from the spaceship, the motion of the spaceship moves elastically faster in the respective direction.

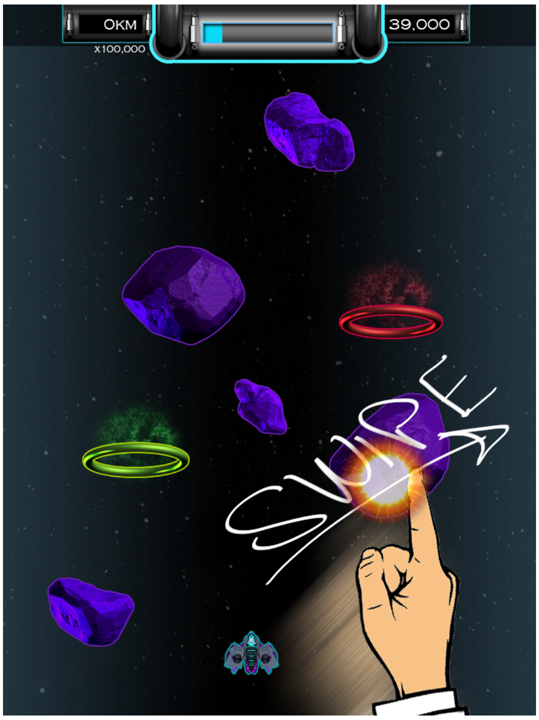

Figure 5.12a Killing enemy using swipe gesture

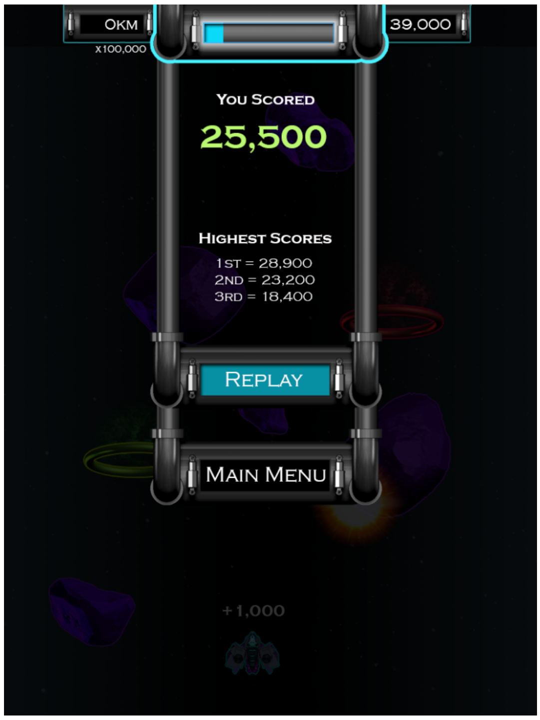

Figure 5.12b Score showing levels completed

As explained in section 5.2.6 above, the color, texture and balance of the *Mission Mars* user interface was modified to create the lower quality game interfaces.

5.4.3 Mars Explorer Game Prototype (Higher Visual Quality)

As previously detailed this game is an adventure game that depicts the mission of the astronaut on Mars (figure 5.2a). The goal of the gameplay is to grow green leaves to sustain survival. The core objective is to navigate the astronaut throughout the planet's landscape and collect treasures from the random chests appearing on screen. *Mars Explorer* is depicted from a top-down view. The player holds the iPad in both hands and makes use of his thumb to navigate the game character. The player has the ability to position the controls on either the lower left or right by choosing the option provided. Once the controls are chosen, the player cannot make any modification. Using the controls (up, down, left and right arrows), the player moves the astronaut around the Red planet. The controls are built are built to allow the game character flexibility to move in any direction. For example, pressing the finger in between the up arrow and right arrow will enable the character to travel in a diagonal direction to the right.

The chests can either contain gold coins or aliens. If the player randomly opens a chest with gold coins, then the resulting energy level is boosted by 50 HP. However, the player loses 10HP if the chest containing an alien is encountered. In order to win the game, the player must score 24 points within a 10-minute timeframe. The game mechanics are devised so that for every four treasures collected, a leaf is grown. Therefore, the score correlates with the number of leaves grown.

The game starts with a full progress bar indicating the HP. The treasure chests appear randomly on stage as the astronaut navigates near them. They are guarded by Mars aliens emitting harmful radiation. This radiation expands into a circle around the aliens for a few seconds and then compresses back. To destroy the aliens, the astronaut has to strike them when the radiation is in a compressed state. If the astronaut is hit by the radiation, he is stunned for a fraction of a second and then he loses 20 HP of the energy level. Conversely, by exterminating an alien, the player earns 20 HP. In addition, sandstorms are blown in either direction horizontally, which the astronaut must avoid; if hit, the astronaut loses 10 HP. Hence, the player loses the game if the HP level decreases to zero. When all six leaves are grown, the player wins the game. This game does not have any levels but instead is played against a time limit.

The color, texture and balance of the Mars Explorer user interface was modified to create the lower quality game interfaces (see section 5.2.6).

On completion of the two game prototypes, the next step was to evaluate the design conditions in order for them to be incorporated into the experimental research design for the hypothesis testing in relation to research questions developed. The following section describes the game evaluation process.

5.5 Visual Design Evaluation

This section describes the outcome of visual design game prototypes testing to evaluate the usability of the lower and higher quality interfaces. Usability testing was also used to debug the games in both the alpha and beta stages. The games usability and functionality were verified while ensuring the game features were discernible in both quality conditions.

5.5.1 Game Prototypes Visual Design Evaluation (iMac)

The first session of visual design testing was carried out on an Apple iMac 27" monitor which was calibrated for best picture and color using the RGB display profile. It was efficient to perform initial visual design and usability evaluation on an iMac monitor, for adjusting game interface elements and make refinements prior to starting the game programming for the iPad devices. The evaluation of the visual design of the user interfaces was performed using the *Classical design questionnaire* (Lavie and Tractinsky, 2004). Classical design refers to the traditional design guidelines adopted by artists/designers such as contrast, orderliness, hierarchy, symmetrical design, and grid system. The research instruments can be found in Appendix 5.5. The research objective the evaluation was to determine if the games with higher visual design quality (HQ) were perceived more usable than the lower visual design quality (LQ).

Hard Fun Key – High Visual Design Quality

On the iMac computer (27 inches screen), there was consensus among participants that the head-up display of both types of game were well crafted, and that players could easily discern their scores and health points. However, it was determined that color contrast and saturation should be adjusted to increase the details of artefact tonal values. The yellow tinge of the assets in the front-most layer was accentuated, whereas the cool color scheme was maintained in the background layer. Participants stated that the vertical symmetrical layout of the graphical user interface and the orderliness of the elements were factored into the attractiveness of the visual layout. Minor design adjustments were therefore made by re-organizing the elements in Level 2 and 3.

Hard Fun Key – Low Visual Design Quality

In the monochromatic color scheme interface, participants relied on color *value* to evaluate the detail of the game assets. *Value* determines the amount of darkness and lightness in a hue. The outcome of usability evaluation led to an increase in the saturation to ensure a sharp contrast among the game elements and to accentuate a light value in the explosions when a target is hit.

Easy Fun Key – High Visual Design Quality

No change resulted from the usability testing in the visual layout of the Easy Fun Key, higher quality version (refer to figure 5.2a).

Easy Fun Key – Low Visual Design Quality

The visual elements had been deliberately designed to clutter the screen; the layout of the assets (rocks and boulders) appeared imbalanced in this version (refer to figure 5.2b) as the principles of design were deliberately violated (based on Tuch et al. 2011, 2012; Wong et al., 2010; Mahlke, 2008).

The graphics of the *low visual design quality* was rendered using 8-bit graphics, the warm red tone was kept at hue: 0% (on a scale of 0–360) and saturation: 25% (on a scale of 0–100), with the colorize box checked. In contrast, the graphics of the high visual design quality was rendered using 16-bit graphics, hue: 0 (on a scale of -180 to +180) and color saturation: 0% (on a scale of 0 to 100%). The visual design ratings for each of the game conditions were evaluated using the mean value from the *Classical design questionnaire* as illustrated in figure 5.13 below. Findings from this approach confirmed that the game interfaces were ultimately usable and therefore suitable for the next research phase.

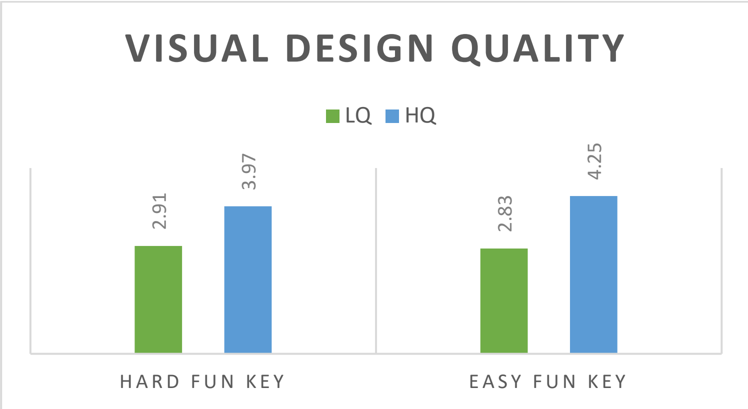

Figure 5.13 Mean values of visual design quality of game prototypes

5.5.2 Games Iterative Usability Testing

During the iterative prototyping of the game development, both types of game were put through a series of usability tests and debugged. In the alpha stage, participants played both game types on three different occasions. Usability testing was conducted to examine if the game feature-sets were visible, functional and intuitive as the researcher intended, as recommended by Warren et al. (2010). In other words, the researcher wanted to investigate whether participants could easily interact with the game user interfaces to build basic and intermediate level skills.

As commended by Notess, Kouper, & Swan (2005), usability testing proved to be more effective as it was performed during the iterative prototyping process and early during the development cycle. The first round of user testing of the Mission Mars game was mainly exploratory in nature, which revealed the following issues - scores were not working precisely in Level 1; the target area of the two control buttons in Level 2 were small and could not be aimed accurately. Moreover, a participant noticed that at times meteorites and red ozone layer rings were falling together at the same speed on stage in level 2. The goal was for the objects to appear at varying speeds on screen; to add to the game mechanics, the law of gravity was taken into consideration for falling objects. In addition, it was reported that the aliens took longer to appear on screen in Level 3. While play testing the Mars Explorer game, participants reported that the score showed -10 points when the character encountered an alien from the treasure chest but this did not add up to the main game score. Another issue was that the leaf from the status bar did not wither after the character lost a certain number of points.

The game apps were built specifically for iPads using *TestFlight*[2] beta testing, which facilitated participant testing. After the first play-test session, both games types were debugged, and play tested again by the same three volunteers on three different occasions. Participants played the games at several times during a one-week period and all the usability issues encountered during gameplay were logged.

During the second round of user-testing, the researcher also observed participants play testing and noted that the sound effects during collisions were not apparent in level 1. Yet, the background audio worked well. It was observed in level 2 that the spaceship was

[2] The TestFlight app allows testers to install and beta test apps on iOS, tvOS and watchOS devices. Testers must receive an invite directly from a developer first before they can begin testing with TestFlight https://itunes.apple.com/us/app/testflight/id899247664?mt=8

crossing the boundary of the two thumb controls on either end. After debugging both the games following the reports received from each participant, game apps were further updated. New builds were created using *TestFlight* following each round of debugging by the researcher. In all, to address usability issues identified, thirteen updates of the *Mission Mars* game apps and seven updates of the *Mars Explorer* game apps were created following multiple rounds of user-testing. Besides testing the game with participants, the researcher personally pursued further testing and debugging for several weeks to identify most of the game usability issues and bugs. A listing of all usability issues encountered is included in Appendix 5.6.

A debriefing session was conducted with participants in the study. The issues encountered during user testing were both minor and major. The usability tests were successful as participants were able to diagnose a wide variety of functionality issues that would have otherwise impeded gameplay. In addition, through the usability testing, it was ascertained that the necessary feature-sets were made visible to users, which enhanced each game's utility.

5.5.3 Games Visual and Usability Evaluation (iPad)

Subsequently, design and development of both the games were evaluated on an iPad 2 Air retina 9.7' with the same key participants to ensure high internal reliability and to minimize errors due to individual variability. The evaluation used the same instruments in order to conform to the recommended principles of design for the game conditions. Both the higher and lower visual design beta version of the two game types were built for the iPad retina devices as shown in figures (5.15a and 5.15b; 5.16a and 5.16b). As expected, usability test participants perceived differences in lower contrast (value), low bit graphics rendering (texture), in addition to the manipulation of game assets visual weight created dynamically through the game programming logic to offset the balance in the case of the LQ game conditions. The mean values of the visual design evaluation of the four conditions assessed using the *Classical design* questionnaire are shown in figure 5.14. The results confirmed the appeal achieved in the higher visual design conditions were relatively higher and therefore appropriate for the next stage of the research.

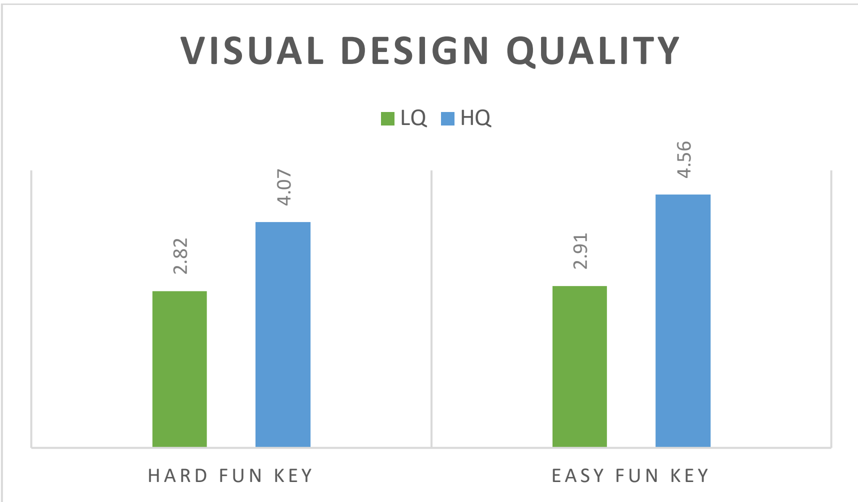

Figure 5.14 Mean values of visual design quality of iOS game apps

Evaluations of visual and usability testing confirmed that the playability attributes for both game types remained unchanged in both interface conditions.

Through player testing, it was also confirmed that the usability attributes for both game types remained unchanged as the same game mechanics and game play developed for the HQ versions were utilized in the LQ conditions. The objective was to investigate the *perception* of game usability of the lower and higher visual design conditions of the Hard

Fun and Easy Fun Keys, as detailed in chapter 6, section 6.2.4.4.

Figure 5.15a Mission Mars iOS app
High Visual Design Quality

Figure 5.15b Mission Mars iOS app
Low Visual Design Quality

Figure 5.16a Mars Explorer iOS app
High Visual Design Quality

Figure 5.16b Mars Explorer iOS app
Low Visual Design Quality

Following games refinement, all the four game apps were potentially of a quality level fit for beta release for use as stimuli in the second phase of the experimental research. At the end of a nine-month period, all four game apps conditions (2 Fun Keys with 2 visual design qualities) were uploaded and released on Apple *iTunes Connect*.

5.6 Chapter Summary

This chapter summarizes the game design and development process. Two different tablet game types were developed using *user centered design* principles with a range of research techniques, including mind-mapping, mockups, and iterative prototyping followed by usability testing and refinement. Game ideation resulted into concepts that were afterwards developed using an iterative prototyping and user-testing process. Games designed through this process have been developed to enable incorporation into a subsequent stage of quantitative research as stimuli to test research hypotheses outlined in Chapter 3.

Chapter 6

ANALYSIS AND FINDINGS

6.1 Introduction

This chapter reports the **Phase 2** findings (figure 6.1), from the mixed methods research design, including both quantitative and qualitative analyses.

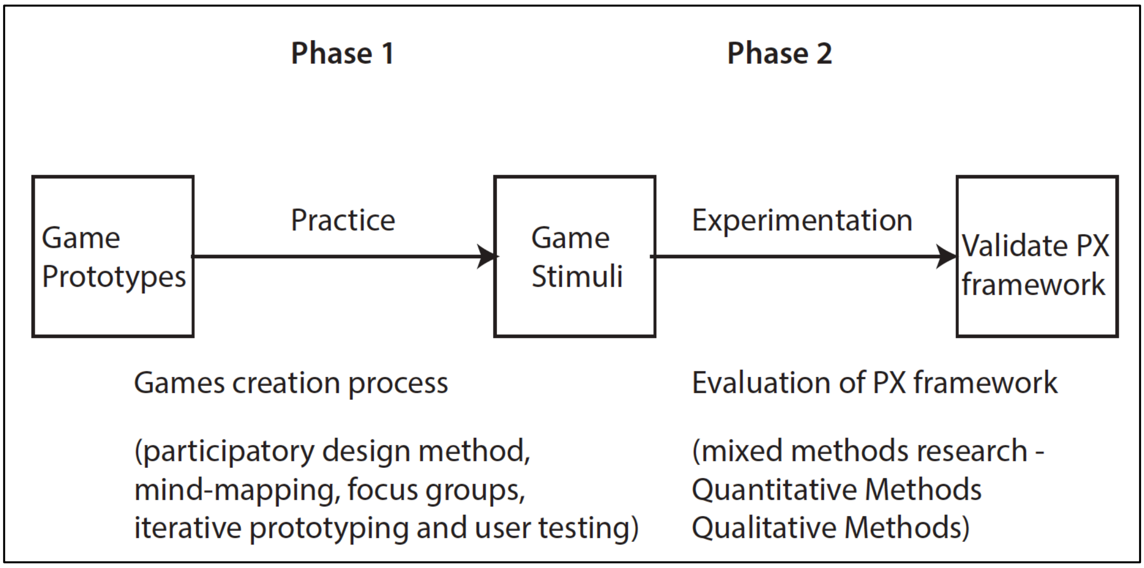

Figure 6.1 Overview of game design and evaluation

The first part reports the results of the quantitative data analyses done based on the responses to a series of questionnaires used during the experimental study to investigate the hypotheses of this study. For each hypothesis, an informal analysis was first conducted to inspect if the data were normally distributed and the necessary assumptions were met for making use of parametric analyses such as ANOVA (Analysis of Variance) and Regression Analysis. Following the verification of data assumptions, a formal quantitative analysis was conducted for each hypothesis.

The remainder of this chapter reports the results obtained from the qualitative analysis of the responses to the three open-ended questions on the features and elements that rendered gameplay in each condition challenging or gratifying, in addition to a reflection on user game experience. The themes emerging from the qualitative analysis served to complement the findings of the quantitative data. In addition, the results of the *Confirmatory Factor Analysis* are presented.

This informal analysis found one version of the visual design quality of the Fun Keys was perceived significantly differently from the other version. This evidence forms the basis of the ground-work to reliably test all the hypotheses. Furthermore, it was revealed that the Fun Keys were significantly different from each other which in fact confirms the theory that the goals of the two game types were not equivalent. According to Lazzaro's (2004) Four Fun Keys theory, each game type evokes different kinds of emotional experience during game play.

6.2 Components of Perceptual PX Design framework

This section provides a description of the parametric analyses and results by examining how low and high visual design conditions of game user interfaces affect the perception of usability, emotional responses (valence and arousal), perception of hedonic quality, game enjoyment, flow and positive player experience on the low and high visual design conditions of game user interfaces. An experimental study was devised to test the following six hypotheses:

H1: High visual design quality game user interfaces are perceived to be more usable.

H2: Participants experience a higher level of arousal while interacting with the high visual design quality game user interface of the Hard-Fun Key.

H3: Participants experience a higher level of valence while interacting with the high visual design quality game user interface of the Easy-Fun Key.

H4: High visual design quality of tablet game interfaces has an effect on the perception of hedonic quality.

H5: Participants who are more sensitive to visual design quality in user interfaces will derive more enjoyment playing the high visual design version of the tablet games.

H6: Players who experience flow during gameplay will derive a greater level of game enjoyment.

6.2.1 Experimental Design

A total of 111 participants were recruited for the experimental study with 68.5% of the total sample were between 18 and 25 years old, and 31.5% were in the age group between 26 and 35 years old. Of the participants, 53.6% of the participants self-reported they played action and adventure games on smartphones and tablets between 1 and 3 hours weekly, 30.7% for less than an hour weekly, and 14.4% for more than 3 hours weekly.

Table 4.13 in the Methodology chapter shows the two independent variables - Fun Keys and Visual Design Quality. Fun Keys is a between-subjects variable with 2 levels (Easy-Fun Key and Hard-Fun Key) and Visual Design Quality, is a within-subjects variable with 2 levels (Low and High Visual Design Quality).

Two different groups of participants each played both the low and the high visual design versions of one of the game types. For example, Group A played both versions of the Easy-Fun Key game whereas Group B played both versions of the Hard-Fun Key game. In other words, the same participant was tested twice in two different controlled game conditions. The assignment of participant to either game condition was counter-balanced. Each person participated for approximately 60 minutes. Fifty-six participants (20 females, 36 males) took part in the Easy-Fun Key game, while fifty-five participants (12 females, 43 males) played the Hard-Fun Key game

6.2.2 Data Inspection for Perception of Visual Design Quality

A mixed-ANOVA (Analysis of Variance) design was conducted to investigate the preliminary assumption, that is, if the low and high visual design quality of each game user interface is significantly different from each other. The basis of the study is grounded on the assumption that the two visual design conditions, low and high versions, of each game type (Fun Keys) are significantly different from each other. Therefore, it was important that the perception of visual design quality for each manipulated game version not to be equivalent. The outcomes of the hypotheses would have been flawed if the stimuli were not rendered as intended, into a low and a high visual design version, as discussed in the game design chapter 5. The following steps verified the preliminary assumption.

The perception of visual design data was primarily inspected for normality of distribution and verified for ANOVA assumptions. The preliminary objective was to examine if the dependent variable, perception of visual design quality, was significantly different across visual design conditions for each Fun Key. The residuals of the dependent variable data, perception of visual design quality, were checked for normality of distribution. The bell shape curve obtained in figure 6.2a revealed that the data were normally distributed, according to the Central Limit Theorem, also known as the law of large numbers

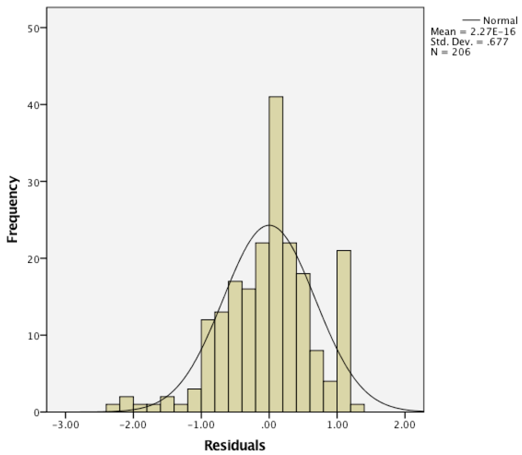

Figure 6.2a: Perception of Visual Design Residuals

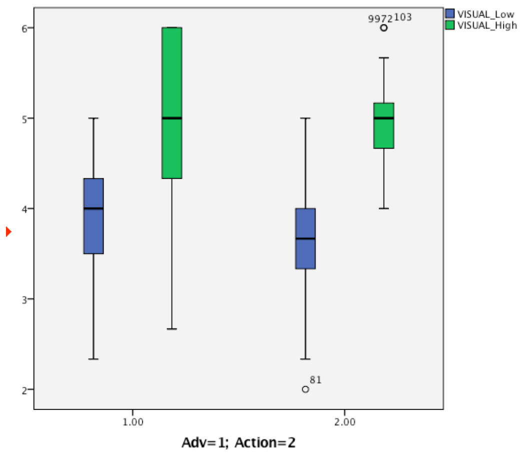

Figure 6.2b: Perception of Visual Design Boxplots

The following assumptions were verified before proceeding with the ANOVA test. Each group had an equivalent sample size. The sample of population was normally distributed (figure 6.1a). Each individual was independent of every other individual, and participants from each group were randomly assigned to each game condition. The descriptive statistics in Table 6.1 reveals that the mean value of the perception of visual design for the high quality (HQ) versions for both games are higher than the mean of the low visual design conditions. The standard deviation shows that there is more variability in the Easy-Fun Key sample playing the high visual design game version and least variability in the Hard-Fun Key group playing the high visual design game condition. From the boxplots (figure 6.2b), it appears that the overall sample data show negligible skewness and a few outliers that are not extremes. Since the ratio of the largest group variance (σ^2 = 0.8214) is no more than four times larger than the smallest group variance (σ^2 = 0.21906), the assumption of homogeneity of variances is not being violated. The assumption of homogeneity of variances test states that the variance among all the groups are equal. Since homogeneity of variances is not violated in this experimental study, Type I and II errors are minimized. As all the above assumptions have been satisfied, the researcher was able to proceed with the mixed-ANOVA test.

		LOW VISUAL DESIGN	HIGH VISUAL DESIGN
HARD-FUN KEY	Mean	3.6767	4.9233
	N	50	50
	Std. Deviation, σ	0.62125	0.46804
	Variance, σ^2	0.38595	0.21906
EASY-FUN KEY	Mean	3.9025	4.9120
	N	53	53
	Std. Deviation, σ	0.64250	0.90633
	Variance, σ^2	0.4096	0.8214

Table 6.1: Descriptive Statistics of perceived visual design (HQ)

6.2.3 Analysis of Perception of Visual Design Quality

Before assessing hypotheses 1–7 using ANOVA tests and Regression analysis, it was important to determine that the dependent variable, perception of visual design quality, was significantly different across visual design versions for each Fun Key. (As a reminder, the independent variables are *Fun Key* and *Visual Design Quality,* and the dependent variable is *perception of visual design.*) In order to do this, a 2x2 mixed ANOVA with a between-subjects and a within-subjects test was conducted with two independent measures: *Fun Keys* (with two levels: Easy and Hard-Fun Keys) and *Visual Design Quality* (with two levels: *Low and High*) The result of the 2x2 mixed-ANOVA is shown below in *Table* 6.2.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Visual Design	65.485	1	65.485	234.698	0.000
Fun Key	0.592	1	0.592	0.910	0.342
*Visual Design*Fun Key*	0.723	1	0.723	2.592	0.111
Error (Visual Design)	28.181	101	0.279		

Significant alpha level 0.05

Table 6.2: 2x2 ANOVA Output of Visual Design and Fun Key

Table 6.2 reports that visual design has a significant main effect $F_{(1,101)} = 234.698$, $p<0.05$; confirming that the mean values of the low and high visual design conditions are not equivalent. This indicates that there is a significant difference of perception of visual design quality between the two manipulated conditions-low and high visual design qualities. Referring to Table 6.1, in the case of Hard-Fun Key, the mean value of the perception of visual design quality is significantly higher in the high visual design condition ($\mu_1 = 4.92$, $\sigma^1=0.468$) than in the low visual design condition ($\mu_2 = 3.68$, $\sigma^2=0.62$). Similarly, in the case of Easy-Fun Key, the mean value of the perception of visual design quality is significantly higher in the high visual design condition (μ_3= 4.91, σ^3=0.91) than in the low visual design condition (μ_4= 3.90, σ^4=0.64). This finding sets a robust ground to accurately investigate hypotheses 1–7.

6.2.4 Visual Design Quality and Perceived Usability

The first research objective is to examine if a variation of visual design quality (low and high) of game user interfaces affects a player's perceived usability. Hypothesis **(H1)** predicts that a *high* visual design quality of tablet game interfaces has an influence on the perception of usability. In order to determine if visual design quality of the Hard-Fun Key or Easy-Fun Key had an impact on *perception of usability,* a regression analysis was conducted for each Fun Key, to observe the correlation coefficient r and the significant value, p. It was also important to conduct a mixed-ANOVA to (i) examine if participants perceived the usability of the two tablet games differently, and (ii) to find out if there was a significant difference of *perception of usability* between the two tablet games (Fun Keys).

6.2.4.1 Data Inspection - Visual Design Quality & Perceived Usability

The *perception of usability* data was primarily inspected for normality of distribution and verified for ANOVA assumptions. The preliminary objective was to examine if the dependent variable, *perception of usability,* was significantly different across visual design conditions for each Fun Key. The residuals of the dependent variable data, *perception of usability,* were checked for normality of distribution. The bell shape curve obtained in figure 6.3a, though slightly skewed to the right, revealed that the data were normally distributed. The boxplots confirmed no extreme outliers or skewness (figure 6.3b). More variability occurred in the Easy-Fun Key-high visual design condition sample, whereas least variability is shown in the Hard-Fun Key-high visual design condition. *Levene's* test is used to verify the homogeneity of variances assumption; the significant value p=0.221output shows that the low visual design quality group does not violate the assumption; but the significant value $p<0.05$ in the case of the high visual design quality group indicates that variances are not equivalent, which violates the assumption of homogeneity of variances. In this case, a more conservative approach is required, such as the Welch's ANOVA, because this test has more *power* and lowers Type I or II errors rate (Moder, 2010).

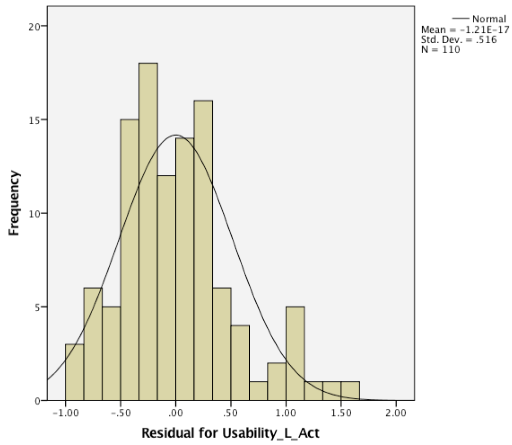

Figure 6.3a: Perception of Usability Residuals

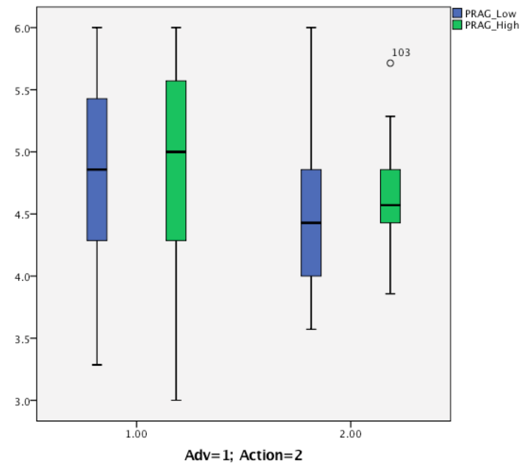

Figure 6.3b: Perception of Usability Boxplots

		LOW VISUAL QUALITY(PQ_LOW)	HIGH VISUAL QUALITY (PQ_HIGH)	AVERAGE
HARD-FUN KEY	Mean	4.4961	4.6010	4.54855
	N	55	55	
	Std. Deviation, σ	0.65052	0.33882	
	Variance, σ^2	0.42317	0.11479	
EASY-FUN KEY	Mean	4.8418	4.8878	4.8648
	N	56	56	
	Std. Deviation, σ	0.73839	0.79503	
	Variance, σ^2	0.545219	0.63207	

Significant alpha level 0.05

Table 6.3: Descriptive Statistics of Pragmatic Quality

6.2.4.2 Data Analysis - Visual Design Quality and Perceived Usability (H1)

The independent variables are *Fun Key* and *Visual Design*, and the dependent variable is *perception of game usability*, measured using the self-report pragmatic quality (PQ) section of *AttrakDiff* questionnaire. Table 6.3 shows the descriptive statistics of the variable pragmatic quality which measured perceived usability from the low and high visual design quality of each game type. To answer the hypothesis whether the high or low visual design quality of the Hard-Fun Key (or Easy-Fun Key) had an impact on *perception of game usability*, a regression analysis was conducted to examine the Pearson Correlation r between each independent variable and the dependent variable. Prior to the Regression test, a 2x2 mixed ANOVA, with a between-subjects and a within-subjects test, was conducted with *Fun Key (with two levels: Easy and Hard-Fun Keys)* and *Pragmatic Quality (with two levels: Low and High),* as independent measures. The result of the mixed-ANOVA is shown in *Table 6.4*.

Source *Dependent variable: Perception of Game Usability*	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pragmatic Quality (PQ)	0.316	1	0.316	1.21	0.273	0.011
Fun Key	5.549	1	5.549	9.240	0.03	0.078
*Pragmatic Quality*Fun Key*	0.048	1	0.048	0.186	0.667	0.002
Error (Pragmatic Quality)	65.463	109	0.601			

Significant alpha level 0.05

Table 6.4: 2x2 ANOVA Output of Fun Key and Pragmatic Quality

Referring to *Table* 6.4, it is observed that *PQ* did not have a significant main effect (F (1,109) = 1.214, p >0.05). The researcher fails to reject the null hypothesis, indicating that mean values of the dependent variable (PQ) recorded for both low and high visual design conditions were equivalent. The participants perceived that both low and the high visual design version of each game type to be equally usable. Furthermore, it was observed that *Fun Key* had a significant main effect (F (1,109) =9.240, p<0.05), which also revealed that the mean value of Easy-Fun Key (μ=4.86) was significantly different from the mean value of the Hard-Fun Key (μ=4.55). This result confirms the theory that Easy-Fun Key and Hard-Fun Key were distinct from each other in terms of goals for the player, as the mean values μ were significant. Finally, there was no significant interaction between *visual design* and *fun keys* (F (1,109) =0.186, p>0.05); this implies that the effect of *fun keys* on the dependent variable PQ did not depend on the level of the other independent variable, *visual design.*

6.2.4.3 Regression Analysis - Visual Design and Perceived Usability

This section explains the findings of the Linear Regression analyses. The data for the item "*good-bad*" was excluded from the Visual Design component of the *Attrakdiff* questionnaire because beauty and perceived usability is mediated by *goodness,* and this could create a "halo" effect while the participants judged the game user interfaces. In other words, *goodness* would act as a covariate affecting the result on the dependent variable, *perception of game usability*. "Goodness" is the overall quality judgment of a product in a given context (Hassenzahl & Monk, 2010). It is measured by the item "*good-bad*" in the (visual design component) Attrakdiff questionnaire (Hassenzahl, 2003). In order to verify if the visual design quality had an effect on *perception of game usability*, a regression analysis was conducted separately for each condition of Hard-Fun Key and Easy-Fun Key.

Hard-Fun Key – Low Visual Design Quality

1. A linear regression test was used to predict *perception of game usability* from the independent variable, *perceived low visual design quality* of the game user interface. Low visual design quality did not significantly predict *perception of game usability*, *F (1,53) =0.05, p>0.05,* R^2*=0.001*. It was deduced that low visual design quality of the Hard-Fun Key game interface did not influence perceived game usability.

Hard-Fun Key – High Visual Design Quality

2. A regression test was used to predict perception of game usability from the independent variable, perceived high visual design quality of the game user interface. High visual design quality significantly predicted perception of game usability, F (1,52) =4.080, p < 0.05, R^2=0.073. There was a weak-moderate relationship between the explanatory variable (perceived high visual design quality) and the dependent variable, given the Regression Coefficient r=0.270. It was deduced that high visual design quality of a Hard-Fun Key game interface influenced perceived game usability.

Easy-Fun Key – Low Visual Design Quality

3. A regression test was used to predict perception of game usability from the independent variable, perceived low visual design quality of the game user interface. Low visual design quality did not significantly predict perception of game usability, F (1,54) =0.891, p > 0.05, R^2=0.127. Based on this observation, it

was deduced that low visual design quality of the Easy-Fun Key game interface did not influence perceived game usability.

Easy-Fun Key – High Visual Design Quality

4. A regression test was used to predict perception of game usability from the independent variable, perceived high visual design quality of the game user interface. High visual design quality significantly predicted perception of game usability, $F\,(1,54)=7.292$, $p < 0.05$, $R^2=0.119$. There was a moderate relationship between the explanatory variable (perceived high visual design quality) and the dependent variable, given the Regression Coefficient r=0.345. Based on this observation, it was deduced that high visual design quality of the Easy-Fun Key game interface influenced perceived game usability.

6.2.4.4 Summary of Results for hypothesis H1

Table 6.5 shows a summary of the results from the Regression Analyses for hypothesis 1, which explains that game user interfaces that are highly appealing have an impact on the perception of game usability for both types of tablet game. Game user interfaces with low visual design quality do not have any influence on the perceived game usability.

	Perceived Game Usability		
	Pearson Coefficient, r	p-value Significance level (0.05)	
Low Visual Design Quality			
Hard-Fun Key	0.031	0.824	Non-significant, no correlation
Easy-Fun Key	0.127	0.349	Non-significant, weak correlation
High Visual Design Quality			
Hard-Fun Key	0.270	0.049	Significant, weak correlation
Easy-Fun Key	0.345	0.009	Significant, weak-moderate correlation

Regression Coefficient, r: 0.7-1 (strong), 0.40-0.60 (moderate), 0.1- 0.30 (weak)

Table 6.5: Summary of Regression Analysis - perceived game usability and visual design

6.2.5 Visual Design Quality and Emotion (valence and arousal)

The second research objective is to examine the impact of visual design quality (low and high) of two types of tablet game interfaces on emotional responses (valence and arousal) of players.

Hypothesis **H2** predicts the following:

H2: Participants experience a higher level of arousal while interacting with the high visual design quality condition of the Hard-Fun Key.

Hypothesis **H3** predicts the following:

H3: Participants experience a higher level of valence while interacting with the high visual design quality condition of the Easy-Fun Key game

The emotional response data were gathered using the Self-Assessment Manikin instrument over time, at every 5 minutes interval during game play (Bradley & Lang, 1994). The data gathered after 10 minutes were analyzed with the assumption that participants were involved into the tablet game at mid-point stage and could therefore provide a more accurate picture of their subjective feelings. Initial mood data for each participant were collected using the *Multidimensional Mood State* questionnaire (Steyer et al., 1997) at the beginning of the experiment. *Mood* was a confounding factor in this experiment as not every participant had the same affective state at the start of the experiment.

6.2.5.1 Data Inspection for Visual Design Quality and Emotion

The following assumptions were verified before conducting the *Pearson's Partial Correlation* analyses:

(i) The independent variable, dependent variable, as well as the covariate, were all measured on a continuous scale.

(ii) There was at least one covariate (*mood* was a control variable).

(iii) There was a linear relationship between all the three variables, as verified by the scatter plot matrices, determined by Loess line at 90% of points to fit the scatter plots (figures 6.4a-d)

(iv) The scatter plots did not show any significant outliers, except for the mood variable.

(v) The residuals (errors) of the regression line were approximately normally distributed.

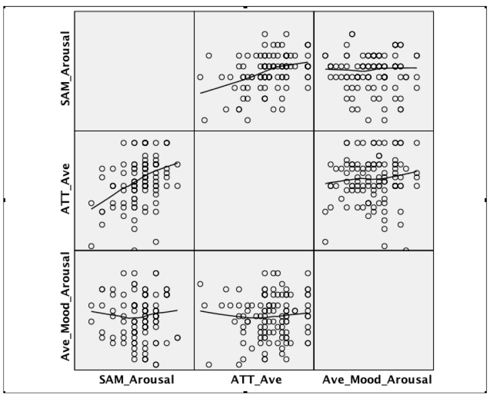

Figure 6.4a: Linearity Test
Easy-Fun Key (Visual Design, Arousal and Mood)

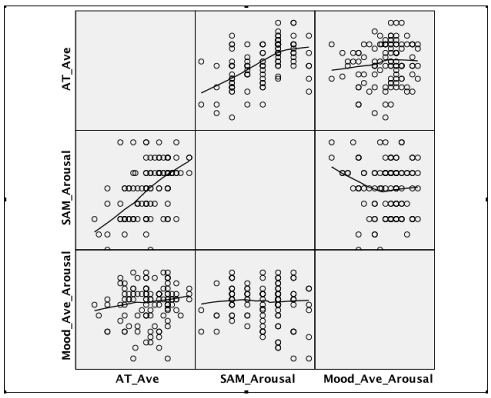

Figure 6.4b: Linearity Test
Hard-Fun Key (Visual Design, Valence and Mood)

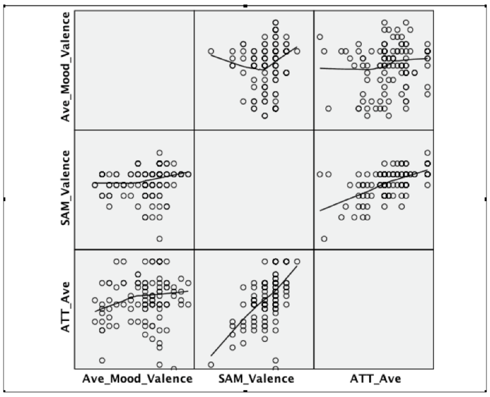

Figure 6.4c: Linearity Test
Easy-Fun Key (Visual Design, Valence and Mood)

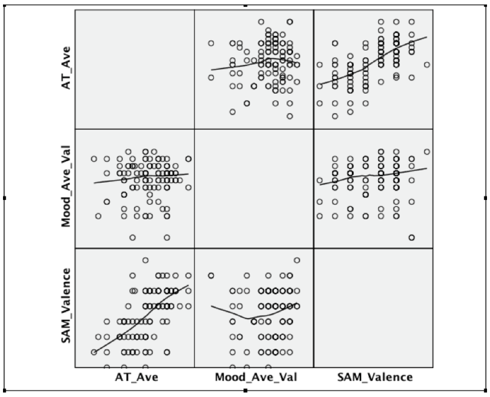

Figure 6.4d: Linearity Test
Hard-Fun Key (Visual Design, Arousal and Mood)

6.2.5.2 Data Analysis for Visual Design Quality and Emotions

After checking the preliminary assumptions, it was statistically sound to proceed with the Pearson's Partial Correlation. In order to verify hypotheses 2 and 3, the first step was to check if a relationship existed between (i) arousal and visual design quality (ii) valence and visual design quality, and secondly if the correlation in each case was significant. Furthermore, the mean values of valence and arousal from the descriptive statistics would determine their relative intensity in each visual design condition.

Correlations between visual design quality and emotion (valence, arousal)

In order to verify the above hypotheses **H2** and **H3**, a partial correlation analysis was conducted between (i) visual design quality and valence, and (ii) visual design quality and arousal, by controlling the confounding variable, mood. The relationship of the two components of emotion, valence and arousal, and visual design quality (AT_LQ and AT_HQ) for each Fun Key were then examined as detailed in the section below.

Furthermore, the output of the zero-order correlations, i.e., a correlation without the confounding variable Mood, was provided as well.

Keywords: AT_LQ: Visual Design Low Quality; AT_HQ: Visual Design High Quality

1. Easy-Fun Key (Low) - AROUSAL_LQ and AT_LQ

A partial correlation was conducted to determine the relationship between arousal_LQ and AT_LQ whilst controlling for mood. There was a weak, positive partial correlation between arousal_LQ (5.22 ± 1.73) and AT_LQ (3.75 ± 0.886) whilst controlling for mood (3.99 ± 0.82), which was statistically significant, $r(52) = 0.315$, $n = 55$, $p = 0.020$'.

Zero-order correlations showed that there was a statistically significant, weak, positive correlation between arousal_LQ and AT_LQ ($r(53) = 0.315$, $n = 55$, $p < .005$), indicating that mood had very little influence in controlling for the relationship between arousal_LQ and AT_LQ.

2. Easy-Fun Key (High) - AROUSAL_HQ and AT_HQ

A partial correlation was conducted to determine the relationship between arousal_HQ and AT_HQ whilst controlling for mood. There was a moderate, positive partial correlation between arousal_HQ (5.83 ± 1.43) and AT_HQ (4.78 ± 0.999) whilst controlling for mood (3.99 ± 0.82), which was statistically significant, $r(52) = 0.393$, $n = 55$, $p = 0.003$'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between arousal_HQ and AT_HQ ($r(53) = 0.387$, $n = 55$, $p < .005$), indicating that mood had very little influence in controlling for the relationship between arousal_HQ and AT_HQ.

3. Hard-Fun Key (Low) - AROUSAL_LQ and AT_LQ

A partial correlation was conducted to determine the relationship between arousal_LQ and AT_LQ whilst controlling for mood. There was a moderate, positive partial correlation between arousal_LQ (4.16 ± 1.57) and AT_LQ (3.55 ± 0.73) whilst controlling for mood (4.43 ± 0.72), which was statistically significant, $r(52) = 0.420$, $n = 55$, $p = 0.002$'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between arousal_LQ and AT_LQ ($r(53) = 0.413$, $n = 55$, $p < 0.005$), indicating that mood had very little influence in controlling for the relationship between arousal_LQ and AT_LQ.

4. Hard-Fun Key (High) - AROUSAL_HQ and AT_HQ

A partial correlation was conducted to determine the relationship between arousal_HQ and AT_HQ whilst controlling for mood. There was a weak, positive partial correlation between arousal_HQ (5.80 ± 1.38) and AT_HQ (4.76 ± 0.72) whilst controlling for mood (4.43 ± 0.72), which was statistically significant, $r(52) = 0.262$, $n = 55$, $p = 0.05$'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between arousal_HQ and AT_HQ ($r(53) = 0.231$, $n = 55$, $p < 0.05$), indicating that mood had little influence in controlling for the relationship between arousal_HQ and AT_HQ.

5. Easy-Fun Key (Low) - VALENCE_LQ and AT_LQ

A partial correlation was conducted to determine the relationship between valence_LQ and low visual design condition (AT_LQ) whilst controlling for mood. There was a moderate, positive partial correlation between valence_LQ (5.89 ± 1.38) and AT_LQ (3.75 ± 0.886) whilst controlling for mood (4.80 ± 0.63), which was statistically significant, $r(52) = 0.367$, $n = 55$, $p = 0.006$'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between valence_LQ and AT_LQ ($r(53) = 0.370$, $n = 55$, $p < .005$), indicating that mood had very little influence in controlling for the relationship between valence_LQ and AT_LQ.

6. Easy-Fun Key (High) - VALENCE_HQ and AT_HQ

A partial correlation was conducted to determine the relationship between valence_HQ and high visual design quality, AT_HQ, whilst controlling for mood. There was a strong, positive partial correlation between valence_HQ (6.58 ± 1.19) and AT_HQ (4.78 ± 0.999) whilst controlling for mood (4.80 ± 0.63), which was statistically significant, $r(52) = 0.660$, $n = 55$, $p <0.05$'.

Zero-order correlations showed that there was a statistically significant, strong, positive correlation between valence_HQ and AT_HQ (r(53) = 0.676, n = 55, p < .005), indicating that mood had very little influence in controlling for the relationship between valence_HQ and AT_HQ.

7. Hard-Fun Key (Low) - VALENCE_LQ and AT_LQ

A partial correlation was conducted to determine the relationship between valence_LQ and AT_LQ whilst controlling for mood. There was a moderate, positive partial correlation between valence_LQ (4.71 ± 1.54) and AT_LQ (3.54 ± 0.73) whilst controlling for mood (4.42 ± 0.52), which was statistically significant, r(52) = 0.407, n = 55, p = 0.002'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between valence_LQ and AT_LQ (r(53) = 0.408, n = 55, p < .005), indicating that mood had very little influence in controlling for the relationship between valence_LQ and AT_LQ.

8. Hard-Fun Key (High) - VALENCE_HQ and AT_HQ

A partial correlation was conducted to determine the relationship between valence_HQ and AT_HQ whilst controlling for mood. There was a moderate, positive partial correlation between valence_HQ (6.33 ± 1.28) and AT_HQ (4.76 ± 0.72) whilst controlling for mood (4.42 ± 0.52), which was statistically significant, r (52) = 0.436, n = 55, p = 0.001'.

Zero-order correlations showed that there was a statistically significant, moderate, positive correlation between arousal_HQ and AT_HQ ($r(53) = 0.442$, $n = 55$, $p < 0.05$), indicating that mood had little influence in controlling for the relationship between arousal_HQ and AT_HQ.

6.2.5.3 Correlation between Arousal and Valence

A Pearson's correlation was run to examine the relationship between arousal and valence for the Hard-Fun Key game. The data for arousal and for valence were aggregated respectively from the low visual design quality and the high visual design quality game conditions. There was a strong, positive correlation between valence (5.5182 ± 1.6296) and arousal (4.9818 ± 1.68633), which was statistically significant, $r\ (110) = 0.855$, $n=110$, $p<0.005$'.

Similarly, a Pearson's correlation was run to examine the relationship between arousal and valence for the Easy-Fun Key game. The data for arousal and for valence were aggregated respectively from the low visual design quality and the high visual design quality game conditions. There was a strong, positive correlation between valence (6.2411 ± 1.3237) and arousal (5.5446 ± 1.6045), which was statistically significant, $r\ (112) = 0.799$, $n=112$, $p<0.005$'.

6.2.5.4 Summary of Results for hypotheses H2 and H3

In general, the confounding variable mood had little influence on emotional responses. The findings from #4 and #8 reveal that high visual design quality of the Hard-Fun Key game had an effect on both valence and arousal, which is substantiated by the plots in the Circumplex Emotional Model (Russell, 1980) in figure 6.5. The data are observed pulling more along the positive x-axis (valence), than along the y-axis (arousal). Figure 6.5 shows that high visual design quality of a game user interface gives rise to positive valence and arousal, equivalent to an increased intensity of pleasurable experience, as most of the observed data occur in the first quadrant. The emotional responses of participants ranged from in-control, excitement, courageous, passionate, and enthusiastic. On the other hand, the findings from #3 and #7 show that low visual design quality version of the Hard-Fun Key game had a significant influence on arousal and valence; the most common observations occurred in the third quadrant (figure 6.6), indicating participants were less aroused, and with signs of negative valence (displeasure). The emotions elicited by participants in the low visual design quality Hard-Fun Key game were grouped around adjectives like apathetic, worried, guilt, and bored. Remarkably, it is noted that a few responses were sparingly spotted around the expectant and passionate emotion (with weak positive valence and arousal) of the first quadrant, close to the center of the *Circumplex Model*.

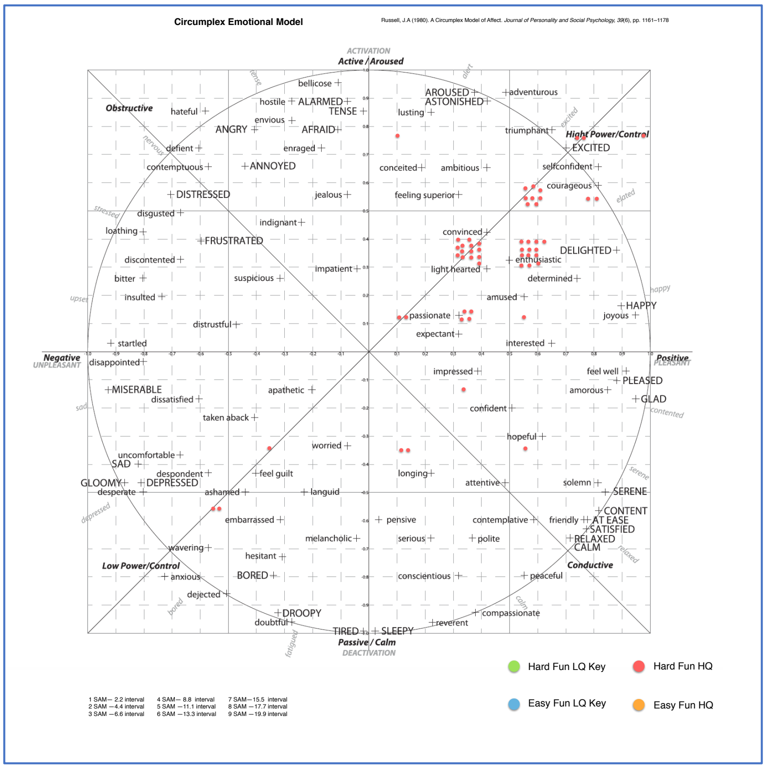

Figure 6.5: Emotional elicitations - Hard-Fun_HQ

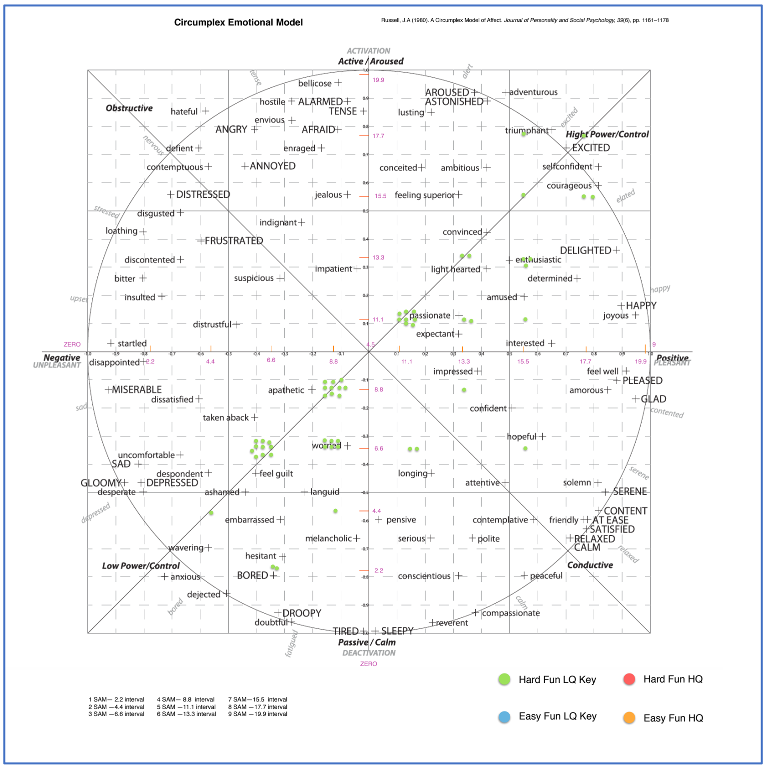

Figure 6.6 Emotional elicitations Hard-Fun_LQ

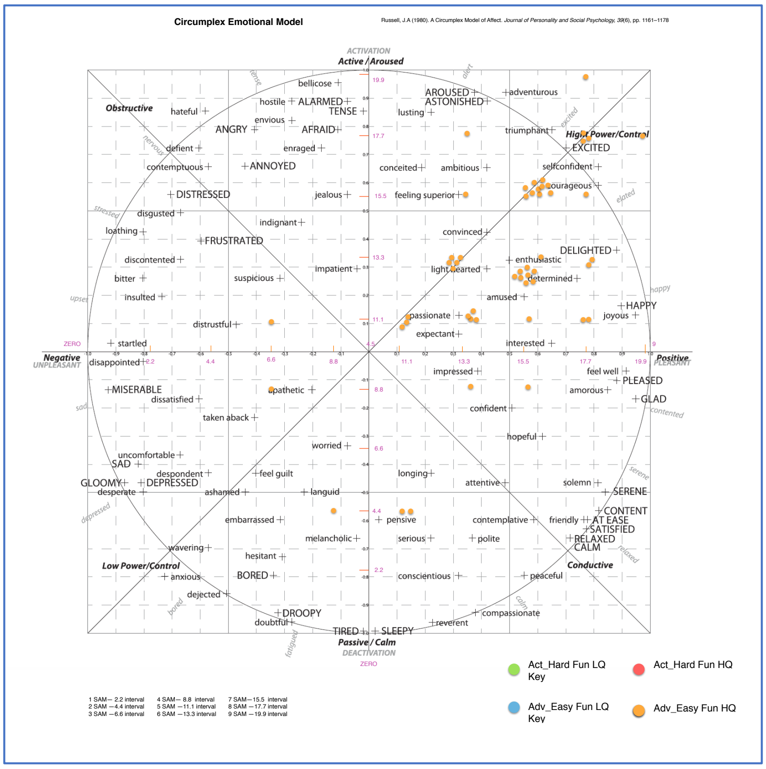

Figure 6.7: Emotional elicitations - Easy-Fun_HQ

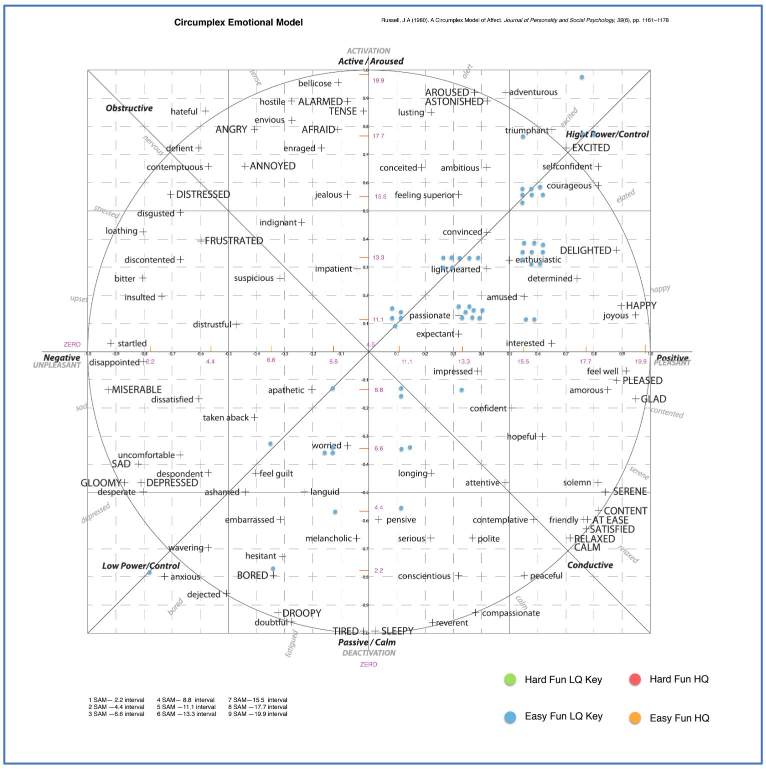

Figure 6.8: Emotional elicitations - Easy-Fun_LQ

Furthermore, the results from #2 and #6 reveal that high visual design quality of Easy-Fun Key had a strong influence on valence and a moderate influence on arousal, both were statistically significant. Figure 6.7 illustrates clusters of observation in the first quadrant, mostly indicating positive valence and positive arousal. The emotional responses ranged from passionate, light-hearted, determined, delighted, courageous, self-confident, in-control to excited.

In addition, results from #1 and #5 reveal that low visual design quality of Easy-Fun Key had a moderate influence on valence, and a weak influence on arousal, both significant. Figure 6.8 further substantiates the findings of #1 and #5, showing that a few participants were aroused negatively (a tendency to be deactivated), the observations occurred along the y-axis in the third and fourth quadrants, while valence was positive for the most part, as the observations spread away from the y-axis, in the first quadrant.

H2: In the case of Hard-Fun Key, the above findings confirm that the mean value for arousal in the high visual design condition (5.80 ± 1.38) was higher than the arousal in low design condition (4.16 ± 1.57); arousal was significant ($p<0.05$). Therefore, it is deduced that participants experienced higher level of arousal in the high visual design version game than in the low visual design version. Interestingly, in the case of Easy-Fun Key, the mean value for arousal (5.83±1.43) in the high visual design condition was significantly ($p<0.05$) greater than the arousal (5.22±1.73) in the low visual design condition.

H3: The above results confirm the mean value for valence was significantly higher ($p<0.05$) in the high visual design quality condition (6.58 ± 1.19) of the Easy-Fun Key than in the low design condition (5.89 ± 1.38). The results also hold true in the case of Hard-Fun Key, as valence was significantly higher ($p<0.05$) in the high visual design condition (6.33 ± 1.28) than in the low visual design condition (4.71 ± 1.54). This indicates that participants experienced higher level of pleasure in the high visual design condition of both the Easy-Fun Key and Hard-Fun Key games.

6.2.6 Visual Design Quality and Perception of Hedonic Quality

The third research objective examines the impact of visual design quality (low and high) of two types of tablet game interfaces on the perception of hedonic quality.

Hypothesis **(H4)** predicts the following:

H4: The high visual design quality of both game types (Fun Keys) has an influence on the perception of hedonic quality.

6.2.6.1 Data Inspection - Perception of Visual Design and Hedonic Quality

Preliminary analyses were performed to ensure the assumptions of normality, linearity and homoscedasticity were not violated.

The following assumptions were verified:

- There was one dependent variable and one independent variable measured at the continuous level.
- There was a linear relationship between the dependent variable and the independent variable, as shown by the scatter plots (Figure 6.9–6.12, below).

The data showed homoscedasticity, indicating that the variance of the errors (residuals) was constant across all the values of the independent variable. If there is homoscedasticity the residuals (errors of prediction) will be equal across the standardized predicted values. This means that the points of the plot will exhibit no pattern and will be approximately constantly spread, as shown below (Figures 6.9a and 6.9b).

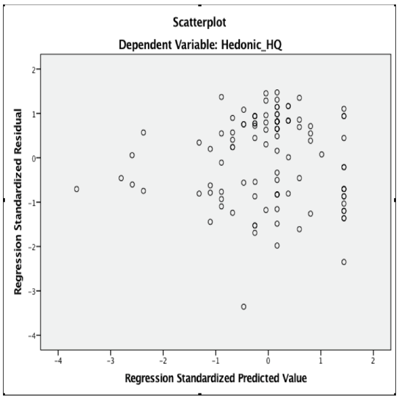

Figure 6.9a: Scatterplot of HQ

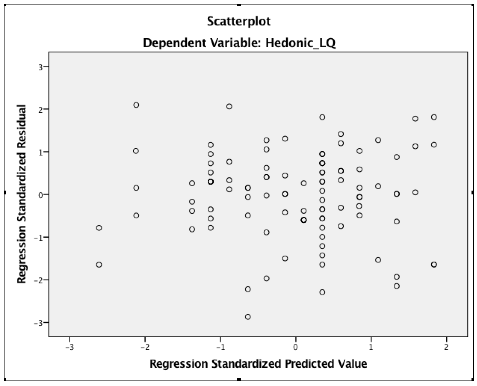

Figure 6.9b: Scatterplot of LQ

- The residuals of the regression line were approximately normally distributed (figures 6.10a and 6.10b).

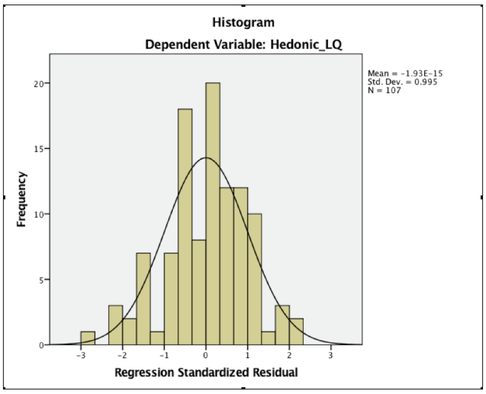

Figure 6.10a: Histogram of LQ

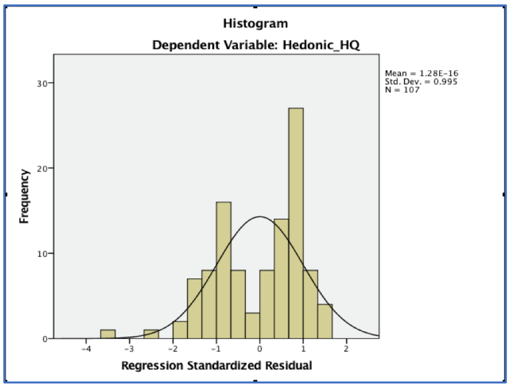

Figure 6.10b: Histogram of HQ

6.2.6.2 Regression Analysis between Perception of Visual Design and Hedonic Quality

The relationship between the perception of visual design quality of tablet game user interfaces (as measured by AT_HQ and AT_LQ) and perception of hedonic quality (as measured by Hedonic_HQ and Hedonic_LQ) were investigated using Pearson product-moment correlation coefficient. The output of the regression analysis shown in Table 6.6 are discussed below:

	Pearson Product Moment Correlations of Perception of Hedonic Quality and Visual Design Quality		Visual Design Quality
High Visual Design condition	Hard-Fun[a]	Perception of hedonic quality	0.607***
	Easy-Fun[b]	Perception of hedonic quality	0.645***
Low Visual Design condition	Hard-Fun[c]	Perception of hedonic quality	0.652***
	Easy-Fun[d]	Perception of hedonic quality	0.496***

*** $p < 0.001$; [a] n= 51; [b] n = 56; [c] n = 54; [d] n = 53

Table 6.6: *Correlation between Hedonic and Visual Design Quality*

Hard-Fun Key (Visual Design - High Quality)

There was a moderate positive correlation between the two variables, perception of high visual design quality (AT_ACT_HQ) and perception of hedonic quality (Hedonic_HQ), r=0.607, n=51, p<0.05, with a high level of visual design quality associated with a high level of perception of hedonic quality. From the value of R^2, it was deduced that 36.8% of the total variation in the dependent variable, perception of hedonic quality, could be explained by the independent variable, perception of high visual design quality (AT_ACT_HQ). The scatter plot in figure 6.11 shows that the form of the graph is roughly linear, the strength appears to be moderate (since not all the points are close to the line), and the direction of the relationship between the explanatory variable (high visual design quality) and response variable (perception of hedonic quality) is positive.

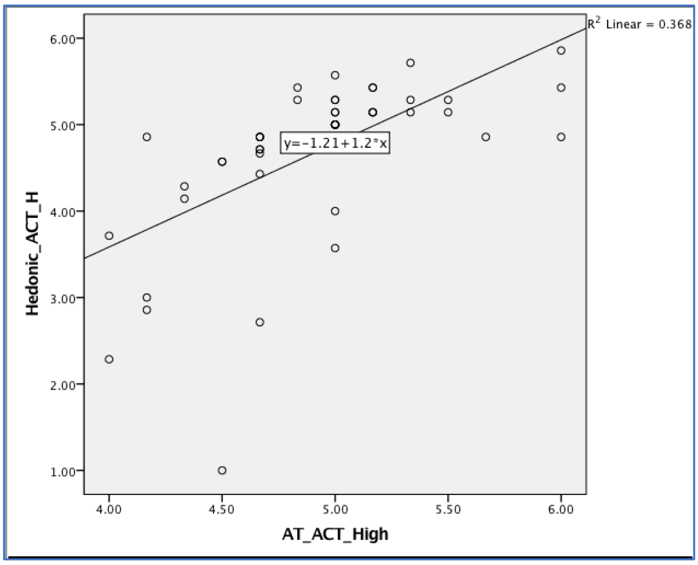

Figure 6.11: Scatterplot of High Hedonic v/s High Visual Design (Hard Fun Key)

Hard-Fun Key (Visual Design - Low Quality)

There was a moderate, positive correlation between the two variables, perception of low visual design quality (AT_ACT_LQ) and perception of hedonic quality (Hedonic_LQ), r=0.652, n=54, $p<0.05$, with high level of visual design quality associated with high level of perception of hedonic quality. From the value of R^2, it is deduced that 42.5% of the total variation in the dependent variable, perception of hedonic quality, can be explained by the independent variable, perception of low visual design quality (AT_ACT_LQ). The scatter plot in figure 6.12 shows that the form of the graph is linear, the strength appears to be moderate (since not all the points are close to the line), and the direction of the relationship between the explanatory variable (perception of low visual design quality) and response variable (perception of hedonic quality) is positive.

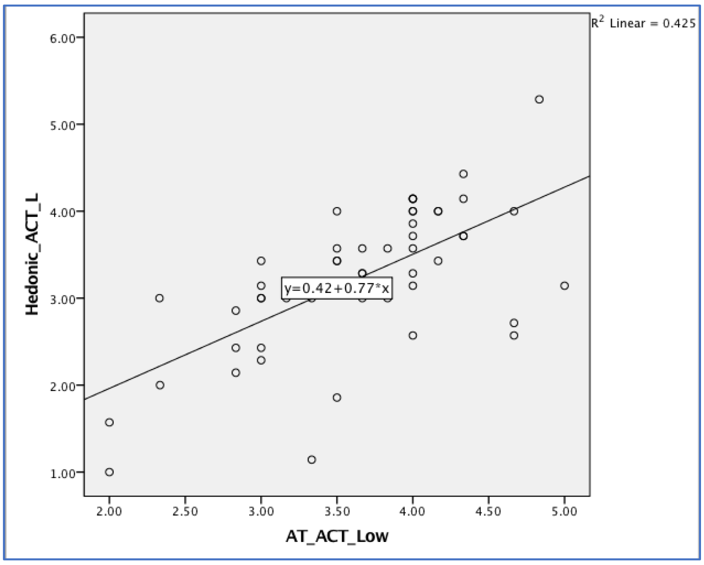

Figure 6.12: Scatterplot of Low Hedonic v/s Low Visual Design (HF)

Easy-Fun Key (Visual Design - High Quality)

There was a moderate positive correlation between the two variables, perception of high visual design quality (AT_ADV_HQ) and perception of hedonic quality (Hedonic_HQ), r=0.645, n=56, $p<0.05$, with high level of visual design quality associated with high level of perception of hedonic quality. From the value of R^2, it is deduced that 41.6% of the total variation in the dependent variable, perception of hedonic quality, can be explained by the independent variable, perception of high visual design quality (AT_ADV_HQ). The scatter plot in figure 6.13 shows that the form of the graph is roughly linear, the strength appears to be moderate (since not all the points are close to the line), and the direction of the relationship between the exploratory variable (high visual design quality) and response variable (perception of hedonic quality) is positive.

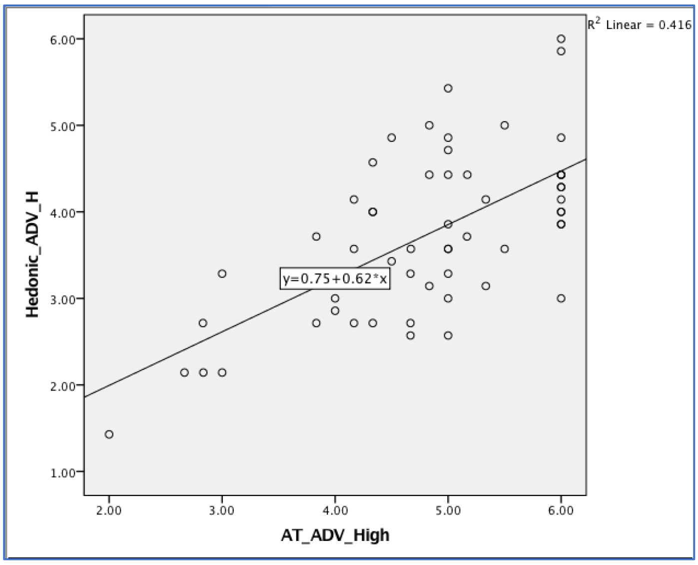

Figure 6.13: Scatterplot of High Hedonic v/s High Visual Design (Easy Fun)

Easy-Fun Key (Visual Design - Low Quality)

There was a moderate, positive correlation between the two variables, perception of low visual design quality (AT_ADV_LQ) and perception of hedonic quality (Hedonic_LQ), r=0.496, n=56, p<0.05, with high level of visual design quality associated with high level of perception of hedonic quality. From the value of R^2, it is deduced that 24.6% of the total variation in the dependent variable, perception of hedonic quality, can be explained by the independent variable, perception of low visual design quality (AT_ADV_LQ). The scatter plot in figure 6.14 shows that the form of the graph is roughly linear, the strength appears to be moderate (since not all the points are close to the line), and the direction of the relationship between the explanatory variable (perception of low visual design quality) and response variable (perception of hedonic quality) is positive.

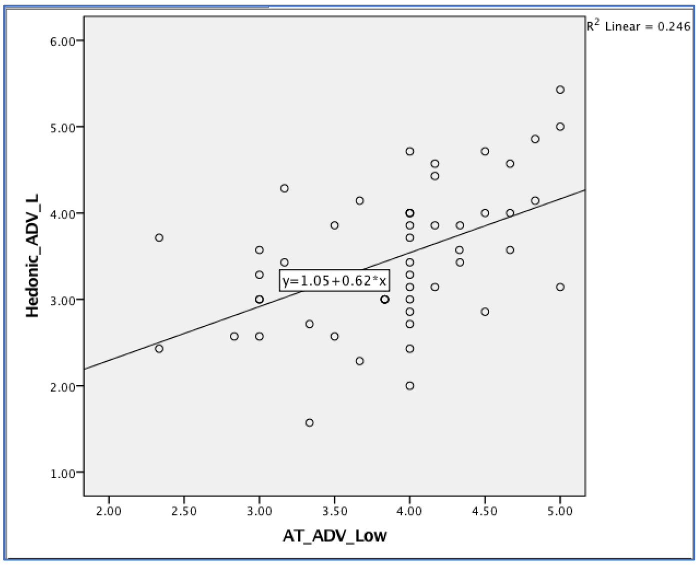

Figure 6.14: Scatterplot of Low Hedonic v/s Low Visual Design (EF)

The above findings confirmed that visual design quality of the tablet game user interface had an impact on user perception of hedonic quality. Predicted by each of the above graphs, higher values of visual design quality are associated with higher level of perception of hedonic quality. In addition, the findings illustrate that perception of visual design quality had a significant (p<0.05) and positive correlation with the perception of hedonic quality for both Fun Keys and visual design conditions (see Table 6.7).

		Hedonic_LQ
Low Visual Design	Pearson Correlation	0.590
	Sig. (2-tailed)	0.000
	N	107
		Hedonic_HQ
High Visual Design	Pearson Correlation	0.563
	Sig. (2-tailed)	0.000
	N	107

Table 6.7: Correlation between Visual Design Quality and Hedonic Quality

Visual Design Quality	Perceived hedonic (Mean ± Std dev)
Easy-Fun Key Low Visual Quality	3.48 ± 0.81, p <0.05, r=0.496
Easy-Fun Key High Visual Quality	3.74± 0.96, p <0.05, r=0.645
Hard-Fun Key Low Visual Quality	3.23± 0.81, p <0.05, r=0.652
Hard-Fun Key High Visual Quality	4.69 ± 0.92, p <0.05, r=0.607

Table 6.8: Mean perceived hedonic quality of each game condition

Table 6.8 illustrates the mean value of perceived hedonic quality in each game condition supporting that higher level of perceived hedonic quality is associated with high visual design quality game interfaces.

6.2.6.3 Summary of Results for hypothesis H4

To verify hypothesis **(H4)**, visual design quality continuous data were split into Visual_Low and Visual_High for each Fun Key as shown in Table 8, to compare the correlation coefficients of each visual design condition with the response variable, perception of hedonic. The correlation coefficient for low visual design condition was statistically significant ($p<0.05$), $R_1=0.590$ (converted to $Z_1=0.678$), $N_1=107$. The correlation coefficient for high visual design condition was also statistically significant ($p<0.05$), $R_2=0.563$ (converted to $Z_2=0.637$), $N_2=107$. In order to calculate the observed value of z-score, Z_{obs}, the values of Z_1, Z_2, N_1, N_2 were applied into the Fisher Z-transform equation $Z_{obs} = \frac{Z1-Z2}{\sqrt{\frac{1}{N1-3}+\frac{1}{N2-3}}}$.

Since $Z_{obs} = 0.2957$ fell within the range of $-1.96 < Z_{obs} < 1.96$ for a two-tailed significant test, it was deduced that the correlation coefficients of the Low Visual Design quality group (Visual_Low) and its relation to perception of hedonic quality (Hedonic_LQ) was not significantly different from the High Visual Design quality group (Visual_High) and its relation to perception of hedonic quality (Hedonic_HQ). To respond to **H4**, it was found that perception of high visual design quality of both Fun Keys had a moderate and significant effect on the perception of hedonic quality. It was also deduced that the low visual design quality of both game types had a moderate and significant effect on the perception of hedonic quality. The difference of the coefficient correlation between the high visual and the low visual group was not statistically significant; the strength of the relationship was moderate in each case. Moreover, participants derived a higher level of hedonism from the high visual design quality interfaces, Hedonic_HQ (4.19 ± 1.05) as compared to low visual design quality interfaces, Hedonic_LQ (3.35 ± 0.82), combined.

In sum, both levels of visual design quality of game interfaces have a significant impact on the perception of hedonic quality.

6.2.7 User Characteristics (CVPA) and Game Enjoyment

The fourth research objective was to determine if a player's traits had an effect on game enjoyment. The hypothesis **(H5)** predicts that participants who are more sensitive to visual design quality in user interfaces will derive more enjoyment from the high visual design version of the tablet games. In other words, participants with a high CVPA score will derive more enjoyment by playing the high visual design games.

Centrality of Visual Design (CVPA) is a measure of user characteristic defined as the visual design sensitivity one has towards a product (Bloch, Brunel & Arnold, 2003). The overall CVPA data was calculated for each participant using the CVPA screening instrument. The median CVPA score for both low and high was 3.27 (SD=0.65), referred as the baseline measurement. In order to examine if participants with high CVPA level derived higher level of game enjoyment, the sample was split into two groups called CVPA_low and CVPA_high. On the CVPA rating scale of 1–5, participants who scored from 1 to 3.26 were designated to the CVPA_low group, whereas those who scored from 3.27 to 5, were placed into CVPA_high group. There was a significant difference between the high CVPA group (N=52), a mean score of 3.71(SD=0.39) and the low CVPA group (N=52), which had a mean score of 2.79 (SD= 0.38), ($t= -11.954$, $df=102$, $p<0.001$).

Since there were three independent variables, two in-between subjects: *CVPA* (low and high), *Fun Keys* (Easy-Fun and Hard-Fun), and one within-subjects: *GEQ* (low and high), a 3-Way Mixed ANOVA was conducted to assess if there was a significant difference on the dependent variable, *Game Enjoyment,* between the two groups *CVPA_low* and *CVPA_high*.

6.2.7.1 Data Inspection for CVPA and Game Enjoyment

Game enjoyment self-reported data were normally distributed in both visual design conditions, low and high, as assessed by the Shapiro-Wilk test, at a conservative significant level of 0.05'. Since $p > 0.05$ in all the groups as shown in Table 6.9, this implies that the assumption of normality has not been violated and that the data are normally distributed.

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	CVPA	Statistic	df	Sig.	Statistic	df	Sig.
GEQ_LQ	Low	.088	49	.200*	.977	49	.447
	High	.122	62	.023	.962	62	.054
GEQ_HQ	Low	.079	49	.200*	.991	49	.976
	High	.065	62	.200*	.986	62	.718

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 6.9: Test for Normality - GEQ

Levene's Test of Equality of Error Variances determines whether the variances between groups for the dependent variable, game enjoyment for the low and high visual design quality, represented by GEQ_LQ and GEQ_HQ. Levene's test was not statistically significant (i.e., $p > .05$) as shown in Table 6.10, which indicates that variances are equal and the assumption of homogeneity of variances has not been violated, in order to proceed with an ANOVA test. There was no homogeneity of variances for game enjoyment for both low visual design (p=0.223) and high visual design quality (p=0.142), as assessed by Levene's test for equality of variances.

	F	df1	df2	Sig. (p-value)
GEQ_LQ	1.485 (6.083)	3	107 (101)	0.223 (0.01)
GEQ_HQ	1.856 (2.018)	3	107 (101)	0.142 (0.116)

Table 6.10: Levene's Test of Equality of Error Variances

6.2.7.2 Data Analysis for Game Enjoyment

Referring to Table 6.11, there was a main effect for Fun Keys, $F(1,101)=10.549$, $p=0.002$. A Tukey post-hoc test revealed that game enjoyment mean value for Easy-Fun Key (2.753±0.038) was statistically significant and higher than that of Hard-Fun Key (2.579±0.037).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
GEQ	1.178	1	1.178	22.745	0.000	0.184
Fun Keys	1.448	1	1.448	10.549	0.002	0.095
CVPA	0.350	1	0.350	2.548	0.114	0.025
GEQ*CVPA	0.002	1	0.002	0.042	0.839	0.000
GEQ*Fun Keys	0.690	1	0.690	13.324	0.000	0.117
CVPA*Fun Keys	0.117	1	0.117	0.854	0.358	0.008
GEQ*Fun Keys* CVPA	0.035	1	0.035	0.677	0.412	0.007
Error		101				

Significant alpha level 0.05

Table 6.11: Summary of Mixed-ANOVA – GEQ and CVPA

A main effect for GEQ was reported, Wilks' Lambda = 0.816, $F(1,101)=22.745$, $p<0.01$, partial eta squared = 0.184'. This confirms that mean difference (μ) recorded for game enjoyment between the low visual design quality (μ=2.5905, SD=0.031) and the high visual design quality (μ=2.7518, SD=0.333) was significant ($p<0.05$). Employing the commonly used guidelines proposed by Cohen's d (1988, pp. 284-7): 0.01=very small effect, 0.2= small effect, 0.5=moderate effect, 0.8=large effect, this result of partial eta squared = 0.184 suggests a small effect size. Partial eta squared represents the proportion of the variance in the dependent variable, game enjoyment, that can be explained by the independent variables, namely GEQ, CVPA and Fun Keys.

There was a significant interaction between GEQ and Fun Keys, Wilk's lambda = 0.883, $F(1,101)=13.324$, $p<0.01$, partial eta squared = 0.117, which suggests that the mean difference of the enjoyment level obtained from each game type was statistically significant. The mean values for game enjoyment (Mean GEQ) for the Hard-Fun Key and Easy-Fun Key, in each condition (low and high visual design quality) are illustrated in figure 6.15a below.

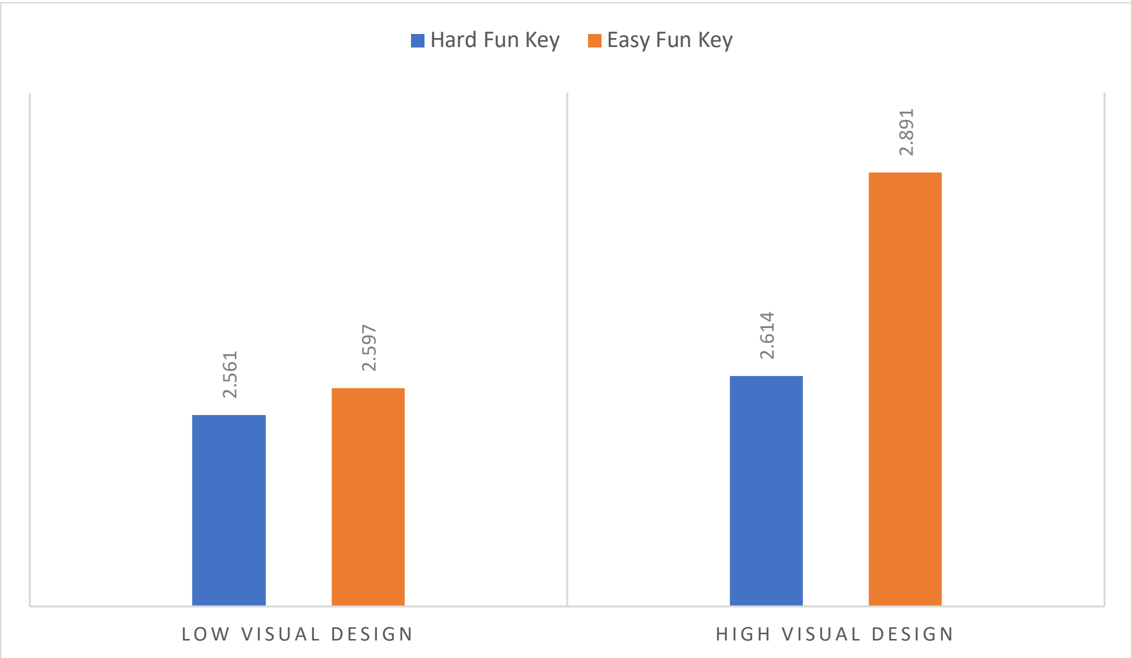

Figure 6.15a: Mean Value for Game Enjoyment in each Fun Key condition

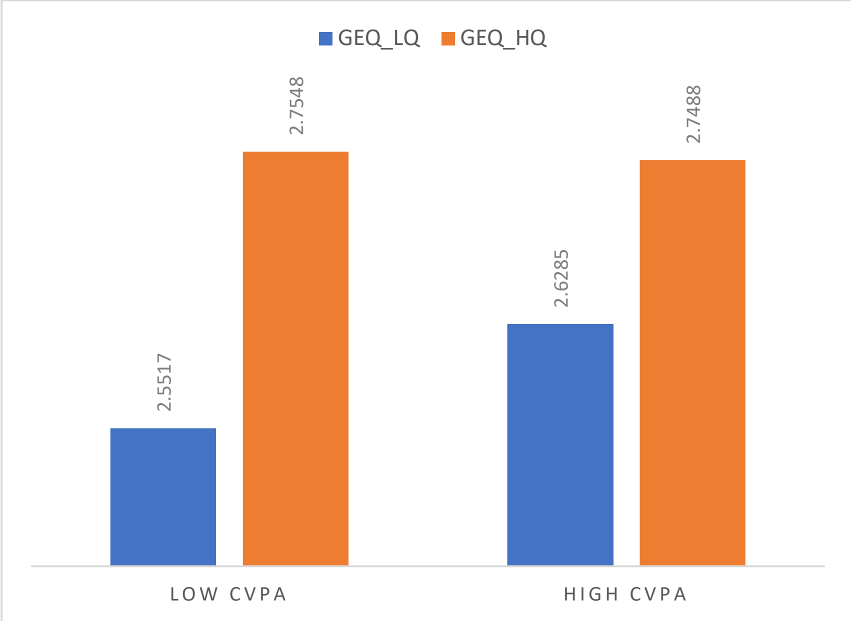

Figure 6.15b: Mean Value for Game Enjoyment in low and high CVPA groups

However, no main effect for CVPA, *F* (1,101) =2.548, *p*=0.114, no interaction effect between CVPA and Fun Keys, *F*(1,101)=0.854, *p*=0.358, and no interaction effect between GEQ and CVPA, *F*(1,101)=0.042, *p*=0.839, were observed.

Regression Analyses

A regression analysis was conducted to assess whether CVPA level of participants had an influence on game enjoyment GEQ in each game type and condition.

	LOW GEQ	HIGH GEQ
LOW CVPA[a]	**-0.005**	**-0.125**
HIGH CVPA[b]	**-0.079**	**-0.309**

*$p < 0.05$, [a]n=54, [b]n=57

Table 6.12: Pearson Product-Moment Correlations – GEQ and CVPA

Table 6.12 shows the correlation coefficients of the two CVPA levels and game enjoyment in the low and high visual design quality conditions. The correlations between game enjoyment in the high and low visual design quality conditions and high and low CVPA groups were not statistically significant (p>0.05).

6.2.7.3 Summary of Results for H5

In general, the results reveal that high visual design quality of game user interfaces yielded significantly (p<0.05) higher level of game enjoyment μ=2.7518, SD=0.333 than in the low visual design quality μ=2.591, SD=0.309 from the game participants. A follow-up analysis of Hard-Fun Key reveals that there was significant difference (p<0.05) in the level of game enjoyment experienced between the high visual design quality μ=2.6204, SD=0.352 and low visual design quality μ=2.5775, SD=0.375 game user interfaces. However, the difference in game enjoyment level was not significant (p=0.557) in the case of *Easy-Fun Key* between the low and high visual design game conditions. Comparing the two types of game, the level of game enjoyment derived by participants in the Easy-Fun Key (2.753±0.038) was significantly higher than the Hard-Fun Key (2.579±0.038). *Table 6.11* shows there were no interaction between *CVPA* and *GEQ*, F (1,101) =0.042, p=0.839'. It indicates that the differences between levels for one factor, CVPA, did not depend on the level of the other factor, GEQ. In other words, the effect of a CVPA level (low or high) on the dependent variable game enjoyment did not depend on any level of GEQ (low and high). The regression analysis shows that CVPA did not have a significant influence on game enjoyment, since p>0.05 in all the cases. It is deduced that participants in the high CVPA group did not necessarily derive more enjoyment than the low CVPA group.

6.2.8 Channels of Experience and Game Enjoyment

The fifth research objective was to compare game enjoyment level derived from different channels of experience. The hypothesis **(H6)** predicts the following:

H6: A player who experiences flow during gameplay will derive greater level of game enjoyment.

In order to respond to H6, the data collected from the challenge/skills questionnaire were first coded into four categories: flow (N=31), apathy(N=93), arousal (N=76) and boredom (N=10), as these were the four main experience participants self-reported. Participants who reported they were in the "worry" state were not included in the analysis due to the relatively small sample size. The data recorded were during gameplay. As per figure 6.16, participants who reported low skills, low challenge, were coded into the apathy group; those who reported medium skills and medium/high challenge fell into the arousal category; similarly, medium skills and low challenge were clustered into the boredom category; and high skills and high challenge were categorized into flow. A 2x2x4 (or 3-Way) in-between subjects ANOVA was conducted with the following independent variables: Fun Keys (Easy and Hard-Fun), Visual Design Quality (Low and High), and Channels of Experience (Boredom, Flow, Apathy and Arousal). The dependent variable was Game Enjoyment. Data was split into four categories (boredom, arousal, flow and apathy) from a total number of 106 participants who played both game versions. There were five missing data.

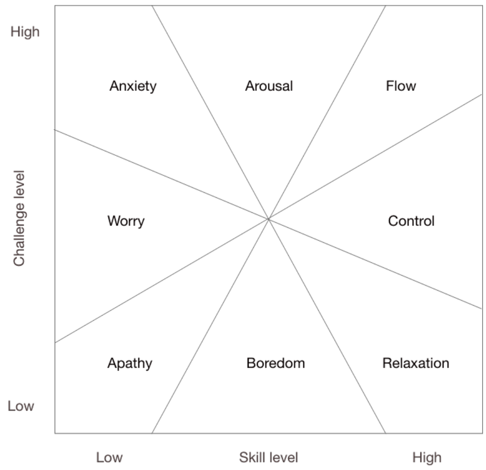

Figure 6.16: Channels of Experience (Adapted from Csikszentmihalyi, 1997)

6.2.8.1 Data Inspection - Channels of Experience and Game enjoyment

The GEQ (dependent variable) data were verified for normality, which was normally distributed as shown by the bell-shaped curve (figure 6.17). Levene's test was conducted to test for homogeneity of variances, which confirmed that this assumption was not violated, *p*=0.282' (Table 6.13). It was legitimate to proceed with the ANOVA test. Extreme outliers as provided by the boxplot were removed from the dataset. The number of participants in each visual design group were: N=105 for low visual design group and N=104 for the high visual design group. Moreover, 108 participants played the Hard-Fun Key while 101 participants played the Easy-Fun Key game.

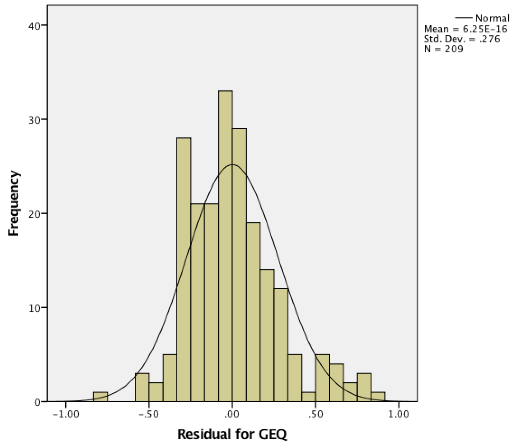

Figure 6.17: GEQ Residuals distribution for Normality

Dependent Variable (GEQ)			
F	df1	df2	Sig.
1.190	15	193	0.282

Table 6.13: Levene's Test of Equality of Variances

6.2.8.2 Data Analysis for Channels of Experience and Game Enjoyment

A three-way in-between subjects ANOVA was run on a sample of 105 participants, split into four groups, to compare the effect of channels of experience (arousal, boredom, apathy and flow) on game enjoyment. Table 6.14 below shows a significant three-way interaction, among the three independent variables, Fun Keys, Visual Design Quality, and Channels of Experience, $F\,(3, 193) = 3.504$, p=0.003'. The simple two-way follow up on Channels*Fun Keys interactions reveal that the low and high visual design group were significantly different from each other.

Source *Dependent Variable: GEQ*	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Visual Design Quality	0.016	1	0.016	0.190	0.663	0.001
Channels	4.226	3	1.409	17.165	0.000	0.211
Fun Keys	0.096	1	0.096	1.166	0.282	0.006
*Channels*Visual Design Quality*	0.046	3	0.015	0.186	0.906	0.003
*Channels*Fun Keys*	0.408	3	0.136	1.656	0.178	0.025
*Visual Design Quality *Fun Keys*	0.129	1	0.129	1.572	0.211	0.008
*Channels*Visual Design Quality*Fun Keys*	0.863	3	0.288	3.504	0.016	0.052
Error		193				

Table 6.14 Summary of 2x2x4 between groups ANOVA

A follow up Tukey test revealed that there was a statistically significant simple two-way interaction between Fun Keys and Channels of Experience for both low visual design quality, $F\,(3,193) = 2.803$, $p = 0.041$ and for the high visual design quality $F\,(3,193) = 2.704$, $p = 0.047$ as shown in Table 6.15 below.

Design	Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Low	Contrast	0.690	3	.230	2.803	0.041	0.042
	Error	15.839[a]	193[a]	.082			
High	Contrast	.666	3	.222	2.704	0.047	0.040
	Error	15.839	193[a]	.082			

Table 6.15 Simple two-way interaction between Fun Keys and Channels of Experience (Dependent Variable: GEQ)

In addition, there was a simple two-way interaction between Visual Design and Channels of Experience for the Easy-Fun Key, $F\,(3, 85) = 5.243$, $p = 0.002$' but not for the Hard-Fun Key, $F\,(3, 97) = 1.075$, $p = 0.363$'. There was a main effect on Channels of Experience, $F\,(3, 193) = 17.165$, $p < 0.05$'. This indicated that the level of game enjoyment was significantly different among the four groups. The mean values reported for each component of the Channels of Experience were as follow: flow (3.111 ±0.069), Arousal (2.795±0.038), Boredom (2.708±0.105) and Apathy (2.583±0.035). This finding confirms the hypothesis **H6**, indicating that participants in the flow state derived the highest level of game enjoyment. A follow up Tukey HSD post hoc test revealed that the mean value for game enjoyment in the case of flow was significantly different from apathy, arousal and boredom ($p < 0.05$). There was no interaction effect between Fun Keys and Channels of Experience, $F\,(3,209) = 1.656$, $p = 0.178$, on game enjoyment, indicating the mean values of the four channels of experience between the two Fun Keys, Easy-Fun and Hard-Fun, were not significantly different ($p = 0.178$). The level of enjoyment reported in both visual design conditions combined by participants in the flow channel was higher in the Easy-Fun game (3.174±0.088) as compared to the Hard-Fun game (3.048±0.107), as shown in Table 6.16 below.

Fun Keys	Channels	Mean	Std. Error
Hard-Fun	Apathy	2.685	0.053
	Arousal	2.906	0.061
	Boredom	2.747	0.165
	Flow	3.048	0.107
Easy-Fun	Apathy	2.522	0.045
	Arousal	2.685	0.044
	Boredom	2.669	0.131
	Flow	3.174	0.088

Table 6.16 Summary of Mean Values - Fun Keys and *Channels of Experience*

There were no interaction effect between (i) Channels of Experience and Visual Design Quality, $F\ (3, 193)$ =0.186, p=0.906, on game enjoyment (ii) Visual Design Quality and Fun Keys, $F(1, 193)$=1.572, p=0.211 on game enjoyment. Moreover, there was no main effect for Visual Design Quality, F(1,193)=0.190, p=0.663 on game enjoyment, implying participants derived equivalent amount of game enjoyment from both the low and high design quality games. In addition, there was no main effect for Fun Keys F (1,193) =1.166, p=0.282'.

From the Post-hoc Tukey tests, the mean difference of game enjoyment level was significant between flow and the other channels in the high visual design condition: arousal (μ=0.29, p<0.001), apathy (μ=0.50, p<0.001) and boredom (μ=0.43, p=0.004). Additionally, the mean difference of game enjoyment level was significant between flow and the other channels in the low visual design condition: arousal (μ=0.39, p=0.003), apathy (μ=0.57, p<0.001) and boredom (μ=0.46, p=0.014).

6.2.8.3 Summary of Results for hypothesis H6

Hypothesis **H6** confirms interesting results that players in the arousal state were immersed and engaged at the same time. Those in the flow state derived the highest level of game enjoyment as compared to the other channels of experience, and that the mean difference was statistically significant ($p < 0.05$). This finding also reports that visual design quality of game user interfaces did not have a significant effect on game enjoyment. This implies that the level of game enjoyment derived from both conditions of Hard-Fun and Easy-Fun Keys was equivalent.

6.3 RESULTS of QUALITATIVE DATA

This study used mixed-methods research in order to complement the quantitative data with rich qualitative data, thus clarifying the results of the quantitative method (Johnson & Onwuegbuzie, 2004). At the conclusion of the tablet game experiments, participants reflected upon their overall game experiences after playing the two-different visual design game versions by completing an open-ended questionnaire that posed the following three questions:

1. Which aspects, elements and features of the low visual design game made gameplay challenging?
2. Which aspects, elements and features of the high visual design game made gameplay gratifying?

3. Which of the two game versions was more pleasurable to play? Why?

A phenomenological approach to data analysis, known as applied thematic analysis, was employed to examine the qualitative data (three open-ended questions from the structured questionnaire) whereby themes are identified around a pattern of keywords and concepts (Guest et al., 2012). Through this method of data analysis, the researcher had the ability to capture the experiences and perceptions of research participants through the response data. analysis. The results provided in-depth understanding about players' behavior during game interaction. Open-ended questions of the structured questionnaire were analyzed using thematic analysis techniques (Braun & Clarke, 2008), by first reading the data responses thoroughly, coding and grouping the like data, related to the theory. Data that did not support the theory were also highlighted in this process. After that, potential themes were examined whereby data were categorized under broad themes. The themes were further refined to fit under specific themes. Connections were speculated between the meaningful themes generated by carefully reflecting on each category, by making reference to the research questions. Finally, the themes were defined in conjunction with context of the research questions.

In this section, the results of the questionnaires are presented, first for the Hard-Fun Key game, *Mission Mars*, and then for the Easy-Fun Key game, *Mars Explorer*.

6.3.1 Results of Hard-Fun Key Qualitative Data

The Hard-Fun Key game known as Mission Mars is an active shooter game played on an iOS tablet (iPad 2) in the portrait position.

Hunter, Lusardi, Zucker, Jacelon, & Chandler (2002, p. 389) argue that in qualitative research method, the "meaning making process" does not take place sequentially but instead, occur dynamically. Meaning occurs by labeling, identifying and classifying emerging concepts; interrelating concepts and testing hypotheses, finding patterns and generating theories."

A set of themes emerged from the analysis of the post-game play questionnaire. Player made it clear that they preferred high quality visual design, including color and graphical elements.

Positive Aspects of the High-Quality Version (Hard-Fun Key)

- **Attractive user interface**

Out of the 55 participants who took part in the study, 49 participants preferred the HQ game while only 6 participants preferred the LQ game. For example, one player said, "Although the game play was identical, the high design version one was more pleasurable because of the variety of colors and textures." Other players mentioned the following:
"Objects were easier to distinguish,"
"The high visual game was easier to engage with."

- **Graphical attributes made gameplay enjoyable**

13 of 49 respondents (26.5%) claimed the graphics and the imagery used in the HQ game made gameplay more enjoyable as the graphics used in the tablet were visually appealing as compared to the LQ game with poor graphics and images. It felt modern, refined, and more sophisticated in comparison with the LQ version. It gave them a realistic look and feel of an actual 2.5D tablet game.

For the high visual design version, players mentioned the following: "The colors were more appealing, leading to a better gameplay experience in the high visual one." "The higher design is more satisfying to play because of the clear objectives and higher graphics quality." "Felt more involved with the higher design version." For the low visual design version, players stated: "poor graphics and display," "graphics tend to be blurry," "poor graphics and lack in appeal," "poor controls and graphics."

- **Colorful palette made the game more pleasing**

14 of 49 participants (28.5%) claimed the multi colors of the HQ game made the game more pleasing and appealing to the participants. The colors enabled the participants to differentiate the obstacles with ease and to be more focus on the dynamics of the game. The vibrant landscape made the visual experience more rewarding and was more realistic. Players' comments were:

"The effects and colors of the obstacles were creative." "The high visual version was more visually attractive because the real light condition." "The colors popped out; they were pleasing to the eyes."

- **Game mechanics - Tilt interaction improved game play**

A few participants liked the mechanics of the game and focused more on it than on the game visual design. They liked that the levels had different touch interaction styles (tap, swipe and tilt), which added variety to the game, and made gameplay more interesting. The majority preferred the tilt option when it comes to the responsiveness of the controls in the HQ game.

Players stated, "*the higher-end version was more enjoyable. It felt less mechanical and more immersive.*" "*game with controls like level one to tilt the screen to move the spaceship.*" "*the responsiveness of the controls and game appeal.*"

- **Clear objectives and goals**

The objectives of the HQ game were much clearer and the participants could figure out the gameplay easily than they did for the LQ version.

"The higher end is more satisfying to play because of the clear objectives and higher-bits graphics."

- **Game involvement**

Participants felt more involved during the gaming experience with the HQ version. They felt connected to the game and enjoyed it better.

"The level of difficulty requires me to pay more attention to the game."

- **Game Engagement**

The color visuals in the HQ game made gameplay more engaging to some players than the LQ game.

"engagement was more in the higher quality game as I wanted to continue to play."

Challenges of Low-Quality Version (Hard-Fun Key)

- **Mentally draining**

A few participants complained that in the LQ game, it was harder to differentiate between game elements such as the *good* and the *bad* rings, since they were all monochromatic. Many participants complained that having no colors in the LQ game was very challenging to make quick decisions during gameplay. Some participants said that they had to squint in order to figure out the objects in the LQ game. The following statements were reported by participants:

"Low quality graphics were hard to control." "There was no color difference in the rings, so I didn't know which ones to avoid." "The lack of vibrant colors put a drain on my mental focus, it felt like playing the game was more of a chore than for any enjoyment." "Distinction between the rings."

- **Absence of color**

Participants playing the LQ monochromatic color game felt the lack of vibrant colors which rendered gameplay difficult and dull.

"Makes me not want to play with the game compare to the one with colored." "the user interface was dull and gloomy."

- **Game Controls**

7 of 49 participants (14.3%) asserted that the responsiveness of the controls in the LG game made gameplay more challenging. Because of this, the players reported that they were less motivated; it became difficult for the participants to shoot at level two or to use the swipe touch option in level three. *"The game was less engaging and controls were not good." "low graphics hard to control."*

- **Difficult to focus on targets**

In the LQ version, the monochromatic colors made it hard to distinguish between the (good or bad) rings and the spaceship was not properly visible at times. Hence targeting the objects was difficult.

"The color of the low visual design game made it very difficult to focus on my target."

Summary of themes for Hard-Fun Key

The themes arising from the gaming experience of the Hard-Fun Key, confirmed a predilection for the high visual design quality. It was reiterated that a multi-color user interface not only engaged the players, but also increased gameplay usability. The colorful game attributes were deemed to be more enjoyable to interact with. Moreover, the high visual design version of the game provided clear goals and objectives, which in effect promotes gameplay. Participants felt that the high visual design version provided a more rewarding gaming experience. On the other hand, the themes emerged from the low visual design quality provided cues that participants induced some kind of anxiety, and it was difficult to focus on targets. Surprisingly, participants noted that game controls were perceived to be less usable in the low visual design quality despite the fact that the mechanics of both versions were similar.

6.3.2 Results of Easy-Fun Key Qualitative Data

Mars Explorer is an adventure game depicting an astronaut who has just landed on the planet Mars as part of a quest for exploration.

A set of themes emerged from the analysis of the post-game play questionnaire. Participants specified that they preferred the high-quality visual design, including color and graphical elements. Almost all the experiment participants, 52 out of 56, reported that they preferred to play the HQ game version. By contrast, four participants reported that with, they could make the connection and virtually identify the Red planet through the monochromatic color scheme used in the LQ game. This is because they had prior ideas how Mars looked like through satellite imageries and could visualize the textures of the Red planet in the game.

Positive aspects of the High-Quality version (Easy-Fun Key)

- **Engaging graphics**

Players reported that the high-quality graphics used in the HQ version made gameplay more engaging.

"high design game was more pleasing to the eye. It helped me to engage more in the game. Also, it helped me to distinguish what I was looking over."

- **Attractive Interface**

The HQ game was deemed to be more attractive and appealing to participants. They derived more pleasure playing the HQ version.

"The higher version was visually better and more challenging." "The color made it look better and I felt good playing this game." "The high visual game was more pleasurable because it provided a more well-rounded game experience than the low visual game."

- **Enjoyable color environments**

The majority of the participants stated that color visuals made a difference in the game. The HQ game was more enjoyable and pleasurable to play. Some stated that the color visuals enlightened their mood in the HQ, which was not the case in the LQ game. The bright color contrast in the HQ game made the gameplay attractive and gratifying. The presence of colors enabled the participants to identify the obstacles quickly, and the scenario was visually pleasing as well.

"*The high visual game was more pleasurable because it provided a more well-rounded game experience than low visual game." "The bright and more colorful visuals made the gameplay more satisfying."*

- **Easy navigation**

Some participants mentioned that they were able to navigate with ease in the HQ game, as they could see where they were going and they could differentiate between the obstacles. They also stated the crisp graphics, and color of the HQ game made it easy to navigate around the game and felt they had more control over the game.

"High Visual Design game was much better; easily identifiable and pleasing to eyes during gameplay." "Easier to navigate." "It was easier to navigate to find the treasure chests."

- **Appropriate challenge level**

Players found the HQ version to be more challenging and engaging than the LQ version.

"It was visually pleasing and more challenging"

- **Playfulness**

Many participants stated that having high graphics and visual design made the gameplay more exciting. They had a more pleasurable experience playing the high visual design game. The participants preferred to play the game with high quality graphics as it was a pleasurable experience with the high visual design game. In the HQ game, players were able to see the obstacles in the game clearly and navigate through them.

"I liked the monsters in the game, it was easy to interpret." "The high graphics made it better."

Challenges of the Low-Quality version (Easy-Fun Key)

- **Distinction of game elements**

One of the major issues with the LQ game was that the participants were unable to discern the game elements properly because of the low contrast color between objects and background. The alien's harmful radiation was sometimes not visible by some participants, and hence they could not attack the aliens without getting harmed. The inability to distinguish the objects in the game scene posed a challenge to the players. In addition, the participants were not able to discern the sandstorms and navigating around game elements proved to be difficult. The randomness of the aliens popping up, not knowing which treasure chests gave positive points, the sandstorms that start randomly etc. were some of the challenges that made gameplay hard for a few participants.

"Some of the figures seemed identical due to color scheme, especially when it came to the ring around creature." "It was more difficult to see the obstacles." "At first, it was confusing to figure out the differences between what I was supposed to be looking for." "It was confusing to differentiate all the elements in the game."

- **Difficult navigation**

Participants found it difficult to navigate through the game environments and to dodge enemies. *"Navigating the astronaut; not knowing which treasure chest would give you points."*

- **Overly simple**

  11 participants (19.6%) felt that the LQ game was not challenging and it was simple to play, despite the fact that both game versions were identical in terms of game mechanics. The simplicity of the game made it boring for the presumably experienced participants.

"The game was not demanding or challenging in any way. It was too long for such a simple game. The game could have had more objectives and levels."

- **Uninteresting**

Many participants found that the LQ game version was plain and uninteresting. Some mentioned that it made the game look duller and antiquated. They said that the LQ game had relatively fewer amount of details. It looked unfinished and did not provide a full gaming experience. "It was without color which made it appear more boring and older." "I wouldn't really classify it as challenging, but it would be straining to play with the mono-color scheme for longer periods of time."

Summary of themes for Easy-Fun Key

The results echoed those obtained in the case of Hard-Fun Key. The HQ version was more playful, pleasing and enjoyable. A balance of challenge and skills made the HQ game more engaging to play. Participants found the HQ game easier to navigate as the objects were more distinct on screen. Colorful graphics enhanced gameplay experience. By contrast, the LQ version blurred the game elements, and rendered gameplay uninteresting.

6.3.3 Summary of themes for both Fun Keys

Table 6.17 below displays the themes that emerged from the qualitative data set from both game conditions and types.

Low Visual Design Quality	High Visual Design Quality
Difficult to make distinction between game elements due to low contrasting color.	Visual Design quality highly preferred.
Not so easy to focus on gameplay due to monochromatic color schemes.	Clear goals and objectives perceived
Lack of colors perceived as mentally draining.	Game mechanics easy to discern, more usable.
At times, game felt uninteresting.	Increased level of game involvement.

Difficult to make use of game controls.	More gratifying and rewarding experience.
Few participants who enjoyed the Easy-Fun Key LQ could connect with the monochromatic color scheme of the game to the actual atmosphere on Mars.	Game looked more refined and modern.
Overly simple to play	Gameplay perceived to be more engaging.
	Sophisticated graphics captured and sustained user attention.
	Attractive color environments added value to game interfaces.
	Easier to navigate.
	Exciting to play.
	Easier to focus on game play due to distinctive color variation of objects.
	Color variations enhanced game experience.
	Graphical attributes enhanced gaming experience

Table 6.17 Themes for both Fun Keys

6.4 Significance of PX Design Model for tablet games

This section presents the standardized path coefficients of the high visual design quality dataset for the *conceptual PX design model* in figure 7.2 (chapter 7). In a *Confirmatory Factor Analysis* model, the factor structure prompting the measures was postulated and was afterwards verified if the datasets supported the hypotheses, as indicated by Koufaris (2002). *Confirmatory Factor Analysis* (O'Rourke and Hatcher, 2013) was applied to examine the relationships of the components predicted by the hypothesized PX framework in figure 3.2. The result indicated a marginal good model fit, as the Fit Summary showed that $p < 0.0001$; *Bentler Comparative Fit Index*=0.8665 (values above 0.9 are considered a good fit), as per Bentler's (1990) guidelines. Cronbach Coefficient

Alpha was used to verify the internal consistency of the dependent variables. *Confirmatory Factor Analysis* makes use of Chi-square model test criterion such that the uncorrelated factor model is rejected at the alpha level, α =0.05. The first iteration of the *conceptual PX design model* (figure 7.2) showed all the path estimates were significant. Non-significant paths ($p > 0.05$) such as from AT to Emotion (arousal/valence), and from PQ to Emotion were removed from the diagram. In order to improve the Chi-Square Model fit, adding a new path from PQ to GEQ was theoretically recommended by the output. The LM (Lagrange Multiplier) Stat value was 68.63046 ($p < 0.0001$) which explained an approximation of the Chi-square drop if this parameter would be included in the framework. The variance explained for each dependent variable is reported as R^2 in figure 7.2. The model rationalizes a significant proportion of 88.10% in PQ and 59.31 % in HQ. Consequently, HQ explains 65.11% in Visceral Emotion, which in turn explains 63.59% and 63.27% of the variances in Reflective level (PX) in Behavioral level (BX) respectively.

6.5 Chapter Summary

The seven hypotheses were analyzed using mixed-methods. The findings from the first hypothesis **(H1)** revealed that *perception of game usability* in both Fun Keys was equivalent; however, *perception of game usability* was deemed more usable in the case of high visual design quality. This quantitative result was substantiated by the responses of the qualitative data from the questionnaire. Participants perceived game controls and game play to be more usable in the high visual design condition.

The result from hypothesis **(H2)** confirmed that participants were more aroused in the high visual design condition of the Easy-Fun Key, as supported by figure 6.7 (Circumplex Model). The levels of *arousal* were equivalent in both conditions of the Hard-Fun Key. This was indicated by the spread of the plots of the quantitative analyses on figures 6.5 and 6.6 (Circumplex Model). Furthermore, the qualitative responses from the semi-structured questionnaire supported the findings as many participants showed sign of excitement (playfulness activity) during gameplay in the Easy-Fun Key.

Moreover, the third hypothesis **(H3)** revealed that *valence* was relatively higher in the high visual design versions of both Fun Keys. This result was substantiated by both the quantitative analysis and the qualitative responses. In the Circumplex Model illustrated in figures 6.5 and 6.7, the spreads of the plots appeared horizontally along the positive direction of the x-axis, as compared to Figures 6.6 and 6.8. According to the qualitative result, participants enjoyed interacting with the high visual design games because of the colorful, crisp and high-quality graphics and environments.

The findings from the fourth hypothesis **(H4)** confirmed that both low and high visual design quality of game user interfaces had an influence on the perception of hedonic quality. For example, the correlation between *visual design quality* and *perception of hedonic quality* was stronger in the HQ version (r=0.645) than in LQ (r=0.496) for the Easy-Fun Key. According to the semi-structured questionnaire responses, respondents had a sheer preference for the high visual design quality games when it comes to pleasure. For example, a few participants could make connection with the monochromatic color scheme of the Easy-Fun Key LQ game to the actual atmosphere on Mars, which enhanced gameplay activity.

In addition, the results from the fifth hypothesis **(H5)** established that participants who were more sensitive to visual design quality in products did not necessarily derive more enjoyment from the high visual design version of the tablet games. The low and high CVPA groups did not have a significant influence on game enjoyment.

The results for hypothesis **(H6)** confirmed that participants in the *flow* state derived more enjoyment as compare to the other states. A deeper examination of the sample data revealed that those who were in the flow group, used words such as *enjoyment, involvement, engagement* and *excitement* in their qualitative responses. Moreover, participants in the arousal channel experienced a heightened level of engagement.

Chapter 7

DISCUSSION

7.1 Introduction

In this chapter, the discussion elaborates on the findings gleaned from each phase of the research, the game development processes adopted, the development of the research framework hypotheses tested, as well as the quantitative and qualitative evaluation of the datasets. Firstly, in section 7.2, the development of the games as experimental tools is considered in relation to the qualitative research findings in the first phase of the study. Secondly, the research framework, hypotheses, and use of the games as stimuli to elicit findings are discussed in the context of theoretical and practical contributions of the research (section 7.3). Afterwards, section 7.4 highlights the contributions of the research with an assessment of the PX Design model introduced in Chapter 3 (figure 3.2). The chapter concludes with a summary of key contributions to the thesis.

7.2 Game Development as an Experimental Tool

To increase robustness of the results, two different types of tablet games (Mission Mars and Mars Explorer) were created for the experiment. The games were created to allow the researcher to modify the visual design quality of the user interfaces. During the first phase of the design-oriented research approach, the two games were designed and developed for tablet devices (iPad Retina) so that the visual design quality variable could be modified into two experimental conditions. As described by Schuler and Namioka

(1993), the participatory design approach was adopted by involving participants from the conceptual stage of the study to conduct mind-mapping and focus group sessions. A user-centered design principle as described by Norman and Draper (1986) was implemented during the iterative design and development process of the two tablet games, which involved prototyping and player-testing and debugging practices. User centered design principles focused more on strategies by placing the end-users at the center of the design process; end-users do not necessarily form part of the team of professional designers and developers. However, in a participatory design approach, end-users are involved in creation process. The visual game elements were modified into two conditions, low and high visual design as elaborated in chapter 5. The design process was followed to create the low-quality game versions which met the necessary game usability parameters and the findings showed that low visual design quality interfaces are perceived to be less usable. It should be noted that the *game usability* including the mechanics and game play were not altered during the game modifications between the high and low visual design conditions. The game design and development followed an iterative process beginning with understanding of user needs, ideation, conception, reflection-in-action or thinking through the design problems, to prototyping and testing.

The game artefacts devised were novel creations and designed specifically for their incorporation into a further stage of exploratory research. They served as stimuli and were empirically evaluated so as to address research hypotheses developed from the proposed conceptual player experience (PX) framework (figure 3.2). The main contributions related to design-oriented game design and development were:

1. The creation of two types of iOS tablet games using user centered design principles (see chapter 6).

2. The application of a design-oriented research methodology combining creative practice and scientific inquiry.

3. The validation of a *conceptual PX design model* in the domain of tablet gaming.

The advantage of the design-oriented research methodology conceptualized in this thesis provides a pathway for game researchers, designers and developers to mold the design process by incorporating qualitative and quantitative methods of inquiry along with creative practice. Several methods can be integrated depending on the context to solve a given design problem in a scientific manner. It entails reflection-in-action of the practitioner as well as rigorous scientific inquiry. The objective of this approach is for creative practice and scientific inquiry to co-exist while producing innovative design solutions. The outcomes of a systematic design process were transformed into design artifacts that could be empirically used to answer predetermined research questions to generate new knowledge. As such, this methodology allowed the researcher to examine the hypotheses through the use of two controlled variables (visual design quality and fun key) that helped measure the dependent variables. The design-oriented research approach allows the researcher to conceptualize the research questions before moving to the practice stage comprising of the game making process; whereas practice-based research privileges the research questions that emanate from that practice.

7.3 Discussions of Research Objectives

This section presents a description of the discussions of the research objectives. The findings of the validated PX design model (figure 7.2) concerning the *Confirmatory Factor Analysis* are reported in Chapter 6 (Section 6.4), followed by a discussion of the assessment of the model in section 7.4 below.

7.3.1 Research Objective #1

The first objective was to examine if the visual design quality level (low and high) of the game interfaces affects players' perceived usability. The goal of this research question was to assess the impact of low and high visual design quality in game interfaces on user perceived usability.

The findings supported hypothesis **H1** by unveiling that the game user interfaces with high visual design quality were perceived to be significantly more attractive than their lower visual design quality counterparts. On the other hand, low visual design interfaces were perceived to be non-usable.

The main contribution to knowledge is that a high-level visual design in user interfaces empowers user design engagement, as reflected in the qualitative analysis. The concept of design engagement seeks to identify the conceptual user experience (Berleant, 2013). Theoretically speaking, it is a comprehensive design experience which combines objective and subjective perspectives of design appraisal, culminating in an interactionist viewpoint (Moshagen & Thielsch, 2010). The design engagement derived from high visual design elements aligns with the theory that explicates visual design appeal to the senses, influencing user perception (O'Brien, Toms, Kelloway, & Kelley, 2010; O'Brien & Toms, 2008) to make a positive design appraisal. The theory of design engagement rationalizes an end-user is quickly drawn into the high visual design interface by virtue of its attractive graphics and engages with the interactive game artefact as an active participant.

On the other hand, game interfaces with low visual design quality did not correlate significantly with perceived usability. In their qualitative responses, participants claimed low visual design quality were perceived to be less usable as the contrast between visual game elements and the background was reduced, and the graphics were rendered into low bits. This implies that low visual design can negatively impact perceived usability. One possible explanation is due to order effect in playing the game. After playing the games with high visual design during the first session, the same or higher level of aesthetic perception could have been anticipated by participants in the lower visual design quality condition. This is because aesthetic experience draws on visual evaluation of artifacts (Palmer et al., 2013; Cinzia & Vittorio, 2009) and is dependent on higher level cognitive processes for visual analysis, according to Zhou et al. (2016). This is plausible as to why game participants soon became disinterested or dissatisfied with low visual design quality user interfaces as the graphics were perceived to be unattractive. This finding somewhat aligns with studies conducted by Hassenzahl (2004), Lindgaard and Dudek (2003), Mahlke (2008), van Schaik and Ling (2009), and Grishin and Gillan (2019). This community of researchers did not find any direct relationship between visual design quality of a product and the perceived usability in interactive domains.

To summarize, the new knowledge that emanates from the above discussion indicates that high visual design quality game interfaces promote gameplay as attractive interfaces including head up displays are perceived to be usable. However, low visual design quality interfaces below a monochromatic color saturation of 25% can negatively impact perceived game usability.

7.3.2 Research Objective #2

The second research objective was to examine the impact of visual design quality (low and high) of two types of tablet game interfaces on the emotional responses (valence and arousal) of game participants.

Previous studies did not discuss the influence of the levels (low and high) of visual design on emotions. The results from hypotheses **H2** and **H3** show that both high and low visual design interfaces have a significant effect on arousal and valence for both game types. Participants experienced a relatively higher level of *arousal* during interaction with the high visual design quality game user interface version of the Hard-Fun Key, as illustrated in *figure 7.1a.* In addition, participants experienced a higher level of *valence* during interaction with the high visual design quality game user interface of the Easy-Fun Key, as shown in *figure 7.1b*. This implies that high visual design quality interfaces have the propensity to make the necessary emotional connect with the end-users.

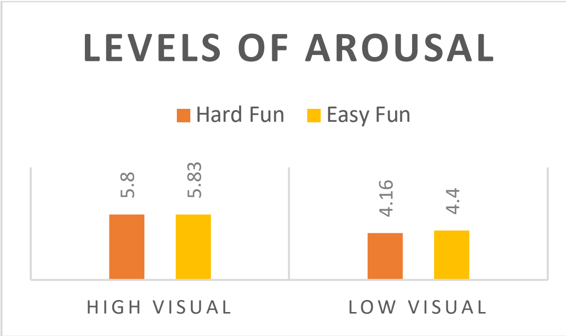

Figure 7.1a Comparison of Arousal levels

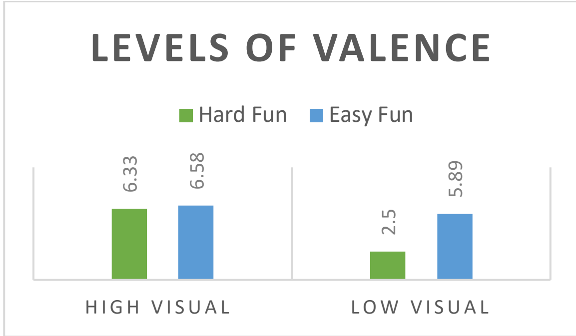

Figure 7.1b Comparison of Valence levels

The above results of **H2** and **H3** as shown in figure 7.1a and 7.2b echo the theory that high quality user interfaces elicit pleasure (valence) and mild arousal, as demonstrated by Sutcliffe (2010), and mediated by the hedonic component, which is the design of interaction (Lenz, Diefenbach, & Hassenzahl, 2014).

Additional pertinent discussion of hypotheses **H2** and **H3** findings obtained from the quantitative data of the *Circumplex Models* (section 6.2.5.4) illustrating emotional elicitations supplemented by qualitative data discussions are provided below:

(1) Hard-Fun Key – High Visual Design Quality

The new findings uncovered in the Hard-Fun Key *high* visual design quality game were that participants experienced emotions ranging from *triumph, excitement, self-confidence and enthusiasm to superiority*, as shown by the plots in the first quadrant of the *Circumplex* Model of Affect (see figure 6.5). This implies that participants exhibited heightened (high intensity) signs of positive frustrations. This result is closely aligned with Lazzaro's theory of the Hard-Fun Key as the goal is to win the game or beat one's opponent, aimed at eliciting emotions such as *relief* and "*fiero*" (*triumph)*, including positive *frustration*, which is comparable to delight and excitement. Positive frustrations are necessary to accentuate the motivational aspects in games, leading to sensory game engagement. This experiment revealed that both positive and negative frustrations could give rise to immersion, as explained by Jennett et al. (2008).

The sophisticated graphics captured and sustained higher level of user attention thereby providing a rewarding gaming experience, which is a significant contribution to the field. A heightened level of arousal (figure 7.1a) can be attributed to game focus and attention facilitated by the high visual design quality of the game elements or metaphors. It is deduced that game focus and attention can be achieved through properties adhering to design principles such as symmetrical or asymmetrical layout, balance, color (tonal values) and high contrast, proportion and texture. The visceral appeal of the game user interface might have a fleeting experience on the users, whereby the behavioral and cognitive aspects played a more important role to achieve the goals of the Hard-Fun Key game genre.

In addition to the above quantitative data discussions, the observations of the qualitative data reveal that game mechanics and game rules played prominent roles. As mentioned in chapter 5, game mechanics motivate and engage the player during gameplay. For instance, a few participants reported they started playing the game instantaneously without realizing the high-quality visual game elements of the interface, which were perhaps subconsciously linked to the *instrumental* quality of the game type (e.g.

practicality, usability and functionality) and hence the reason it was perceived to be usable (as explained in section 7.3.1). Since the activity in a Hard-Fun Key game occurs at a fast pace, the participants strategically focus on the game mechanics to prevent an encounter and attack an enemy in order to achieve the goals of the game. The behavioral level of the emotion design theory (Norman, 2004) explains the essence of functionality and usability in games that influence the player in making decisions during gameplay. Emotional responses of participants can be explained by psychological occurrences that influence their decision-making behaviors during interaction with products or technology as explained by Seo, Lee and Chung (2016). Hence, it is deduced that behavioral level of the emotional design theory helps elicit *delight* and *excitement* along with the impact of attractiveness of the graphics as perceived in the visceral design level.

(2) Hard-Fun Key -- Low Visual Design Quality

The quantitative findings uncovered in the Hard-Fun Key *low* visual design condition were that participants experienced emotions such as feeling *apathetic* and *taken aback*. Most of the observations occurred in the third quadrant of the Russell's (1980) *Circumplex Model of Affect* (see figure 6.6). The low visual design quality of the interface might have given rise to negative valence and negative arousal. In other domains, negative emotions have been attributed to user interfaces with complex visual elements and unorganized hierarchy of information (Ward and Marsden, 2003; Thuring and Mahlke, 2007; Mahlke and Minge, 2008).

Participants reported in the qualitative data that game controls were perceived to be less usable in the low visual design condition, despite the fact that usability attributes were similar in both game conditions. In addition, a few participants felt anxious as it was difficult to focus on certain game elements.

The low contrast and low bit-depth graphics of the low visual design quality interface are the only factors perceived to be conflicting with one's interests or goals that led to negative valence and negative arousal. If one appraises a stimulus conflicting against one's point of view, one will experience negative emotions (Frijda, 2007; Lazarus, 1991; Scherer, 2004) as cited in Moors et al. (2013). This implies that a monochromatic color rendition of the user interface impeded perceived usability and consequently playability, as color saturation was dropped to 25% contrast threshold, which adds to the complexity of the interface design. This in fact accounted for the relatively negative valence (displeasure) and low arousal.

(3) Easy-Fun Key -- High Visual Design Quality

In the Easy-Fun Key high visual design quality game, the findings revealed that participants experienced emotions ranging from *light-hearted, passionate, delighted, enthusiastic, self-confident, joyous to courageous*. The results align with Lazzaro's (2004) theory of the Easy-Fun Key as the goal for the player is to explore the game as the adventurer role-play, and is aimed at eliciting emotions such as *curiosity, surprise, wonder,* and *awe*. The quantitative results indicated that high visual design quality of the Easy-Fun Key had a statistically significant influence on both valence and arousal, and most of the observations occurred in the first quadrant of the *Circumplex Model of Affect* (see figure 6.7), with relatively higher degree of arousal and valence, which supported hypotheses **H2** and **H3** respectively.

The qualitative data revealed that the high-bit depth of the graphics made gameplay more engaging; the highly attractive user interface elements sustained user interests in the game, which enhanced game navigation. Participants experienced a higher level of valence (pleasure) and arousal during interaction. First, the user interface influenced sensory qualities and design perception on first-hand experience and interaction. Second, this game condition was perceived to be highly usable due to its practicality and attractive interface. Third, it was found that tablet game story promoted gameplay; the game was interpreted and remembered by the user after usage (see also Crilly et al., 2004; Mahlke, 2007), which corresponds to the overall gameplay experience. The above observations are supported by Cupchik's (1999) theory, which rationalizes a product has three facets associated with emotional processes namely *sensory/design, cognitive/behavioral, and symbolic meanings*.

The new findings uncovered that the Easy Fun game has a significance reliance on game story (narrative), besides high-quality visual graphics to create the necessary emotional-connect between the game and the player's expectations through the game narrative. This implies that in addition to designing sophisticated graphics, the designer also assumes the role of a creative game narrator who invents imaginary game story from his or her own memory. It can be inferred that positive emotions during gameplay are associated with captivating game narrative and the meaningfulness of high visual design elements.

(4) Easy-Fun Key -- Low Visual Design Quality

The new findings in the Easy-Fun Key *low* visual design condition unveiled that observations in the *Circumplex Model of Affect (see figure 6.8)* occurred in the first quadrant (moderate-positive valence and arousal), from *passionate, enthusiastic* to *self-confident* while a few participants felt *deactivated* and *pensive*.

Design quality is a key aspect during the initial phase of interaction but ultimately game usability and mechanics supersede the overall judgement made by participants during an appraisal. Game participants relied on the game mechanics or narrative to keep them motivated to play the low visual design game quality. As Sutcliffe (2016) pointed out, in the domain of games and entertainment, feedback, presence, and game metaphors play major roles in decision-making. Judgment related to user experience is iterative and can change over time with the evolution of the experience.

According to the qualitative dataset findings, a few participants stated that the monochromatic color scheme of the game interface appeared to have relatively fewer details, which influenced their judgment and caused them to perceive the gameplay as uninteresting despite the fact that both versions had the same components, with the exception of the modification of the visual design quality. In fact, when a design principle is violated (e.g. use of poor contrast and low bit graphics), it hinders participants in identifying objects distinctly from their backgrounds (Graham, 2008). In addition, since emotion forms part of the decision-making process, it also impacts judgment. Visual working memory can influence an experience from an interaction as well as judgment (Kalamala, Sadowska, Ordziniac, & Chuderski, 2017) and emotions (Sutcliffe, 2014).

It is recommended that designers should focus on devising game mechanics that will captivate the interest of the player if the strength of the visual interface is not the principal design component. Designers should be aware that if a user is able to connect with the game narrative, then the other component such as game mechanics help in accentuating gameplay. It is clear that game mechanics played a prominent role when the other characteristic such as game visual elements appeared to be subdued in this game condition. The game mechanics compensated for the low visual design interface and surprisingly resulted in moderate pleasure and mild arousal during game play (figures 7a and 7b).

To summarize the new contribution of research objective #2, it is deduced that attractive user interfaces can capture and sustain user attention thereby creating sensory game immersion. Game story forms an important component in an Easy Fun Key game, along with high visual design quality graphics which can create the emotional-connect between the user and gameplay. Monochromatic color rendition of 25% saturation level and below can impede perceived game playability. It has been found that game mechanics can counterweigh the low visual design interface quality.

7.3.3 Research Objective #3

The third research objective examines the impact of the levels of visual design quality (low and high) of two types of tablet game interfaces on the perception of hedonic quality.

The result supports hypothesis **H4** as visual design quality of game user interfaces significantly influence hedonic quality (figure 7.2), in line with the findings of Van Schaik, Hassenzahl, and Ling (2012). The results of the regression analysis (section 6.2.6.2) of this study reveal that both high and low levels of visual design qualities have a moderate, positive, and significant effect on the perception of hedonic quality. Both game types designed for this study were perceived to have hedonistic pursuits rather than utilitarian values. This is substantiated by Hirschman and Holbrook's (1982) description of hedonic consumption designated to elicit fun, fantasy, and emotional experience with product interaction. The quantitative results of this study empirically confirm that higher degrees of visual design quality of game user interfaces are associated with superior levels of perceived hedonic quality.

The qualitative data complement the quantitative findings. In the high quality (HQ) versions, participants found that the colorful palette (analogous color scheme) and crisp graphics were pleasing to the eyes and more fun to interact with. There was mention of game satisfaction and engagement in the HQ that prompted participants to continue playing the games on the tablet. Moreover, user-interaction styles play an important part in evoking hedonism (see Lee et al., 2015). For instance, gestures such as *swiping, tapping, tilting, and double tapping* for the touch screen devised in each game level provided a basis for the inclusion of the hedonic attributes in the game interface for user control and navigation.

The different types of user interaction (touch gestures) integrated in each game level increased their perceived sense of *autonomy* and *competence* (Valenzuela, Codina, & Pestana, 2018). The feeling of *autonomy* and *competence* is associated with a higher level of pleasure (positive valence) and arousal in high visual design user interfaces. The findings reveal a new way of understanding how hedonic features (e.g. implementing a variety of user interactivity using touch gestures) may inform perceived usability to promote clear navigation, better user control and freedom in user interfaces, which are prominent usability features in digital games.

The action of visceral emotional responses impacted by product appearance have been explained before (Creusen and Snelders, 2002) yet, this thesis clearly explicates that visual elements of game interfaces elicit emotional responses, mediated by the perception of hedonic quality.

Prior studies only indicated a direct relationship between visual design and the perception of hedonic quality (e.g. Monk & Hassenzahl, 2010; van Schaik, Hassenzahl, & Ling, 2012), whereas the new contribution in this study sheds light on the relationship between the *levels (low and high)* of visual design quality and the perception of hedonic quality, which also acts as a mediator between perceived visual design and visceral emotional responses. Participants derived a higher level of hedonism from the high visual design interfaces in both game types as empirically demonstrated by the descriptive statistics in Table 6.9.

7.3.4 Research Objective #4

The fourth research objective examines if a player's characteristics, in this case, the degree of affinity for visual design (referred as CVPA) in user interfaces has an effect on game enjoyment. In other words, the research objective was to analyze how individuals with low and high CVPA impacted user behavior. The findings show that hypothesis **H5** was not supported by the study as participants' sensitivity to visual design in user interfaces was not a predictor of game enjoyment. This also implies that participants with a high CVPA level (i.e. those who were more sensitive to visual design quality in user interfaces) did not necessarily derive a higher level of game enjoyment. There is a distinction between hedonic quality and enjoyment. Hedonic quality is associated with positive valence or pleasure derived during product use (Hassenzahl and Monk, 2010); the concept of game enjoyment is adapted from the flow theory which incorporates elements of challenge, player skills, control, concentration, clear goals and immersion (Sweetser et al., 2017) and motivation (Vorderer and Ritterfeld, 2009).

The findings of this hypothesis reveal that the dependent variable game enjoyment was non-significant for the *low CVPA* group in either game condition, and the correlation was non-significant between *high CVPA* and *game enjoyment* in the low visual design condition. This implies that low CVPA individuals are indifferent to visual design in products as no correlation was found. Surprisingly there was a negative association between high CVPA participants and game enjoyment (high visual design condition).

High CVPA participants had a statistically non-significant and moderate strength but with a negative correlation on *game enjoyment* in the high visual design game user interface. This negative correlation infers that participants who were more sensitive to visual design quality in products might have derived less enjoyment in the high visual design tablet game condition. Since the correlation was not statistically significant, this implied that there was no relationship between the high CVPA group and enjoyment. The results asserted that the high CVPA group did not necessarily derive a relatively higher level of enjoyment as compared to the low CVPA group, as expected. Therefore, it is affirmed that individual characteristic (CVPA) cannot anticipate intrinsic behaviors of participants since other motivational factors such as *challenge, skills, immersion, clear goals* and *concentration* are appropriate predictors.

7.3.5 Research Objective #5

The fifth research objective was to compare the game enjoyment level derived by participants from the four *channels of experience,* namely *flow* (N=31)*, apathy* (N=93)*, arousal* (N=76) *and boredom* (N=9). Hypothesis **H6** confirmed that players who experienced flow during gameplay derived the highest level of game enjoyment, followed by the arousal channel.

Adapted from motivational theory, the concept of enjoyment is defined as the outcome of intrinsic needs accomplishment (Tamborini et al., 2011; Tamborini, Bowman, Eden, Grizzard, and Organ, 2010; Vorderer and Ritterfeld, 2009), similar to *eudaimonic enjoyment,* a form of enjoyment derived by participants from meaningful game experiences pertinent to the players (De Schutter and Brown, 2016).

The degree of enjoyment obtained in the high visual design condition was slightly higher than enjoyment in the low visual design, though enjoyment was statistically non-significant in both game conditions. The main effect on Channels of Experience F (3, 193) = 17.165, $p<0.05$' indicated that game enjoyment level was significantly different in all four channels of experience categories. The mean enjoyment is reported as follows: *flow* (3.111 ±0.069), *arousal* (2.795±0.038), *boredom* (2.708±0.105) and *apathy* (2.583±0.035).

The level of flow experienced by participants in the high visual design condition (μflow=3.0561±0.161) was greater than the level of flow (μflow=3.039±0.365) in the low visual design condition in the Hard-Fun key. However, it was surprising to note that the level of flow experienced by a few participants in the high visual design condition (μflow=2.9732±0.1953) was inferior as compared to the level of flow (μflow=3.250±0.1415) in the low visual design condition in the Easy-Fun key. This may be explained by carry-over effects from one game condition to another. After playing the high visual design game condition, the same experience was translated into the low visual design quality game.

The analysis from the qualitative dataset provided another explanation why a few participants in the low visual design condition with a monochromatic color scheme might have experienced *flow*. Participants made mental connections between the red planet

Mars and the monochromatic visual elements of the low visual design quality Easy-Fun Key through a cognitive conceptual map. They were interested in the game as the depiction of the monochromatic visual elements and interface design closely resembled the atmospheric environment of the red planet, which helped them make those associations quicker. Admittedly, in a content analysis, Wang, Shen, and Ritterfeld (2009) confirmed that factors such as *realness, novelty, gratification,* and *characters* were geared towards the notion of fun in gaming. Moreover, through the lens of intrinsic motivational theory, game *autonomy*, *connectedness*, and *competence* could empirically predict game enjoyment (Ryan, Rigby, and Przybylski, 2006).

Furthermore, the qualitative dataset revealed that for a few participants the Hard-Fun Key game with high visual design condition had clear goals, which increased the game involvement level. They had a more gratifying and rewarding experience interacting with the high visual quality game interface. A high degree of game enjoyment along with the ability to focus on the game activity can give rise to the *flow* state, which is defined as a balance between skill levels and challenges that produces an optimal experience (Csikszentmihalyi, 1990; Engeser and Rheinberg 2008; Nah et al., 2010). Similarly, it is inferred that in a state of flow, game enjoyment level is at its apex.

To summarize, besides the *flow* channel, it was found that the *arousal* channel had the potential to immerse and engage game participants. It is therefore deduced that designers and researchers should design game artifacts to transport players into the channels of flow and arousal, for participants to experience game control, excitement, attention, and relaxation in addition to a heightened level of game enjoyment. This can be achieved through metaphorical elements, use of 2.5D graphics in 2D tablet games, and creative narrative for game players to symbolically make the necessary emotional connect. It is worth noting that both cognitive and emotional behaviors are used in the evaluation of game enjoyment.

7.4 Assessment of the Player Experience (PX) Design Model

The major contribution of this thesis is the development of the PX Design model which is validated by an empirical assessment of the hypotheses discussed above and substantiated by a *Confirmatory Factor Analysis* (CFA). The following section provides a theoretical explication of PX Design model (figure 7.2).

The model illustrates that visual design quality in tablet game interfaces has an influence the following components: perception of hedonic quality, perception of usability, visceral emotion, player experience (reflective level) and game enjoyment. First, the path from Visual Design Quality (AT) to Perception of Usability shows that high visual design quality game interfaces have a significant influence on perceived game usability, which is defined as the "degree to which a player is able to learn, control, and understand a game" (Pinelle, Wong, & Stach, 2008). This implies that high visual design quality game interfaces were perceived as easy to use, learn, control and understand by the participants. Also known as the design-usability effect (Norman, 2004; Moran, 2017), this concept aligns with the notion of "what is beautiful is usable" (Kurosu & Kashimura, 1995; Tractinsky et al., 2000; Ben-Bassat, Meyer, & Tractinsky, 2006; Sonderegger & Sauer, 2010; Lee & Koubek, 2010). From a practical point of view, this concept explains that attractive products are perceived to be more usable by end-users. Sophisticated graphics in game user interfaces contribute to game usability.

On the other hand, the CFA conducted on the low visual design datasets support the fact that game interfaces with low designs quality were not perceived to be usable, since there was no path from AT (visual design) to PQ (perceived usability). The rendition of low-bits graphics, low monochromatic color contrast, and saturation of the low visual design interface quality might have obstructed playability and hence the game were perceived non-usable. More visual efforts are required by participants to utilize interfaces with low visual design quality, as demonstrated in Salimun's (2013) eye-tracking study.

Furthermore, the results of the CFA in figure 7.2 reveal that the new addition of the theoretical path from perception of usability (PQ) to game enjoyment (GEQ) infers game enjoyment can sustain perceived game usability. In other words, a game is enjoyable to play if the interface is easy to use. This theory can be substantiated by studies in the Technological Acceptance Model (Sun & Zhang, 2006; Igbaria, Zinatelli, Cragg, & Cavaye, 1996) and Motivational Model (Davis, Bagozzi, & Warshaw, 1992; van der Heijden, 2004) deducing the causal direction from perceived ease of use to enjoyment.

Moreover, figure 7.2 shows a direct path from Visual Design Quality (AT) to Perception of Hedonic Quality (HQ), which indicates that both low and high AT have an influence on HQ. There is no direct path from AT to Visceral Emotion. This study demonstrates that Visceral Emotional response is mediated by HQ as substantiated by the fluency theory (Reber, Schwarz, & Winkielman, 2004). This finding provides evidence that hedonic quality, and not inferences from perceived usability, influences Visceral Emotion. Furthermore, mood (not shown in figure 7.2) was a confounding variable that had a significant but detectable influence on both arousal and valence. It should be noted that several studies have expounded on how individuals play games to alter their moods, thereby enriching their emotional states (Russoniello, O'Brien, & Parks, 2009; Ryan, Rigby, & Przybylski, 2006).

Moreover, the model reveals a path from emotion (valence and arousal) to player experience (PX). This indicates that games elicit a wide range of emotional responses that can influence player experience, which is in line with Fernandez's (2008) gameplay experience model indicating fun is a principal component of player experience, as it forms part of an individual's cognitive and emotional responses.

The model predicts that adding a path from *perceived usability* (ease of use and learnability) to *game enjoyment* (LM STAT 68.63, $p < 0.0001$) will improve the model chi-square fit. Evidently, a contributing factor to perceived game enjoyment as explicated by Merikivi et al. (2017) is the *playability* attribute and ease of use.

There are two approaches to study the theoretical PX Design model. Primarily, there is a cyclic effect of the three emotional design levels (visceral, behavioral, and reflective) giving rise to game enjoyment, as illustrated by the paths in figure 7.2. The degree of enjoyment experienced is based on goal accomplishment or failure, influenced by player experience. The player in turn transits into one of the channels of experience – flow, arousal, apathy or boredom. This sequence repeats itself until the game is over.

The theoretical PX Design model can be studied further from a different perspective by following the path from perceived usability (PQ) to game enjoyment (GEQ), which in turn feeds into the channels of experience (BX), in line with the Technology Acceptance Model (Davis, 1989; Sun & Zhang, 2006).

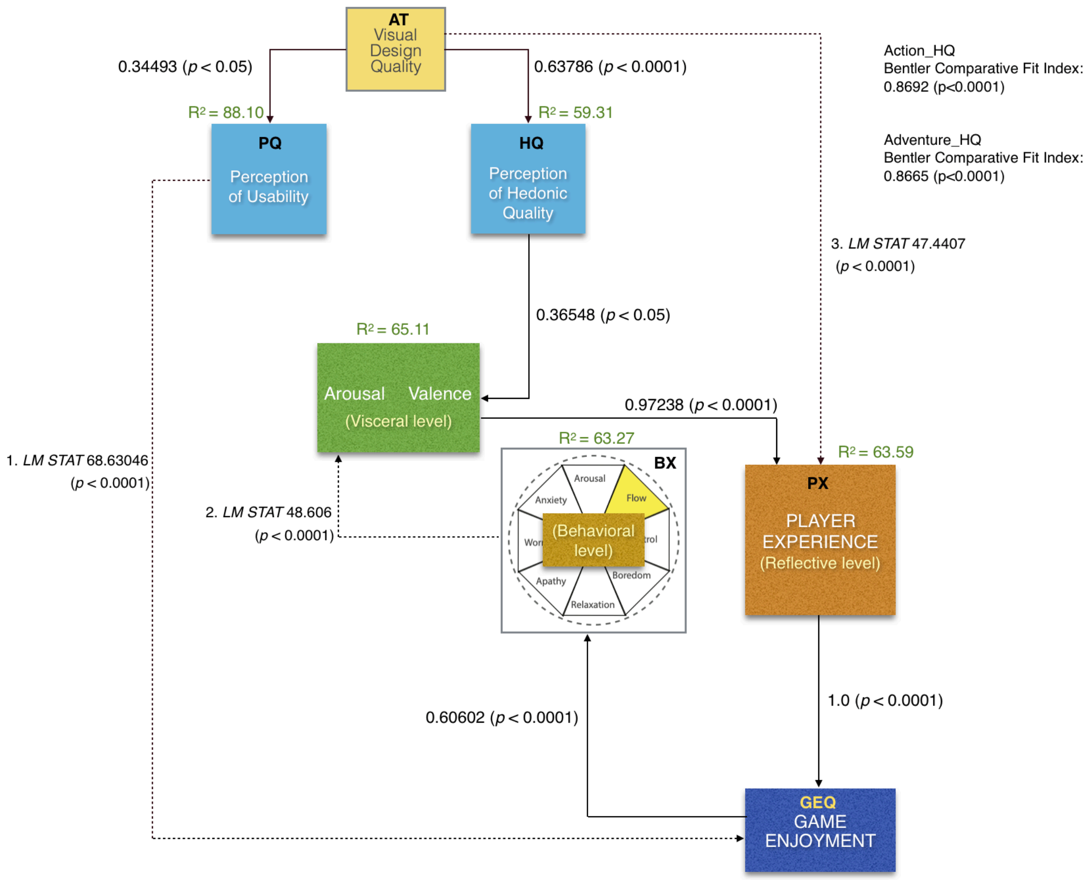

Figure 7.2 Theoretical Player Experience (PX) Design Model

7.5 Chapter Summary

The 2.5D graphics style rendering in the high visual quality played a prominent role in capturing participants' attention in the gameplay. Sophisticated graphics from the attractive interfaces were perceived to be highly usable and evoked a heightened level of arousal whereas low visual design game user interfaces did not correlate with perceived usability. Besides high-quality visual elements, game narrative is an important component in an Easy Fun Key due to its exploratory nature. In a Hard-Fun Key game, the game mechanics are given more consideration, perhaps because of the rapid judgments that are necessitated during gameplay.

It has been empirically shown that visceral emotion elicitations of visual design elements are mediated by hedonic quality as there is no direct path from visual design to hedonic quality. This explains that individuals made use of hedonic responses as a shortcut to appraise the visual design quality of the game user interface. The visual design quality of game user interfaces is conveyed to players through hedonic game attributes to experience the game aesthetics through the unconscious behavioral level during game play.

This study also found that game usability properties was a predictor of game enjoyment rather than personality traits such as CVPA. As anticipated, participants who transited into the flow channel derived the highest level of enjoyment. It was also observed that participants experienced a heightened level of engagement in the arousal channel.

In addition, the PX Design model shows a re-contextualization of the emotional design theory (Norman, 2004) in the domain of tablet games, such that the reflective level is representative of both positive and negative player experience, the behavioral level represents the channels of experience, and the visceral level signifies *valence* and *arousal*, the two dimensions of emotion.

Designers and researchers cannot rely on personality traits such as individual affinity to visual design in products to gauge perceived enjoyment. Game enjoyment may be associated with other individual characteristics, such as skills, preferences, and the context of play (Wang, Shen, & Ritterfeld, 2009) which form part of the physiological, emotional and cognitive dimensions, as explained by Vorderer, Klimmt, and Ritterfeld (2004).

Chapter 8

CONCLUSION

8.1 Introduction

This final chapter begins with a summary of the research outcomes in relation to set aims and objectives. It discusses the main findings of the study in relation to the game design process, hypotheses testing, and qualitative analyses. It highlights the theoretical and practical implications of the research. It also recommends possible directions for future research.

8.2 Summary of Research Aims

The purpose of this thesis was to develop a *conceptual framework for player experience design* (figure 3.2) in order to explore research questions and test hypotheses. The research study involved designing and developing two types of tablet games followed by an empirical evaluation of the research questions for validating the *conceptual model for player experience design* (figure 7.2). The research game artifacts were used as stimuli in an experimental design to evaluate the components of the *conceptual model for player experience design*. The aim of this design-oriented research study was to evaluate the varying effects of visual design quality in game user interfaces on different components of the *conceptual model for player experience design*. The tablet games were designed from a user-centered perspective by employing mind-mapping, focus groups and participatory design methods, as described in Chapter 5.

8.3 Research Findings

The main areas of contribution to knowledge of this research were the (i) application of a design-oriented research methodology to design, develop and evaluate two types of tablet games and (ii) development and empirical validation of the *conceptual model for player experience design* (figure 7.2) to test the six hypotheses. The study also adopted a mixed methods research within a design-oriented research methodology to test a series of hypotheses developed from the framework.

The design-oriented research methodology proved to be a successful and effective approach for collecting and analyzing qualitative and quantitative data. It helped incorporate the practitioner's reflection-in-action along with the user centered principles and techniques into the design process. Practice was seamlessly integrated with scientific inquiry. In addition, the design-oriented research approach facilitated the implementation of both quantitative and qualitative methods in the second phase of the research. The experimental design for hypothesis testing consisted a simple randomized design to yield robust results. The design-oriented research may prove to be an effective tool for design practitioners and game researchers as it can be used to generate new theories and expand the model by integrating practice with other relevant research methods.

The research findings from the research undertaken to answer those questions are as follows: Hypothesis **H1** was supported by the study as it provides empirical evidence in the domain of interactive gaming that high visual design quality user interfaces were perceived to be usable. The main contribution to knowledge is that high-level visual design quality of game user interfaces empowers user design engagement as sophisticated graphics appeal to the senses. However, it was found that user interfaces with low visual design quality were perceived to negatively impact perceived usability. The games with low visual design quality as the monochromatic color scheme did not sustain their interests.

Hypothesis **H2** was confirmed by the study, in that participants experienced a relatively higher level of arousal in the high visual design quality interface. The visceral aspects of the interface elements are governed by Design Principles such as symmetry, balance, color contrast, and texture which facilitated game focus of the game mechanics by captivating player attention.

Hypothesis **H3** was also supported by this study as participants experienced a mild valence during experiential encounter with the high visual design quality game user interface that induced sensory qualities and game immersion. The implication that expands current knowledge is that affective states are found to be mediated by perceived hedonic quality (figure 7.2) during a visual design appraisal. This can be explained by Reber et al.'s (2004) fluency theory which predicts appraisal of the visual design quality of a product result in hedonic responses as a shortcut for the judgment of beauty. Additionally, a creative game story in an Easy Fun Key game type helps create an emotional connect between the player and the game.

Furthermore, the study supports hypothesis **H4** confirming that both levels (low and high) of visual design quality in game user interfaces have the propensity to prompt hedonism from research participants. The higher visual design quality is shown to elicit higher level of perceived hedonism. A variety of user interaction touch gestures in each game level played a key part in eliciting hedonism. The new contribution to knowledge is that this finding provides a novel way to understand how hedonic cues can inform perceived game usability by promoting clear goals and user control.

The study does not support hypothesis **H5** as it was revealed that participants with high affinity to visual design (high CVPA level) did not necessarily derive higher level of game enjoyment than the low CVPA counterparts. No significant correlation was found between CVPA levels and visual design. Therefore, it is deduced that CVPA cannot be used to envisage game enjoyment while motivational characteristics are considered more important assets in assessing enjoyment.

Hypothesis **H6** was sustained by the study confirming that game participants who experienced flow derived the highest level of game enjoyment as compared to those who transited into the other channels of experience such as arousal, boredom and apathy. The new contribution to knowledge is that arousal channel should not be overlooked since participants who experienced arousal were deeply engaged during gameplay. This implies that game design should include hedonic features capable of invoking player arousal.

8.4 Theoretical and Practical Significance of the PX Model

The design-oriented research approach combines the practitioner's creative and professional practice along with a series of research techniques and methods, followed by empirical evaluation of the game artifacts. It also incorporates theories from multidisciplinary disciplines such as human computer interaction, game theories, aesthetics, emotional design and motivations. The creation of interactive games was based partially on self-reflections and iterative design and development, including usability testing and refinement. The *design-oriented research* methodology allowed for the game prototypes modification into two visual design quality conditions to be used as stimuli in the second phase of the research, with the adaptation of mixed methods research.

It is argued that practice may get self-centered and subjective if only evaluated through a series of self-reflections; hence, additional rigorous qualitative methods such as observations, mind-mapping, and focus groups were necessary to provide a solid basis and justification for the practice. The *design-oriented research* approach is unique in this context. It would not have been possible to create the tablet game artefacts using a combination of the practitioner's self-reflection and user centered design principles, focus groups, hypotheses testing, implementation of a semi-structured questionnaire using a single method. It does not necessarily follow a sequential path from conception, execution and to final deliverable. The *design-oriented research* is a practical methodology as the design methods can be approached with certain level of flexibility to solve a given research problem. In the domain of game design, the evolutionary prototyping proved to be an effective and efficient principle within the *design-oriented research* methodology. The *conceptual framework for player experience design* required to be empirically evaluated using quantitative methods and validated for its external validity using *Confirmatory Factor Analysis*. The framework showed signs of a model-fit, though in its exploratory stage. Consequently, the robust solution was to implement mixed methods research methodology in this research with the application of the design-oriented research approach to respond to the research objectives. The qualitative methods applied though the open-ended questionnaire provided rich data to substantiate the quantitative data in the second phase. The qualitative method such as focus groups worked in unison with game creation process and the user centered design principles. The robust theoretical knowledge generated using the *design-oriented research* methodology can be applied with high confidence in future studies.

The new *conceptual model for player experience design* (figure 7.2) may serve as a useful tool for researchers to utilize and further develop in game research; the *design-oriented research* approach provides a new methodology for practitioners to utilize with certain level of flexibility. The *conceptual model for player experience design* can explain effect of visual design and usability features on the visceral, behavioral and reflective level, perceived hedonic quality and game enjoyment, which is meaningful to game practitioners and researchers. Norman's (2004) three levels of emotional processing namely *visceral, behavioral* and *reflective* level have been integrated into the framework and mapped as *arousal/valence*, *channels of experience*, and *player experience* respectively.

This study has shown that higher visual design quality of the game user interface is a key element in facilitating the visibility of the feature sets and functionality.

8.5 Limitations of the study

First, the sample recruited for this study was not selected using the probability sampling technique for both the quantitative and qualitative methods. While it is understood that a representative cross-section of the population would have yielded informative results, it would have been very challenging to recruit over 100 participants randomly due to resources constraints. The southeastern geographical location in the USA where this study was conducted, with the demographics of 18–35 years old, and recruitment on a university campus may not be totally representative to the actual population of tablet game players. However, in order to increase the internal reliability and hence the robustness the results, participants were assigned randomly to each game condition. Therefore, the findings of the research were considered reliable and were concluded to be generalizable on the age segment of the game player population through tests conducted on the dataset.

The other challenge of this thesis is that the scope was broad and ambitious given that six dependent variables were examined. The duration of the experimental study for data collection was quite lengthy; filling multiple self-report questionnaires for each game condition might have led to participant fatigue and lack of interest in the data gathering process. Thus, there is a risk that the interface conditions might not have been appraised with accuracy. Furthermore, evaluation of emotional responses was restricted to a single subjective method of self-report instrument measuring valence and arousal. An objective method such as a physiological technique (e.g. electro-dermal activity) would have been useful in triangulating the results. This is because it is not possible to ascertain whether the emotional responses that are self-reported by the individuals were precisely how they felt during the activity (Peterson et al., 2015), as they were required to reflect back on their brief moment of experience. Another limitation is that the researcher was the only observer during the user testing sessions, so pertinent information might have gone unnoticed. It would have been beneficial to include additional stakeholders (e.g. game artists and developers) along with game designers during game session observations.

If the tablet games were to be redesigned using the design-oriented research approach, it would have been practical to conduct user testing of the game prototypes in the earlier alpha stage with different groups. During the first phase of the game creation process, the same group of participants were used in the user testing and trouble-shooting procedures repeatedly, which could have led to a faster saturation point of data collected. In addition, as the same participants took the usability test multiple times, this could have led to fatigue or exhaustion. By utilizing different groups of participants during the game life cycle and production, it is envisaged that the percentage of usability error detection would have been increased.

It would have been useful to troubleshoot the programming bugs during the iterative design and development process. While keeping the theme consistent for the player to experience novelty each time it is played, it would have captivated more interests to include multiple twists in the story lines. Narrative is the backbone in an interactive game, in particular the Easy Fun Key. Employing a variety of short plots within the story would have accentuated the level of hedonism in a game with high visual design quality. The game could have been re-designed so that every plot has actions that would prompt and elicit a variety of emotions. The adaptive interface should not be overlooked as it ties the participant's skills to the level of game challenges to keep one involved and engaged during the entire game activity.

In addition, other approaches such as practice-based research would have posed a limitation as the tablet game artefacts could not be created by the practitioner's reflection alone. It demanded a rigorous procedure of adopting user centered design principles and qualitative methods in the practice phase to minimize the level of subjectivity during the creation process.

8.6 Recommendations

This study has introduced the design-oriented research methodology in the domain of tablet game design that combines creative practice, qualitative, and quantitative methods (scientific inquiry) seamlessly. The aim of this section is to provide insights for design practitioners and developers to adopt an effective method to design and evaluate touch screen game user interfaces:

- In the industry, a typical game development cycle takes approximately 20–24 months; similar timeframe was expended in the game design and development of the tablet games applications in this study. Based on this study's findings, it is recommended that player experience evaluations be conducted at different intervals during the game development cycle for the designer and developer to have enough time to collaboratively enhance or modify major game mechanics and design.

- Design practitioners must make wise selection of game user interface color schemes (e.g. triadic, analogous, tetradic) to embrace aspects of universal usability. Though game accessibility does not fall within the realm of this study, it is important to consider individuals with visual impairments (e.g. color blind) by using textures for optimal contrast and adapting safer color combinations, for example, by avoiding red and green or green and blue hues. However, since visual elements rendered using a monochromatic color scheme may be devoid of focal areas and definition, its application must be carefully considered in touch screen game user interfaces.

- Inherent to the designer, artistic styles conveyed in game user interfaces are unique forms of visual expression that play a crucial part in captivating users' attention and interest. In this study, the rendition of 2.5D graphics style accentuated the illusion of visual volume for game assets to stand out from their background. It is also recommended to conduct user-testing using iterative medium to high fidelity prototypes to evaluate the perceived visual design or artistic quality to ensure the design enthralls the user.

- The results of this study support the idea that suitable graphics alone does not lead to engaging gameplay. A combination of a creative (compelling) game story, consisting of a combination of game user interaction along with a congruent artistic style, make gameplay experience pleasurable, exciting, and memorable. In other words, the perceived hedonic quality is necessary to consolidate gaming experience.

- Players seek to identify symbolic meanings of the game visual elements including the narrative that they can relate to at the reflective level in order to make an emotional connect, which impulses them to return to play.

- By virtue of their enhanced qualitative diversity (see Cupchik, 1994), highly sophisticated graphics built in the games give rise to relevant perceived hedonic quality by influencing emotional experiences. It is recommended to devise game user interfaces by considering eye balance, color contrast, harmony, unity, and proportionality because visual elements influence both hedonic quality and affective states of players. Hierarchy of visual elements help maintain eyeflow within the dynamic interface design, while assisting in-game focus.

- Post-game play experiences should create a long-lasting impact on players, similar to the cinema or theatre. Fun aspect is usually associated with positive emotions; developers and designers should not hesitate to integrate a minimal dose of negative emotions in games to balance the intense and immersive moments. In conjunction with both positive and negative emotions (valence), positive arousal channel is germane to game engagement.

- Designers should ensure game events trigger emotions as illustrated in the first or second quadrant of Russell's Circumplex model (figure 6.5) whereas emotion elicitations can be avoided through premeditated user-testing in the third and fourth quadrants. Moreover, the goal is for designers to create unique emotional responses for every individual to experience in different game events or scenarios.

- While depicting the tablet games in this study using the *reflect-in-action* method, the outcomes branched out into multiple design solutions. Different knowledge nodes surfaced, which took alternative routes to reach the desired goals. Iterative design process of the game artefact proved to be beneficial as it yielded into a functional, creative, and novel design solution that served its purpose.

- Mixed methods research fit the design-oriented methodology that supported the research design. The analyses of qualitative datasets complemented and supplemented quantitative data by providing the researcher with a deeper understanding about the implications of the findings.

8.7 Future Work

In future work, the *conceptual model for player experience design* can be tested and developed using other interactive gaming medium (e.g. smartphones with different screen sizes) or by examining different game genres (e.g. augmented reality or 3D games). A natural progression of this work is to further examine the model by exploring the role of the three emotional design levels distinctly: *visceral*, *behavioral* and *reflective*, as they apply to sub-components of player experience such as presence, involvement, and cognitive.

Furthermore, the emotional responses did not emanate solely from the design quality of the game visual interfaces as initially hypothesized in this thesis. The emotions elicited could have been mixed from external ongoing factors such as player experience derived during gameplay. Researchers can devise methods to measure emotions distinctly from the visual user interfaces, independent from the dynamics of gameplay.

Objective methods of measurement such as facial tracking technology can be implemented to gain deeper understanding of emotional reactions of game participants' gestures as emotions are volatile phenomena. Further research may also explore the development of an application that can be integrated within the game apps to detect strokes of touch-screen gestures for accurate measurement of different levels of arousal and valence. This will enable game developers to devise a wide range of game experiences. Subsequently, conducting the research in different geographical locations, or cultural set up with similar or different age groups to obtain deeper insights of environmental and cultural factors on human behaviors would be essential. The emotional component (valence and arousal) plays a key role as it senses perceptions of usability, visual design and hedonic quality in the product for the participant to experience game enjoyment. Hence, the PX design model can guide design practitioners and researchers to design and evaluate user centric game interfaces using the design-oriented approach, which may in turn help increase the Return of Investment from a business perspective.

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APPENDICES

Appendix 4.1

Participant Info Sheet

The effect of visual aesthetics on player experience in tablet games

Participant Information Sheet

Dear Participant,

I would like to ask you to participate in the data collection for a study on *Player Experience,* which is an integral part of my doctoral study at De Montfort University, Leicester, United Kingdom.

I hope better to understand the components of player experience in tablet gaming through the following research questions:

- To investigate if visual aesthetic quality of game interfaces affect perception of usability.
- To examine the impact of visual aesthetics on emotional reactions of users.
- To examine the relationship between visual aesthetics quality of game interfaces and perceived hedonic quality.
- To investigate if positive player experience leads to a higher degree of game enjoyment.

Participation in this study is entirely voluntary. First, you will complete a preliminary survey. Second, you will take part in an experiment involving two tablet games and will complete two surveys during the experiment. Following the experiment, you will complete six structured questionnaires and one semi-structured questionnaire. It will take approximately 50-60 minutes to complete the whole experiment and surveys.

You may decide not to answer any of the questions in the questionnaires if you wish. You may also decide to withdraw from this study at any time by advising the researcher or by emailing ukokil@kennesaw.edu or using the contact detail at the end of this document. If you notify us of your withdrawal, all identifiable data will be destroyed. Any data that is obtained in connection with this study and that can be identified with you will remain confidential. The information gained by participating in this study will only be used for the above objectives.

I may ask for clarification of issues raised in the semi-structured questionnaire some time after it has taken place, but you will not be obliged in any way to clarify or participate further. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study or would like additional information please ask the researcher before, during, or after the experiment.

Yours Sincerely,

Uttam Kokil

De Montfort University, The Gateway, Leicester, LE1 9BH, UNITED KINGDOM

Tel.: 470-578-7203 E-mail:uttam.kokil@email.dmu.ac.uk

Appendix 4.2
Participant Consent Form

DE MONTFORT UNIVERSITY LEICESTER

The effect of visual aesthetics on player experience in tablet games

Consent form

Issue	**Respondent's initial**
I have read the information presented in the information letter about the study "The effect of visual aesthetics on player experience in tablet games"	
I have had the opportunity to ask any questions related to this study, and received satisfactory answers to my questions, and any additional details I wanted.	
I am also aware that excerpts from the interview may be included in publications to come from this research. Quotations will be kept anonymous.	
I also understand that I will be observed during the experiment.	
I understand that the researcher and his thesis advisors may look at relevant sections of the data collected during the study. I give permission for these individuals to have access to my responses.	

With full knowledge of all foregoing, I agree to participate in this study.

I agree to being contacted again by the researchers if my responses give rise to interesting findings or cross-references.

☐ no

☐ yes

if yes, my preferred method of being contacted is:

☐ telephone ……………………………………………………..

☐ email ………………………………………………………….

☐ other …………………………………………………………..

Participant Name:		Consent taken by	
Participant Signature:		Signature	
Date		Date	

Appendix 4.3

Research Ethics Approval (De Montfort University)

DE MONTFORT UNIVERSITY LEICESTER

14 April 2016

Mr Uttam Kokil
Leicester Media School
Faculty of Technology

Dear Uttam

Research Ethics Application Approval: 1516/341 - The effects of visual aesthetic quality on player experience in tablet games

Your application to gain ethical approval for research degree activities has been considered and approved by Prof Mark Lemon.

Please be aware that changes to the project plan or unforeseen circumstances may raise ethical issues. If this is the case it is the researcher's duty to repeat the ethics approval process.

I will prepare a letter for you and let you know when it is ready for collection.

Kind regards

Anne Smith

Anne Smith
Research & Innovation Coordinator

Faculty of Technology, The Gateway, Leicester, LE1 9BH, UK **Tel** 00 44 (0)116 250 6519 **Fax** 00 44 (0)116 207 8159

For official use

Tracking No:
Date approved:
Initials:

Faculty of Technology Application to Gain Ethical Approval for Research Degree Activities

All Research Degree Projects require ethical approval. Research Students in the Faculty of Technology should complete this form to gain Internal Human Research Ethical Approval in consultation with their supervisors and submit it to the Faculty Assessor with their 'Application to Register for a Research Degree form (RDC:R).

NOTE: If your research involves using human tissue or fluid samples or animals please DO NOT use this application form. You should seek guidance from the Chair of the Faculty Human Research Ethics Committee before starting the project.

1. Applicant			
Surname	KOKIL	First Name	UTTAM
DMU Email Address	uttam.kokil@email.dmu.ac.uk	Student ID Number	P12049825
Working Title of the Proposed Investigation *(Acronyms must not be used)*		The effects of visual aesthetic quality on player experience in tablet games	

If you answer any of the following questions with 'Yes', then specific ethical issues WILL be raised that MUST be addressed. You will need to explain in detail in section 3 how you will address these ethical issues.

Has your research proposal identified any of the following research procedures?

Gathering information from or/and about human beings through: Interviewing, Surveying, Questionnaires, Observation of human behaviour **Yes / No**
Using archived data in which individuals are identifiable **Yes / No**
Researching into illegal activities, activities at the margins of the law **Yes / No**
Researching into activities that have a risk of personal injury **Yes / No**
Supporting innovation that might impact on human behaviour e.g. Behavioural Studies **Yes / No**
Researching topics that are concerned with the following **'sensitive research'** areas: **Yes / Not Applicable**
access to web sites normally prohibited on university servers,
or extremism and radicalisation*
* To identify if a research project should be classified as sensitive research please complete the questions on this appendix form before continuing to complete the main sections. If you have printed this form, please include hard copies of the sensitive research questions if they are applicable to your research (For more information see: http://www.dmu.ac.uk/research/ethics-and-governance/sensitive-research.aspx).

Are there other additional factors that could/will give rise to ethical concerns e.g. communication difficulties?
No

2. Ethical Issues identified (State explicitly if no ethical issues are identified)

- Details of the arrangements for participation in the research by human subjects (including how participants will be recruited, confidentiality procedures, copies of consent forms, any questionnaires that will be used and other documentation as appropriate)
- A copy of all the documentation provided to the volunteer to ensure the clarity of information provided
- Copies of appropriate other ethical committee permissions (internal or external) or supporting documentation
- Other documentation as advised necessary by Supervisory team

Please note, if the methodology is unclear at the time of submission, you can submit and resubmit more specific forms once the methodology is clear.

3. How these issues will be addressed:
Ethical issues will be addressed by the following means – 1. Data collection process – following approval of my research instrumentation by the DMU Ethics Committee, permission will be sought from the Kennesaw State University institutional review board to conduct my study with students from across the university. I am an employee at Kennesaw State University and this is a required process before I may undertake my data collection. I am also required to take the CITI (Collaborative Institutional Training Initiative) online Training Certification Program before IRB office provides me with IRB approval. The CITI info is available here http://research.kennesaw.edu/irb/citi-training.php 2. Identity will be anonymized on instrumentation and its subsequent entry into analytical software. 3. Data will be password protected on my computer and any printed materials will be kept in a locked cabinet at all times

- *Note: You should consider the following:*
- *Providing participants with full details of the objectives of the research*
- *Providing information appropriate for those whose first language is not English*
- *Voluntary participation with informed consent*
- *Written description of involvement`*
- *Freedom to withdraw*
- *Keeping appropriate records*
- *Signed acknowledgement and understanding by participants*
- *Relevant codes of conduct/guidelines*

Three areas are identified :

(i) Data collection process – use of students at Kennesaw State University, Georgia, USA, for observation and completion of the research using a game that has been designed for this study, along with an experiment and survey instruments

(ii) Data protection – identity of individuals participating in the study

(iii) Data management – safeguarding of materials collected for the study

Process of Data collection:

I plan to recruit 100 students (aged between 18-35 years) across Kennesaw State University using flyers and by word of mouth for my sample. The duration of the data collection will be kept open for approximately 1 month as from April 15, 2016 to obtain the required number of participation.

The completion of the study will take place in a classroom on campus at Kennesaw State University. On arrival, students will be handed the consent form for completion. Thereafter they will be screened to assess levels of gameplay expertise (intermediate to expert) prior to participation. Novice game players will be excluded from further participation. Those continuing to the next phase will be handed a participation letter and instructed on the procedure for participation. Students will first be required to complete a preliminary instruction which assesses their current mood state. They will then be given an iPad with which they will be instructed to play two different versions of the same game for a approx 30 mins. During the gameplay experiment, students will complete a series of the same questions every 10 minutes (3 datasets in all). After completion of the experiment a further questionnaire will be completed. The whole data collection process will take approximately one hour per participant. The gameplay will also be observed to assist with data analysis. Students may also be interviewed on exit to further assist with interpretation of datasets, unusual experiences or unanticipated behaviour.

4. To which ethical codes of conduct have you referred?

IRB (Institutional Review Board) at the Kennesaw State University - see http://research.uga.edu/hso/irb-guidelines/

In the USA, the Institutional Review Board (IRB) at universities are accredited by the Association for the Accreditation of Human Research Protection Programs (AAHRPP) available at http://www.aahrpp.org.

Kennesaw State University IRB, where this research will be conducted, has been accredited by the AAHRPP.

The IRB's purpose is to regulate all research activities involving human subjects on the campus of Kennesaw State University, ensuring that people who participate in research are treated ethically and in compliance with all federal and state laws and regulations.

Data will be collected using the IRB code of practice in relation to anonymity, data protection and participation in the study.

Note: For the Faculty of Technology, these codes typically include those published by the BCS, ACM, IEEE or other applicable codes such as the code of the Social Research Association or specific funding bodies, such as the ESRC. Links to some of these codes are available on the Faculty of Technology FHREC website. http://www.dmu.ac.uk/research/ethics-and-governance/dmu-policies-and-external-requirements-.aspx

List of accompanying documentation that MUST be submitted to support the application:

- A copy of the research proposal (Application for Registration (RDC:R) form)

AUTHORISATION

Signature by Applicant			
Signed	UTTAM KOKIL	Date	April 06, 2016

Signature by First Supervisor			
Signed		Date	
Name of Supervisor	________Dr. Tracy Harwood__________________________		

Conditional Approval - Authorising Signature (FHREC Chair)			
Signed		Date	
Tick *here* if approval is conditional ☐			
Note *to applicant: If you receive conditional approval, you may proceed with preparing the project but you must NOT start data collection unless you have met the conditions and received full approval.*			

Conditions

Full Approval - Authorising Signature (FHREC Chair)			
Signed		Date	

NOTES FOR GUIDANCE:

1 Respondents' co-operation in a research project is entirely voluntary at all stages. They must not be misled when being asked for co-operation.

2 Respondents' anonymity must be strictly preserved. If the Respondent on request from the Researcher has given permission for data to be passed on in a form which allows that Respondent to be identified personally:

(a) the Respondent must first have been told to whom the information would be supplied and the purpose for which it will be used, and also

(b) the Researcher must ensure that the information will not be used for any non-research purpose and that the recipient of the information has agreed to conform to the requirements of any relevant Code of Practice.

3 The Researcher must take all reasonable precautions to ensure that Respondents are in no way directly harmed or adversely affected as a result of their participation in a research project.

4 The Researcher must take special care when interviewing children and young people. The Faculty REC will give advice on gaining consent for studies involving children or young people.

Appendix 4.4
Institutional Review Board Approval

The purpose of the Institutional Review Board's (IRB) in the USA is to regulate all research activities involving human subjects in universities and colleges, ensuring that people who participate in research are treated ethically and in compliance with all federal and state laws and regulations.

In the USA, the IRB at universities are accredited by the Association for the Accreditation of Human Research Protection Programs (AAHRPP) available at http://www.aahrpp.org. The institution I approached to obtain authorization to collect data follows the IRB (Institutional Review Board) protocol (http://research.uga.edu/hso/irb-guidelines/), which is accredited by the AAHRPP.

Following the approval of my research instrumentation by the DMU Ethics Committee, permission was sought from the IRB office of a large comprehensive university in the USA to conduct my research study on campus. In order to obtain IRB approval so that the researcher might gather any data with human subjects, it was required to take the CITI (Collaborative Institutional Training Initiative) online Training Certification Program and submit an application substantiated with relevant document. The CITI info is available here http://research.kennesaw.edu/irb/citi-training.php

(i) Data collection process – use of students at Kennesaw State University, Georgia, USA, for observation and completion of the research using two tablet games designed for this study, along with an experiment and survey instruments.

(ii) Data protection – identity of individuals participating in the study.

(iii) Data management – safeguarding of materials collected for the study.

The University Office of Research

Institutional Review Board

April 22, 2016
Uttam Kokil
Assistant Professor | Interaction Design
Department of Digital Writing and Media Arts
Kennesaw State University

Dear Mr. Kokil,

The Kennesaw State University (KSU) Institutional Review Board (IRB) has administratively examined your study materials for the study entitled "The effects of visual aesthetic quality on player experience in tablet games (P12049825)" that were reviewed and approved by the research ethics committee at De Montfort University, Leicester. You are granted permission to recruit participants for this research project on the KSU campus from April 23 11, 2016 through April 24, 2017.

Since you are a member of the KSU faculty you will be responsible for disseminating information and for all recruitment efforts regarding your study. This IRB permission to recruit participants does not provide authorization to access student emails. You will have to get that permission directly from the registrar. In addition, any email recruitment correspondence must conform to the KSU Mass Email Policy and must contain information indicating the study has been approved by the IRB along with the IRB study number (see above) at the beginning of the message.

Please note that permission to recruit is not an IRB review, and applying to recruit does not serve as or replace review by an IRB. De Montfort University, Leicester retains responsibility for conducting all required continuing reviews of the study, and all unanticipated problems or adverse events related to the study must be reported to them. Should the study receive a continuing review or be submitted to the De Montfort University research ethics committee for review and approval of study revisions, you must reapply for permission to recruit research participants at KSU. This is accomplished through submission of copies of revised documents, including the most recent approval documents. Following assessment of these documents, a subsequent letter of permission to recruit may be issued.

Should you have questions, please contact the board by telephone at (470) 578-2268 or by email at irb@kennesaw.edu.

Sincerely,
Christine Ziegler
Christine Ziegler, Ph.D.
Professor of Psychology
Director and Chair, KSU IRB
irb@kennesaw.edu

585 Cobb Avenue, KH 3403, Kennesaw GA 30144
470/578-2268 work | 470/578-9110 fax | http://research.kennesaw.edu/irb

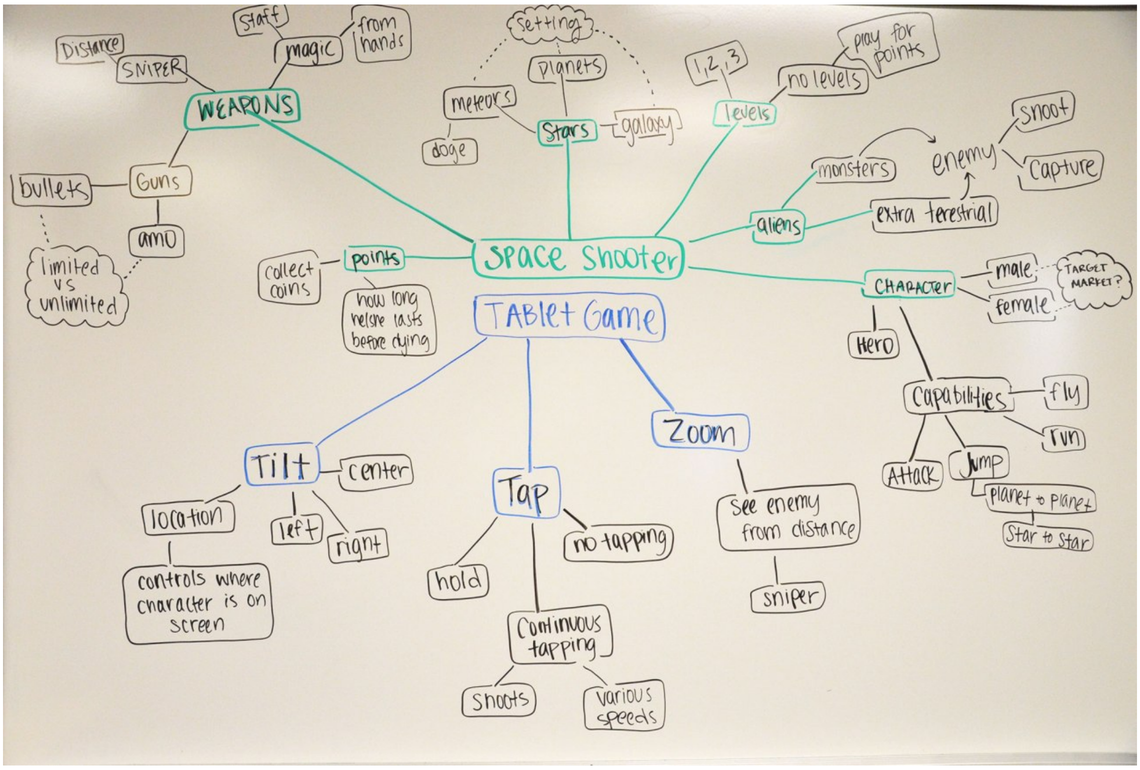
Appendix 4.5
Survey Instruments used for data collection

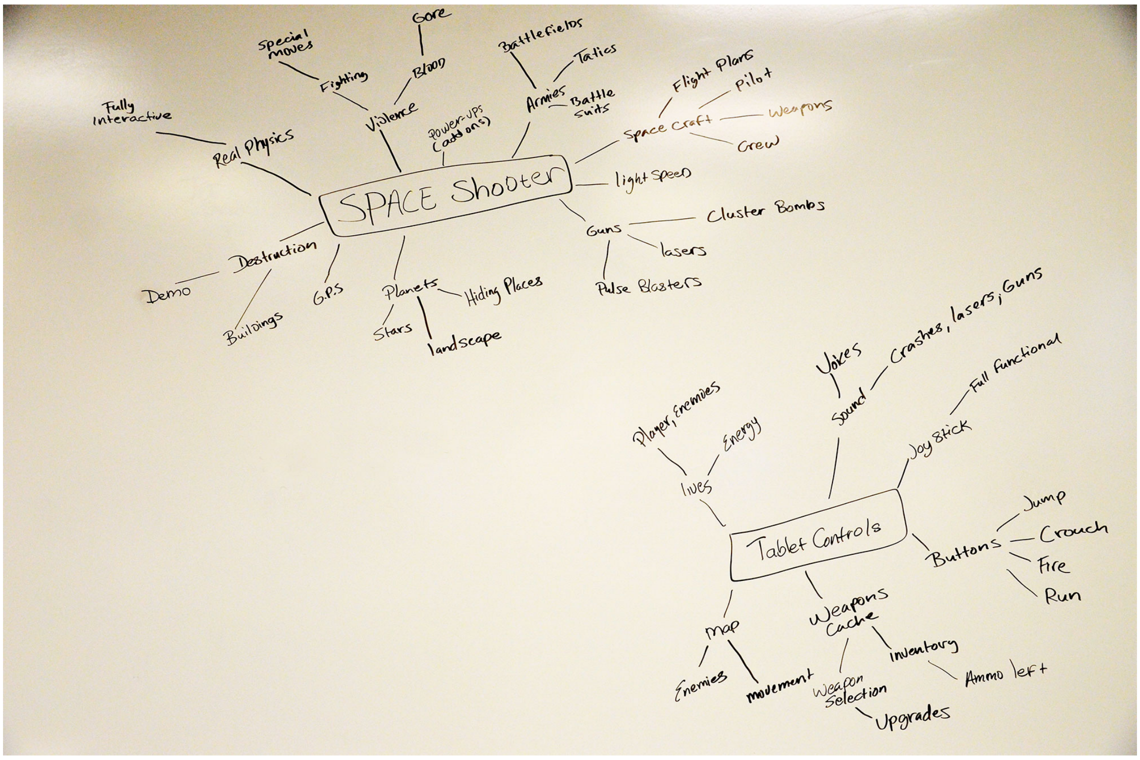
Layout of Online Questionnaires for Easy Fun Key Game
https://sites.google.com/site/adventureksutabletgameresearch/

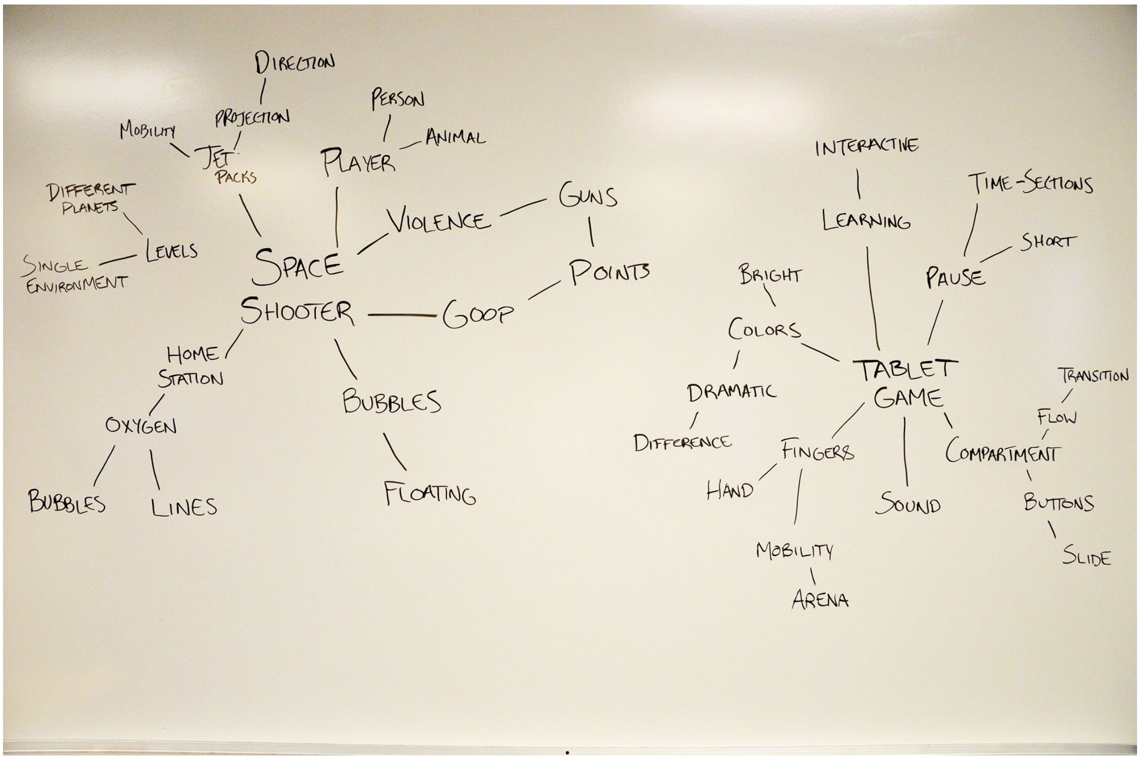
Layout of Online Questionnaires for Hard Fun Key Game
https://sites.google.com/site/adventureksutabletgameresearch/

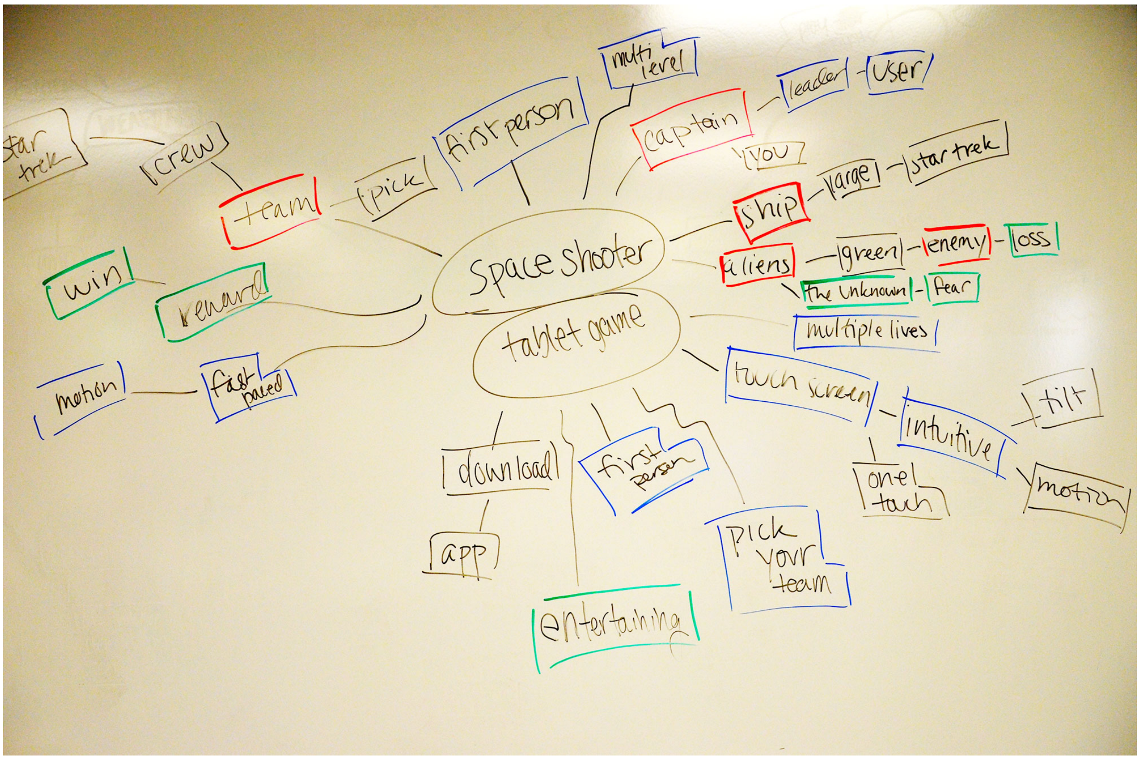
Appendix 5.1

Mind Mapping Examples




Gore
Special moves
Blood
Battlefields
Tatics
Fighting
Flight Plans
Pilot
Armies
Battle suits
Fully interactive
Violence
Power-ups (add ons)
Space Craft
Weapons
Real Physics
Crew
SPACE Shooter
light speed
Cluster Bombs
Guns
Destruction
lasers
Demo
G.P.S
Planets
Hiding Places
Pulse Blasters
Buildings
Stars
landscape
Voices
Crashes, lasers, Guns
Full functional
Sound
Player, Enemies
Energy
Joy Stick
lives
Jump
Tablet Controls
Crouch
Buttons
Fire
Run
map
Weapons Cache
inventory
Ammo left
Enemies
movement
Weapon Selection
Upgrades


DIRECTION
PERSON
PROJECTION
MOBILITY
JET PACKS
ANIMAL
PLAYER
DIFFERENT PLANETS
VIOLENCE
GUNS
LEVELS
SINGLE ENVIRONMENT
SPACE SHOOTER
POINTS
GOOP
HOME STATION
OXYGEN
BUBBLES
LINES
BUBBLES
FLOATING
INTERACTIVE
LEARNING
TIME-SECTIONS
SHORT
BRIGHT
PAUSE
COLORS
TABLET GAME
TRANSITION
DRAMATIC
FLOW
DIFFERENCE
FINGERS
COMPARTMENT
HAND
SOUND
BUTTONS
MOBILITY
SLIDE
ARENA


Space Shooter
tablet game
team
crew
star trek
pick
first person
multi level
captain
leader
user
you
ship
large
star trek
aliens
green
enemy
loss
the unknown
fear
multiple lives
win
reward
motion
fast paced
touch screen
intuitive
tilt
one touch
motion
download
app
first person
pick your team
entertaining


SPACE SHOOTER
"FREE SPACE"
BLACK
DARK
SPACE
COLORFUL
PLANETS
machines
FLYING
Airplanes
wings
U.F.O
STARS
YELLOW
SMALL
"BOXY"
ALIENS
LARGE HEAD
WEIRD
TABLET GAME
meaning
get points
different levels
just for fun
score board
interest
new
fun
colorful
bright colors
aesthetic
"childish design"
straight lines
very simple
why is this cool
appeal to target market
children/teens
achievements
random items
knives
GUNS
weapons
lollipops
"drops"
TOYS/CANDY
ACHIEVEMENTS
POINTS
100p. = 1 extra life
teddy bear
FRUIT
apple
pear
orange
pineapple
FOR CHILDREN
larger market
non-violent

Appendix 5.2
Summary of Keywords emerged from Mind Mapping

exploratory game, action-based game
adventure game, Red planet, enjoyment,
player frustration, joy, fun, challenge, immersion
third person shooter, tap, tilt, swipe, fun,
touchscreen interaction, jump, obstacles, challenge,
skills, head up display, game status,
feedback, scores, 2D game, 2.5D tablet game,
hero, astronaut, visual cues, ammunition
lives, spaceship, Space shooter, stars, galaxies
asteroids, storms, meteorites, planets, space
atmosphere, troposphere, stratosphere,
mesosphere, thermosphere, exosphere
force of gravity, dynamic, adaptive, zoom
accelerometer, motion sensor, acoustics, physics
ozone layer, aliens, top-down view, laser beam
traces of water, metals, precious stones,
dust-storms treasure chests, plants, oxygen tank,
bonus points, extra-terrestrials

Appendix 5.3
Freedom of rotation and movement of main character
(Mars Explorer)

Appendix 5.4
Game Development Brief

The game development process comprised of the following main parts:

I. Tools Used for Development

1. IDE (Integrated Development Environment): XCode 7.
2. Programming languages used: Objective – C and Swift, the language used primarily in Mac OS and iOS environment.
3. Engine Used: SpriteKit - Apple's new game development engine introduced in iOS 9 and XCode 7 (2015). The features used in this game are:

- Basic sprite tasks: creating, animating and performing actions on sprites such as patrolling, fade in, fade out, etc.
- Physics simulation: SpriteKit has its built-in physics engine which is based on the popular C++ physics engine Box2d.

II. Game Scene Design

- The game is divided into two scenes:

1. The menu:

- includes a splash image and a "Start" button.

2. The gameplay scene:

- contains the main logic of the game. When the scene is initialized, it does the following steps:
- It creates a physics-simulated game world in which scenery, obstacle, enemies and character are apparent. It creates different layers of objects on the map.
- It creates a HUD for the game. This includes the game menu, scores/time bar, health bar indicator.
- It creates a background layer of the map - adds the ground (Easy Fun Key) and the illusion of space (Hard Fun Key).
- It adds the rocks, and other scenery objects to the background layer. The game loops through every tile in the map and randomly adds an object if that current tile is empty (Easy Fun Key). It adds scintillations to reflect the stars and moving satellites in the background (Hard Fun Key).
- It drops the character on a specific location onto the map at random (Easy Fun Key). The spaceship is positioned along the x-axis on stage so that the user can move it to the right or left elastically based upon touch gesture user interaction (Hard Fun Key).

- It randomly adds enemies, storms and chests into the map after a certain amount of time after the character has moved some distance (Easy Fun Key). It randomly adds meteorites, red and green ozone layer rings, asteroids, storms and aliens in the respective level for the player to interact (Hard Fun Key).

III. The game logic

The game runs on the following logic:

1. The game loop

This is a method that is called exactly once every 1/60 second to allow the game to update its states, players and enemies' positions, collision detections.

2. Animating enemies

The enemies are programmed to patrol left and right over a certain amount of time. Enemies are unable to walk through rocks or chests or enemies but the storm can move above anything (adventure). The enemies are programmed to move along a vertical axis from top to bottom at different speeds to provide opportunity for the player to strike.

4. Collision detections

The game makes extensive use of Sprite Kit's physics engine to detect collisions between the character and meteorites, asteroids, rings, aliens, rocks, chests and storms. When the character collides with obstacles like storms and enemies, the game programming gives rise to a hit effect, plays a sound effect, and destroys the enemy to score a point.

5. Dynamic Difficulty Adjustment

The game implements Dynamic Difficulty Adjustment. Enemies and chests will appear more frequently and closer to the character if he has less hit-points (HP), so that he can have more chance to recover HP and thus earn points. For instance,

- if the hero has more than 5/6 of his full health, enemies will spawn every 4 seconds. And they will spawn around 4 tiles from the hero.
- if the hero has from 3/6 to 5/6 of his full health, enemies will spawn every 3 seconds. And they will spawn around 4 tiles from the hero.
- if the hero has less than 3/6 (half) of his health, enemies will spawn every 2 seconds. And they will spawn around 3 tiles from the hero.

Enemies spawn less in dense rocky areas, due to the fact that there is not much room for them.

IV. Class architecture

The game follows the Object-Oriented Architecture with the following classes:

AppDelegate
The AppDelegate's role is to receive app notifications and it is also the starting point and ending point of the app.

- MainMenuViewController
  This class represents the main menu of the game. It is just a screen with a splash image and a start button.

- GamePlayViewController
  This class represents a view which contains the gameplay scene. It is also responsible for switching scenes, ending the game scene, etc.

BaseCritterNode
The parent for all the classes representing an interactive object. Including:

- Enemies (aliens, meteorites, asteroids, storms, ozone layer rings)
- character
- Chest
- Sandstorm

These classes overrides the create(), update(), gotHit() and die() methods from the parent class in order to define the behavior of the object.

GameScene
This class represents the actual Game Scene with all the game logic, map creation, update, checking game over conditions, etc.

Appendix 5.5

Research Instruments -
Classical and Expressive Aesthetic Questionnaires (Lavie and Tractinsky, 2004)

Classical Aesthetics	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Clear design					
Aesthetic design					
Pleasant design					
Clean design					
Symmetric design					

Expressive Aesthetics	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Creative design					
Sophisticated design					
Original design					
Fascinating design					
Using Special Effects					

Appendix 5.6
Common usability issues encountered

The major usability issues encountered by participants during the iterative game prototypes development process were

Mars Explorer game prototypes:

II. game status scores were not accurate when attacked by an enemy

III. The animated bubble info (+10 or -10) points were not apparent when character destroyed or was attacked

IV. at times the treasure chest would not open upon interaction.

(iv) the leaf status icon was not synchronizing with the number of hits.

The following main observations were made during usability testing of the Mission Mars prototypes:

- to provide an option for users to click the play button and main menu to start the game, instead of waiting 15 seconds, following the splash screen
- to play a contrasting (tense v/s happy) sound effect when a red ozone ring (an enemy) or a green ozone ring hits the spaceship.
- when swiping the asteroids in level 3, make sure the position of the spaceship is unaffected
- increase the duration of gameplay to make it more engaging for participants
- upon collision with aliens in level 3, spacecraft would at times be disappearing from the screen view.

During the course of game development process, every time Apple released a new iOS version and new devices, apps were affected with bugs.