Tablet Game Design and Evaluation: A Practice-based Experimentation Approach

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Abstract—The aim of this project is to first design, develop and evaluate an iOS adventure game for tablet devices using Practice-based Experimentation (PBE) approach. The objective of creating a digital game is to explore how usability and visual aesthetic attributes of the interfaces affect users' perception of usability and engagement. The new PBE methodology is adopted, involving two phases. First, during the practice phase, the games are designed from a user-centric approach iteratively, and modified into two visual aesthetic conditions, which serve as stimuli, to measure perception of usability and in the future to evaluate user engagement. In the second phase, the game interfaces are empirically evaluated using quantitative methods to measure users' perceptions of usability on the visual quality of the interfaces. As per extant literature, the concepts of perception of usability and visual aesthetics have been a controversial topic. Existing research on user experience have not fully explored perceived usability and visual aesthetics, in the domain of tablet gaming. This research is in its preliminary stage as data have only been collected to examine the first research question concerning users' perception of usability towards the variation of visual aesthetic quality of a tablet game user interface. The preliminary results indicate that there is no significant difference in perception of usability between the two modified visual interfaces.

Keywords-Tablet gaming; user experience; user interface; Practice-based Experimentation.

I. INTRODUCTION

While the concepts of instrumental qualities (usability, functionality) and non-instrumental qualities (visual aesthetics, hedonics, acoustics) have been widely discussed in the field of Human Computer Interaction (HCI), they have not been applied in a coherent manner to the HCI sub-category of gaming, which is distinct from other HCI areas in that its primary aim is to entertain the user, rather than to enhance productivity or task performance. The skyrocketing use of tablets has brought the gaming experience to a new level with a new medium of interaction, the touch screen, in a mobile context. This shift in medium and context of use has only highlighted the lack of critical research on User eXperience (UX) as it relates to instrumental and non-instrumental attributes of system properties in tablets in general, and tablet-based in particular. Koutsabasis and Istikopoulou [1] explain that the methods and knowledge from a user centered design standpoint are scarce in the domain of aesthetics. In addition, UX, a relatively new field, is associated with instrumental and non-instrumental qualities [2], which still has deficiencies in terms of scope, and experiential constructs to assess the experience [3].

O'Brien & Toms [4] explain that user engagement forms part of a positive UX. The researchers further define User Engagement Scale as a multi-faceted instrument that measures experience in terms of its "appeal, novelty, focused attention, felt involvement, usability and durability." Engagement is a phenomenon determined by users' perceptions of usability and aesthetics toward product use, as well as the extent of their activities [5]. Carr [6] stipulates that the visceral property of game visual elements influences players to make choices and quick decisions during gameplay. The next section describes the design process of a new tablet game It becomes imperative to understand users' perceptions and behavior when they interact with tablet games. This will provide a deeper insight of the elements that attract and engage users to play games [7]. The study takes recourse of a novel methodology called PBE, a variant of PBR, which includes both practice and professional research. Section II provides an overview of the literature review. Section III discusses a practitioner's approach of game ideation and narrative. Section IV describes the game design process. Section V justifies the methods, including data collection procedure that is carried out using scientific inquiry. Section VI showcases the analysis portion and Section VII concludes the paper.

II. LITERATURE REVIEW

Practice-based Research (PBR) methodology concerns the generation of new knowledge contributing to understanding of the role of the artifact in that experience [8]. The role of the artifact is crucial in the generation of new knowledge but not necessarily the primary outcome. PBR begins with practice. The artifact is created first and then research questions are devised to evaluate the practical work. The artifact is modified into two conditions – a low and high visual quality prototype, for empirical evaluation by participants. PBE approach can be described as a variant of PBR, comprising of a combination of practitioner research and professional research (scientific inquiry). In this case, PBE begins with aims and pre-defined objectives, which include the creation of an artifact through a series of formal evaluations, referred to as practice. The depiction of the games (artifacts) is informed by theories. Experimental work is carried out on the artifact to create the desired conditions prior to empirical evaluation, using quantitative methods. The latter refers to scientific inquiry. PBE follows the logical sequence of theory informing practice, and the experimental evaluation process of the research questions

leads to the emergence of new knowledge or theory. Arlander [9] states "sometimes artists come closer to scientists than historians since they engage in experimentation" (p 319). This implies that practitioners are already engaged in experimentation to create artifacts during their practice. The word "experimentation" in Practice-based Experimentation plays a key role in the sense that practice has always been associated with experimentation, and experimentation forms the basis of professional research. In this study, the process of PBE follows the sequence: Game Theory → Games characteristics → (Practice) Create Artifacts → Evaluate Artifacts (Empirical Evidence)→ Inform Theory. Each type of game conforms to specific requirements. For example, both Hard Fun Key and Easy Fun Key games portray distinctive characteristics to meet users' needs. Each game is devised based on Lazarro's Four Fun Keys theory [10]. In a Hard Fun Key (Action game), the user's goal is to beat his opponent, or to win against the computer. Easy Fun Key has a different goal, as the game is played for the sake of discovery, not necessarily to win. The Four Fun Keys game theory describes four different types of fun in a game: Har*d Fun, Easy Fun, People Factor, and Serious Fun*. For the scope of this research, an Easy Fun (adventure game) was devised. Easy Fun Key game is geared towards eliciting an appreciation for curiosity and surprise. One does not play to win but to discover or explore, as the focus is on the game activities. The game is used as a stimulus and empirically evaluated by participants to respond to the research questions, from which new knowledge or theory emerges.

Crawford [11] explains that if players find a game enjoyable, with that immersive experience, it is more probable that they will engage and deeply interact with the game. Fun is a kind of user experience triggered by various tangible (i.e., physical) and intangible qualities of products evoking certain relevant emotions in users, such as joy or amusement [12]. Admittedly, fun is related to a "sense of timelessness, similar to flow experiences [13]." Hassenzhal [14] explain that both fun and pleasure are a form of enjoyment, but there is a distinction between the two. Fun is about "distraction," implying that a user is distracted from concerns, motivations and the inner-self. Pleasure has to do with "absorption," such as being immersed in an activity, and one can still relate to one's concerns, motivations and goals. Fun is clearly an experience, not an emotion. Even though one fails 80% of the time while playing a game, the activity is still perceived to be fun [10].

III.   PRACTITIONER'S APPROACH

Seven participants, two game developers, two designers, and three game player experts from a Midwest university volunteered to meet on two different occasions, for a three hours work session for a focus group discussion, and to shape the initial ideas for a *casual* tablet game that can be targeted towards a broader audience. A brainstorming

technique, known as mind-mapping, was employed in the generation of initial ideas for the game design. Mind-mapping is a useful brainstorming tool that organically generates associations that the researcher may not otherwise have considered [15]. It relies on words and begins with a central concept or node as a focal point. Other nodes are added spontaneously to the mind map as the process unfolds. Once a mind map is completed, one needs to identify internal connections and useful adjectives and keywords that have appeared. The theme generated during the first focus group session culminated into a combination of an action and an adventure game. A game genre classifies entertainment games into action, adventure games, puzzle games, role playing games, strategy games, sports games, simulations [16]. An action and adventure game genre were created for the tablet platform. For the scope of this paper, only the adventure game was used to collect data at the time of writing. The tablet game is comprised of two phases - the narrative of first phase is an action-based game (Hard-Fun Key) referred to as a *Space Shooter* game and the second phase of the tablet game encompasses an adventure game (Easy-Fun Key), referred to as *Mars Exploration*. Phase I of the game narrative revolves around a spaceship starting its journey from Earth to planet Mars. On its way, it has to surmount multiple obstacles (storms, asteroids, aliens) to land on Mars. In Phase II, the character explores the landscape of planet Mars, grows green leaves to sustain survival, and copes with enemies (aliens), as well as sand storms on the planet. The player opens treasure chests randomly containing aliens (loses points) or gold coins (bonus points), or must avoid any abrupt sandstorms in order to earn enough points or life to sustain the green leaves. For the purpose of this study, the Easy Fun Key game was the only one used for data collection due to the shorter duration required for a participant to complete a game session.

IV.   GAME DESIGN

Technology has evolved rapidly but game design has been a slow process. The goal of a game is to entertain and provide enjoyment to the user [17]. Game usability is more accentuated towards player satisfaction and learnability, whereas effectiveness and efficiency are considered secondary factors. The game design and development were devised iteratively, with the application of a user centered design approach. The structure of a digital game is composed of the following components: *game play*, *game interface*, *game mechanics*, and *game narrative* [18]. Game play is the process of encountering multiple obstacles before a player can win. Gameplay is the process during which the user overcomes a series of challenges in a simulated environment [19]. Crawford describes challenges as a mental activity aiming to develop one's skill [20]. Game interface is the mechanism through which the user interacts with the game; it includes the physical game controls as well as the game environment, assets and characters. It provides a visual representation of the game. Game mechanics form part of the physics of the game based on the programming and animation. Game mechanics are rules constructs intended to produce gameplay. It is these rules and rewards that make

the activity challenging, satisfying and compelling [21]. Game narrative is the story or the plot that unfolds over time as the game is played.

The iOS game was developed using Xcode and Swift. Xcode allows the developer to build the interactive user interface elements while *Swift*-programming language responds to user events and gestures in order to express the game logic. Three participants tested the game prototype by responding to a usability survey devised by Federoff [18]. The game was refined, and underwent another round of usability testing by four other participants who played the game multiple times, under the observation of the researcher.
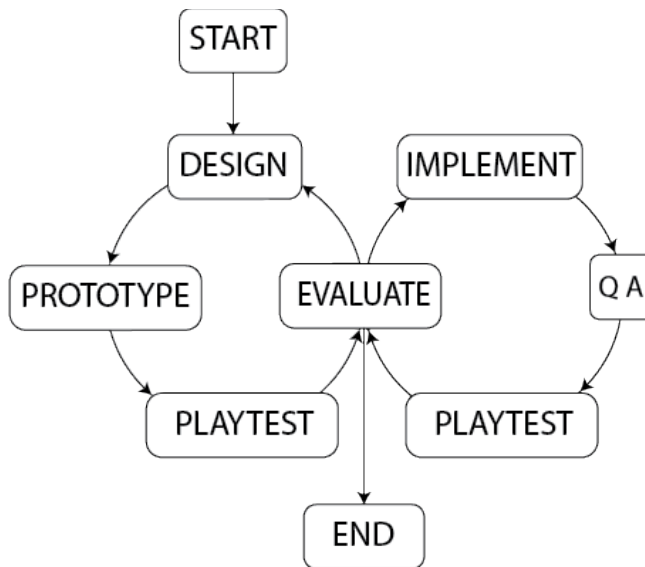

Figure 1 Rapid Iterative Testing and Evaluation
(Medlock et al., 2005)

The first objective was to evaluate whether a variation of visual aesthetic quality while keeping game usability constant affects the perception of usability of players. To respond to this research question, the game interface was devised into two different levels of visual aesthetic qualities for experimentation purposes. An iterative prototyping cycle (Figure 1) session was held to showcase which visual elements could be modified while maintaining the same level of consistency, such as game play, and game mechanics between the two versions for each game category. The Easy Fun Key game was modified into a low and high visual aesthetic value. Elements and Design Principles, such as symmetry, grid system, eye flow, contrast, bitmap images quality were adopted in rendering the two versions. The low visual aesthetic quality version was designed in such a way to violate the Principles and Elements of Design [22]. For instance, to create the low visual aesthetic quality version (Figure 2b), low color contrast, low-resolution bitmaps and a monochromatic color scheme were adopted in achieving the same. This modification objectively changed the look and feel of the game user interface. To create a high visual aesthetic version (Figure 2a), the design elements were accentuated with high quality graphics rendering, high color

contrast and a vivid color scheme, and low bit graphics. Seven participants rated a series of 3 different layouts, with different color schemes, graphics bits, contrast and combinations on a 27-inch iMac. After each prototype was depicted, it was evaluated using the Visual Analog Scales containing two dimensions: *Classical* and *Expressive* aesthetics [23]. The *Classical* aesthetic dimension is guided by three items: clean, pleasant, aesthetic; the *Expressive* aesthetic dimension has three items: sophisticated, creative, and fascinating. Each prototype was evaluated on a scale from *strongly disagree to strongly agree,* which was converted to a 1-7 range for analysis purposes.

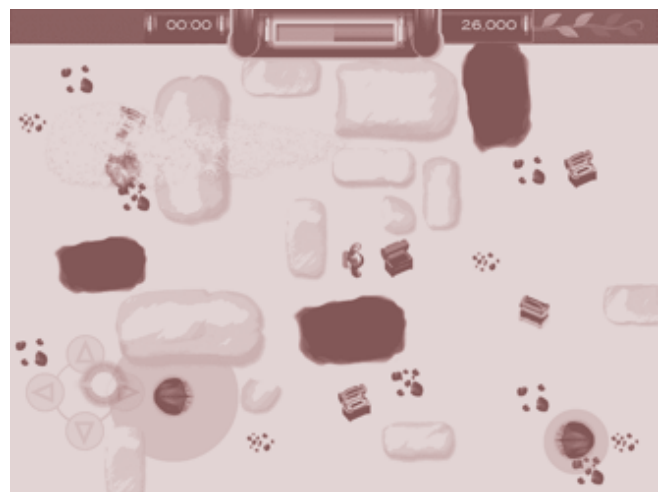Figure 2a Easy Fun Key (Adventure) - High Visual Aesthetics

Figure 2b Easy Fun Key (Adventure) - Low Visual Aesthetics

Referring to Lim, Lee and Kim [24] concepts of user interactivity, the interaction styles most relevant to the games interaction in this study were movement speed, movement range, and response speed. The player interacts with the user interface with a navigation tool. The game begins as the character first explores. The player's goal is to successfully

grow a plant on planet Mars. Every time 100 points are scored, a leaf is grown; conversely, the plant will shed a leaf every time 100 points are lost. There is no level in this game. The character explores the Red Planet, encountering aliens, falling objects and dust storms. The player must ensure that that the oxygen level is sufficient enough to carry out the mission. Destroying aliens earns points, which helps grow a leaf to sustain oxygen levels. Opening treasure chests, either accumulates bonus points or loses points, as the player randomly encounters aliens in the treasure chests.

V. METHODS

The objectives of this study were: (i) to examine if a variation of visual aesthetic level influences perceived game usability. (ii) to measure the level of game engagement of the two different game versions. In order to evaluate perceived game usability, the constructs related to pragmatic quality (PQ) of the *AttrakDiff* instrument were utilized to gather data. Similarly, the constructs related to visual aesthetics quality (VA) of the *AttrakDiff* instrument were used to gather perception of visual aesthetics data [25]. PQ is comprised of seven bi-polar items, and is related to the perceived usability assessing ease of use and whether users are attaining their goals by playing the games. Similarly, VA consists of 7 bi-polar items, aimed to measure the perceived attractiveness of the user interface. The game scores for all the participants were recorded. The procedure involved a within-subjects test whereby the same participant played both game versions. A convenience sample frame of 27 participants was chosen for this study as students 18-35 years old were recruited on a university campus. This age group represents approximately 30% of the population who plays game on their mobiles [26]. Each participant was assigned randomly to either the low or high visual aesthetic game version in order to ensure high internal validity. This also ascertains that two equivalent groups are created, as per the law of probability [27]. At the end of each 10-minute game session, participants were requested to complete the 7-items of the PQ and the 7-items of the VA section of the AttrakDiff instrument. In the future, user engagement will be measured using the *User Engagement Scale* (UES), a self-report instrument using a 31-item questionnaire to capture the six domains of experience [28]. The investigator plans to collect data using the UES tool afterwards at a later date

VI. ANALYSIS

Two results are reported from the AttrakDiff instrument using a one-way ANOVA within-subjects test. The SPSS result for the VA dependent variable shows $F(1,26)=4.056$, $p=0.054$. The mean value of the high visual aesthetic value interface was reported to be 22.26 whereas the mean value of the low aesthetic quality was 18.63; this implies that participants perceived a difference in terms of visual look and feel of the game versions, but given that p>0.05, the

difference was not statistically significant. From the mean values reported, participants recognized and showed preference to the high visual aesthetic version.

The PQ dependent variable reveals Greenhouse-Geisser F-statistic as $F(1, 26) = 0.09$, p-value=0.925, and since p>0.05, this implies that the two game versions were not significantly different from each other; we fail to reject the null hypothesis. In other words, game usability of both game versions, low and high visual aesthetic qualities, was not perceived to be statistically different. Participants found both game versions to be practically usable. Therefore, a variation in visual aesthetic quality did not influence perceived usability in the Easy Fun Key game category. Furthermore, observed power was low at 0.051, which could imply the study lacked sufficient power to detect any effects. Thus, increasing the sample size of this study will certainly boost power statistics, thereby providing a robust result.

VII. CONCLUSION

The preliminary results in this study reveal that when the tablet (adventure) game interface was manipulated into low and high visual quality, game usability was not affected. One shortcoming of this study is the small sample size. Moreover, the participants' affinity to visual aesthetics in products is a confounding variable. The next stage is to screen participants using the (Centrality of Visual Products Aesthetics) CVPA instrument to understand to which degree they are sensitive to visual aesthetics in products [29]. The higher the CVPA score of the participants, the greater the level of accuracy in judging visual aesthetic quality. In future work, the level of user engagement in each game condition will be investigated to examine if the level of visual aesthetic qualities affect game engagement.

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