Developing an Evaluation Framework for Analysing Educational Simulation Games

Souad Slyman[1], Marco Gillies[2] and Vally Lytra[3]
[1]Faculty of Business & Law, University of Roehampton, London, UK
[2]Computing Department, Goldsmiths, University of London, UK
[3]Education Department, Goldsmiths, University of London, UK
souad.slyman@roehampton.ac.uk
m.gillies@gold.ac.uk
v.lytra@gold.ac.uk

Abstract: Despite the emergence of new methodologies for analysing and evaluating games using usability testing and heuristics evaluation frameworks, there is still lack of inclusive game heuristics for analysing educational simulation games. To address this, we conduct two case studies: professional critic game reviews and focus group interviews. We have looked at the effects of games on players' gaming experiences in different gaming context (i.e. playing educational versus (vs.) entertaining simulation games). Findings show various game design similarities & differences between playing these simulation games. It also highlights game design issues. In this paper, we propose a new game evaluation heuristics model (GADDIE) that consists of Game Analysis (GA), Design (D), Development (D), Implementation (I) and Evaluation (E). These heuristics were compiled as a result of game design issues identified from the professional critic game reviews and the focus group interviews. On the basis of the data obtained it is argued that the GADDIE model could provide further guidance that leads on from previous research, since it encapsulates research findings, game design principles, human computer interaction, usability testing guidelines, educational perspectives and overall our experiences as educators and game researchers. Consequently, the proposed framework would support our ongoing research project in game evaluation process (educational vs. entertaining), and other researchers, more effectively.

Keywords: game evaluation heuristics, usability testing, game design, human computer interaction, simulation games

1. Introduction

In recent years, the role of game design has become increasingly significant, especially in the field of user-centred design, as more professionals are developing new methodologies for analysing and evaluating games using usability testing and heuristics evaluation frameworks. Usability testing is a field originated from Human Computer Interaction (HCI), aimed at designing easy-to-use interfaces and activities (Nielsen, 1995, 2000; Desurive, et al., 2004). Whilst usability testing is a key process in designing innovative technologies in industry and particularly in game design, analysing and evaluating games necessitate evaluation heuristics and guidelines. This can be demanding since a comprehensive framework for evaluating educational and entertaining simulation games, from various perspectives such as game design principles (Schell, 2015, 2020), HCI, usability testing guidelines (Falstein and Barwood, 2001; Desurive et al., 2004) and educational purposes, is complex and challenging. To address this, we present a new set of game evaluation heuristics from multifaceted perspectives for educational simulation games, such as game design principles, HCI, usability testing guidelines and educational/theoretical perspectives. For this purpose, educational simulation games are considered in regard to their intended learning purposes as well as their engaging properties as games. They must have clear learning objectives to succeed educationally, if they are not engaging or enjoyable as games they will fail. Whilst entertaining games like Massive Multiple Online Role-Play Games (MMORPG) are intended to concentrate on entertainment rather than learning. MMORPGs are a type of entertainment games, a subgenre of action games, which involve strategy, fantasy, adventure, and simulation. Simulation games (SGs) are games set in an interactive environment where players apply knowledge/skills to solve complex problems.

In this paper, a brief overview of the development of game heuristics is given, highlighting usability evaluation guidelines and game design principles.

2. Game Design and Development: Objectives & Methodology

2.1 Evaluations Heuristics, Game design and HCI principles

Game evaluation heuristics are regarded as a set of design guidelines and they are closely linked with more general design principles relating to the usability of interfaces (Malone, 1980). They are important because they play a major role in the software development life cycle where the aim is to develop new software design after

several iterative stages of implementation. There are several heuristics available like HEP (Desurive et al., 2004), MDA (Hunicke et al., 2004), PLAY (Desurvire and Wiberg, 2009), GAP (Desurvire and Wiberg, 2010), Heuristics for Social games (Paavilainen, 2010), GameFlow (Garris et al., 2002; Sweetser and Wyeth, 2005), Gamification Heuristics (Tondello et al., 2016), the taxonomy of leaning elements of digital games-based learning experiences (Whitton, 2011) and Gee's (2003, 2007, 2011) 13 learning principles. These heuristics can be visualised as follows:

HEP -> MDA -> PLAY -> GAP -> Heuristics for Social Games -> GameFlow -> Game Heuristics -> Taxonomy of Learning of Digital Games -> 13 Learning principles

Even though these heuristics are valid and useful, they appear, however, isolated, repetitive and some do not adhere to HCI principles, usability testing guidelines and educational perspectives simultaneously. For example, Heuristics for Playability is a list of heuristics based on the literature and usability testing for evaluating the usefulness of computer, video and board games, developed by Desurive et al (2004). However, this method is broad and unsuited for evaluating specific issues in the software development and HCI game usability and playability (Desurvire and Wiberg, 2009). Moreno-Ger et al. (2008, 2012) on the other hand, developed a step-by-step methodology for educational games intended for training purposes whilst Whitton (2011) developed a taxonomy of learning elements of digital games.

In this paper, we feel that there is therefore a necessity to develop new game evaluation heuristics based on both computing and educational perspectives, as aforementioned, i.e. HCI principles, usability testing guidelines, educational perspectives and our experiences as educators and game researchers. Furthermore, these heuristics are grounded from the empirical data outcomes and thus offers insights into a new way of employing these heuristics to investigate the effects of games on players' gaming experiences (a transformation/ a journey: for the better/ worse) (Schell, 2015, 2020), by examining closely how players employ language to express their game experience. This is because for educational games additional features have to be accounted for such as game story, mechanics, engagement, feedback, challenge, entertainment and assessment (Nielsen, 1995; Gee, 2011; Whitton, 2011; Schell, 2015, 2020; Arnab, 2017). It has been argued that these elements should be balanced in order to create a game worth playing (Desurvire and Wiberg, 2010; Schell, 2015, 2020). Due to differences in the above approaches, a new set of design principles is necessary.

2.2 Research Objectives
The *research objectives* of this study were:
- What is the relationship between SRPGs (simulation roleplay games) and game players?
- What are game players' feelings/ experiences towards SRPGs, game design, gameplay and development?

2.3 Sample
Study 1 consisted of 40 professional critic reviews of simulation games from the Massive Multiple Online Role-Play Game (MMORPG) website (http://www.mmorpg.com/gamelist.cfm). These were chosen since we are interested in exploring game design, gameplay and development.

Study 2 consisted of three focus group interviews (FGIs), 24 participants (males and females). These volunteers were recruited from our university. They are studying Computing & Business Computing Degrees, our area of interests. We chose these participants because we are interested in exploring their experiences with educational games.

In this paper, we will use the emerging data from the professional critic game reviews and FGIs as a grounding tool to elicit meaning, and players' interaction with the game as a system, and derive the effects of games on players' gaming experiences, and whether it was a transformation for the better or the worse.

2.4 Methods of data collection
The empirical studies were conducted in a series of professional critic game reviews (study 1) and three FGIs (study 2) in the autumn semester for six months. Study 1 consisted of professional game critic reviews of simulation games from the Massive Multiple Online Role-Play Game (MMORPG) website (http://www.mmorpg.com/gamelist.cfm). Reviews of a range of 6 games were collated for analysis from the MMORPG website: Destiny, 4Story, 9Dragons, Black Desert Online, Blade and Soul, and Defiance. I will be referring to these games as simulation games or a game to avoid repetition and since we are interested in game

design and development rather than any specific game. These simulation games were selected due to their popularity, user rating and highest scores on the MMORPG website from 7.1 score to 8.57. Both positive and negative reviews were selected. Reviews with a few words were discarded using this process at least 8 reviews for each game were analysed comprehensively bringing this to a total of 40 professional critic reviews. Whilst study 2 consisted of 24 undergraduates (males & females) who were interviewed, in a series of three FGIs, about their feelings, interactions and experiences with games, and what effects games have on their gaming experiences, in particular educational games. The professional critic game reviews and FGIs were recorded, transcribed and analysed using adaptive method.

2.5 Process of data analysis

We used an adaptive method to analyse qualitative data. We studied data line-by-line, sentence-by-sentence using colour coding highlighting key themes within each section. We looked for hidden meaning & actions. Asking questions, engaging/interacting with data, such as why participants are expressing their views/experiences the way they did. We reflected on each data and examined it, pondering and re-inspecting it. These then accumulated to categories that made up the theoretical model. At this stage, all the coded data were linked back to the literature. The forty professional critic games reviews (study 1) are referred to as P1, P2 & P3 (players)…etc. The responses from the professional critic games reviews were grouped into the following categories of game analysis: Gameplay, game story and story lines; game design and development; game implementation and evaluation. The choice of these categories was made so that data analysis could be undertaken systematically. Recordings of these professional critic games reviews were examined in detail so that we could make note of themes, as afore-highlighted. These professional critic games reviews were then linked back to the literature review. Similarly, the 24 participants (FGIs: study 2) are referred to as M1, M2 & M3…etc (males) and F1, F2 and F3…etc (females), where applicable. The responses from the FGIs in particular game design & development elements/ issues were collated to build the GADDIE from educational perspectives. Recordings of these FGIs and the transcriptions were examined in detail so that we could make note of themes. The FGI responses were then linked back to the literature review. The emerging themes, patterns and categories were highlighted and consistent with the literature review, game design and usability guidelines.

3. Results

Both findings indicate sophisticated game design issues that affect immensely players' experiences - in both case studies- since not all players had an enjoyable experience as research data revealed and this is due to lack of game usability heuristics, HCI principles and many game design issues (Figure 1).

The professional critic game reviews looked at the effects of games on players' gaming experiences and feelings. Similarly, the FGIs (as aforementioned) looked at players' gaming experiences, feeling and the way they construct their realities. Then comparison was made into whether there are any similarities or differences between games, game design, gameplay and development. Interestingly and even though entertaining games are highly developed with multi genres, some players still reported a negative experience. Hence both studies (& despite exploiting two diverse types of games: Entertaining & educational games) suggest that gameplay besides levels, game contents, rewards and feedback, as a key tool to play, are significant mechanisms in determining whether players have an enjoyable experience and whether they continue with their gameplay or stop. Our findings thus suggest that game story is the main driving force behind keeping players engaged and entertained whilst interacting with games, whether it is educational or entertaining games and this provides the basis of the format of the heuristics shown in Figure 1. We identified entertaining games (as mentioned earlier) like the MMORPG. MMORPGs are of type entertaining games, a subgenre of action games, which constitute of strategy, fantasy, role-play and adventure. Whilst educational games (as defined previously) are regarded as games that are intended for innovative learning purposes in mind other than just entertainment i.e. educational. These games have a combination of fun, play and learning (Falstein and Barwood, 2001; Garris et al., 2002; Mullins, 2013). Interestingly, results from both studies suggest many rising themes emerging emphasizing the role of game design principles, usability heuristics with all its game mechanism such as story & storylines, motivation, graphics, design, sound, aesthetic, mechanic and usability testing issues. We will argue that findings suggest that heuristics principles and game design affect players' gaming experiences and how they perceive the game afterwards.

4. Game Analysis

4.1 Gameplay

There is a great deal of emphasis on gameplay, "doing things that are fun and you don't think about it...you just concentrate more and you have great fun" [F1, study 2]. Gameplay requires clear objectives, concentration (Garris et al., 2002; Koster, 2005, Figure 1), "[a]vision", "showdown system… tutorial" and "game contents" besides levels "they're only level 100-105" [P1, study 1]. This highlights the fact that comprehensible outcomes (behaviour outcomes: cognitive, affective (attitudes) and psychomotor (skills)) or objectives of the game are essential (Mayer, 2014) besides constant feedback and progress display: scores and levels (Schell, 2015, 2020). Nevertheless, some players characterize gameplay as "[d]isappointing" with "no real risk and reward incentive… to continue", adding "long term playability severely lacking" [P1, P2, P4, P5, study 1]. Whilst P3 stated that "despite a tutorial" he "dislike[d] it a lot" [study 1]. This is implicitly due to ambiguous outcomes that caused disappointment and disengagement. This disengagement is what our FGI participants referred to as when [the game] "does not go anywhere completely repeating same things over and over again. No amazements or competition, no self-satisfaction, no mission, no variety, no direction [and] no hints" [M1, M2, M3, M4, F1, F2, study 2]. On the whole, this will cause "dislik[ing]" of the gaming experience instead of enjoying the gameplay experience. The game was therefore not self-intuitive as indicated by Nielson (1995, 2000) and rather complex leading players not to understand the game and thus hating the game. Based on Mullins' (2013, 2019) basic motivational model, when needs/ expectations are unmet this results in driving force or a change in behaviour (e.g. dislike of the game experience) because lack of desirable goals/outcomes that led to a gap or no fulfilment. This is because if players could not understand the rules of the game- in order for engagement to take place i.e. lack of understanding the rules of the games' "tutorial" with no reward or risk incentives (Garris et al., 2002; Salisbury & Cole, 2016)- this will lead to unmet expectations or needs that subsequently act as a driving force/ change in the attitudes resulting in disfavour of the whole gaming experience (Federoff, 2002; Slyman, 2014; Mullins, 2013, 2019).

4.2 Game Story and Storylines

Furthermore, game story and storylines emerge as a fundamental tool for engagement (Garris et al., 2002; Figure 1), since "gameplay, and overall design of the game" were found to be "amazing" because this leads to a "pretty awesome" experience [P1, P4, P26, P31, study 1]. This is because "[g]reat storyline…is based on unique skills and character development" [P5, study 1]. In addition, the driving instincts of the game & how the story is built are incredibly essential. As the suspense; the events; the conflicts; the story with its characters and graphics; the novelty and dramatic changes are significantly challenging and inspiring so that players are kept engaged and coming (Malone, 1980; Schell, 2015, 2020). However, some players delineate the game as "[n]ot a good game", a "clone", "not original" and "a pretender" as, [P7, P12, P14, P18, P21, P22, P23, P37, P38, P40, study 1] stated, "it lacks a lot of actual content and feels repetitive after a couple weeks of grinding". This is because if the game's storyline is not appealing i.e. "[n]ot good" or a "clone", this will lead to disengagement. As some players stated, "I couldn't really get into this game it wasn't for me, [I] was bored" [P10, study 1], it is in fact less appealing and "boring" [F1, M1, study 2], since there is "no mission, no variety, no direction [and] no hints" [M1, F1, study 2]. This suggests that the driving instincts of the game & how the story is built were not exciting/ appealing (Moreno-Ger et al., 2012; Schell, 2015, 2020) in fact it was unexciting gaming experience for some, since players could not "get into this game" and so understand the game in a cyclic iterative way. This presumably signifies the significance of the game story to be a generating machine story that captivates players leading them to return to the game each time as stated by Schell (2015, 2020).

In addition, others "[dis]like graphics" and "quests" because they find the game "not that fancy" [P5, study 1] exciting or appealing (Moreno-Ger et al., 2012; Schell, 2015, 2020; Figure 1). It is in fact "simple just not fun", suggesting that players felt disengaged and not immersed in the gaming experience though "it left a bad impression" [P8, study 1; M3, study 2]. On the contrary, other players cherish the gaming experience and the effects of the game on their emotions stating clearly, "[i]t is [the] ultimate fun" and they "love this title" [P10, study 1], signifying that the game is fun and enjoyable due to the fact that the element of play is present, engaging and it is the "ultimate fun" [P9, study 1] and [it is about] "doing things that are fun" [F1, study 2] (Figure 1). This is because games in game design are expected to challenge, engage and stimulate the mind of its users in a fun and appealing manners (Moreno-Ger et al., 2012; Schell, 2015, 2020)

4.3 Game Design & Development

Furthermore, game "mechanics," "animations," "graphics" and "sounds" are characterized as "fantastic" by some suggesting that game mechanics, aesthetic and technology are working in harmony [P1, P3, P5, P25, P26, study 1]. This also highlights the fact that animations, sound effects and graphics increase players' enjoyment and curiosity (Schell, 2015, 2020). These are fundamental characteristics in game design and development (Schell, 2015, 2020). In addition, the aesthetic components of the games should be engaging and entertaining, since players can become disengaged with the games, as the game can "get boring real fast". On the other hand, others put emphasis on technology and how it is crucial in game design, as "lack of meaningful content" and "disappointment" can lead to "shallow and repetitive" gaming experience. This also signifies how game story, content, aesthetics and usability principles "responsive movement and controllers" should be adhere to in game design (Falstein and Barwood, 2001; Schell, 2015, 2020) else this will result in a repetitive experience and generally players "do not want clones of other games" [P7, P14, P15, study 1]. Game players require games that are challenging with hidden problems/conflicts as a part of gameplay: A story machine generator, where the game generates more problems and keep players engaged and coming (Sweetser et al., 2012; Schell, 2015, 2020; Figure 1). This seemingly implies the significance of game novelty from story, design to mechanics and usability principles and this is very much related to game heuristics framework (Figure 1).

5.   Game Implementation & Evaluation

5.1   Usability Principles

Other interesting emerging themes are usability principles where user interface and mechanics were not accurately functional. As "controls" and "immersion hit to a low standard", declared [P7, study 1], while usability issues, lack of useful feedback: "not user-friendly", "stale" interface and error handling message "a few bugs" (Nielson, 2000), promoting users to undo their action (Nielson, 1995; 2000), were critical issues that caused fatal technical errors causing the game to "stop… loading" [P8, P33, P34, P38, study 1](Silverman et al., 2003). This implicitly suggests that Nielson's (1995, 2000) heuristics like error handling and feedback message are missing or not adhere to in game design.

5.2   Socialising and Online Payment Upgrading Systems

On the other hand, it is worth noting that socialising and online payments upgrading level system heuristics were frequently mentioned this is because, we believe, that in today's fast-paced digital technology arena, these 'generation' of players (Horn et al., 2016) exploit the internet as a means of social interaction and networking. This also emphasizes that these generations like to socialise more and pay for online goods, and this plays a significant role in the gaming experience whilst others thought that "not many people like to group" [P18, study 1], indicating that some people did not like socialising. This also implies that a number of game players prefer socialising [M2, F2, study 2], while others do not like to interact/ chat online. In contrast, one player [P7, study 1] suggests that games should involve "other members as well like in real-life because in real-life you work with other people", emphasising that teamwork and collaboration are crucial skills in life.

6.   Discussion

6.1   THE GAME HEURISTICS MODEL: GADDIE

The proposed game evaluation heuristics model shown in Figure 1 is designed to fulfil a gap in the existing literature as previous game heuristics models were either based on entertaining or educational games perspectives but there is not a balance. The research focus thus is to design a game heuristics model that is grounded from the data, combined with HCI principles and usability testing guidelines, and the researchers' experiences as computing educators and game researchers. Consequently, this result in the GADDIE model consisting of five phases: Game Analysis, Design, Development, Implementation and Evaluation (GADDIE), since we trust that these mechanisms are major ingredients in game design be it for entertaining or educational games. The GADDIE model phases are: Game Analysis (This includes analysing players' gaming characteristic, their current levels and styles; the outcomes and any existing constraints they might encounter); Design (houses for instance designing user's experience taking into consideration the cognitive and affective factors and how the game is displayed with its visual, technical and graphical design, which will influence the outcomes); Development (This may include integrating technologies, testing, debugging and reviewing it before final release); Implementation (This involves training facilitators/game players according to the outcomes or curriculum design we would like to implement specifying its method of delivery and testing procedures) and Evaluation (i.e. Formative & summative assessments/ evaluation of the whole design. This includes testing

design and providing opportunities for feedbacks). Consequently, the game heuristic model symbolises a better game evaluation framework categorised according to these phases that were embodied in the framework as game analysis, game design & development, and game implementation & evaluation. Having analysed both findings, as aforementioned, it is worth noting that some heuristics were supported immeasurably while others were not. The theory behind implementing such a model was to profoundly build a constructive framework that will formulate the backbone/ basis of game evaluation heuristics, for analysing our future games (entertaining vs. educational).

The game analysis phase (I) consists of Gameplay. Gameplay has twenty heuristics, from (1.(I) to 20.(I)). It deals with how the player interacts with the game starting with the **game objectives**, players' **preliminary skills** to commence the **game, levels, styles and genres of the game, engagement, surprises** and curiosity to **game story** and how the scene is built up, and whether the **game** is **fun** and **transforms** its players for the **better** or **worse**. **The game story** was remarkably and immensely repeated copiously in both the focus group interviews and the 40 professional critic reviews, and we trust this is the **main drive that motivate players' to continue with the story** or ended it, as the analyses findings revealed. Gameplay also analyses whether the game has **risks**, clear **tutorial & documentation**, constant **feedback**, simple or complex play/ interaction, and if it has an **online upgrading** system; **pay-in** system and clear outcomes of the game.

The game design and development phases (II) have nine heuristics from 1.(II) to 9.(II). It consists of **game mechanics, aesthetics and technology**. This may involve **animation, sound effects, game educational, visual and technical design like menu, attributes to objects, and inputs and outputs resources; Game storylines** and how its design are developed and whether its parts are **integrated harmoniously**, interactive (with the interface and controllers) and **easy-to-use**. As well as online payments system-Upgrading game levels

The game implementation and evaluation phases (III) have from 1.(III) to 13.(III) heuristics. It deals with game usability and how **accessible** and **usable** it is for players to interact with the game. It investigates whether **training** facilities, **outcomes**, **curriculum** and methods of delivery are clear, adding to this **progress, feedback, scores & levels, and checking that they are explicable, challenging & balanced** according to levels. In addition, it examines if game **storyline is stimulating, novel, logical and well designed with engaging** outcomes. It also assesses whether the game has **accessible user-friendly interface** that is consistent throughout the game interface with its **menus design, controllers, sounds and animation** that do not confuse players, and can **handle error message** easily, with **accessible tutorial** and **documentation, and friendly online customer support service.**

The rationale behind this research, as stated, was to generate a comprehensive model for analysing entertaining and educational games and thus create a better game design that caters for players' needs and expectations, leading users to **progress** during gameplay and achieve **fulfilment**.

Key
I.II, III: GADDIE Phases
1., 2., 3,: Sub-categories

Phases & Categories	Heuristics & its description
I. Game Analysis **(Gameplay** **and** **Game Story)**	1. (I) **Clear objectives or outcomes** of the game. 2. (I) **Players do not require any preliminary skills to commence.** Novice/ experts can understand the rules. 3. (I) **Game styles/genres** are distinctive: strategy/ adventure…etc. 4. (I) **Expectations and needs** (behavioural outcomes: cognitive, affective (attitudes) and psychomotor (skills)) are achieved leading to **progress** and **fulfilment** (i.e. positive experience). 5. (I) **Levels** are obtainable/ easy/ hard. 6. (I) The element of **curiosity and manipulation** are **integrated** in the game. 7. (I) Players are **engaged** in the game. The **game** is **valuable** and **players care** about it. 8. (I) Game players are asked to **solve challenging hidden problems/conflicts as a part of the gameplay**. The game generates more problems to keep players engaged and coming. 9. (I) The **driving instincts of the game & how the story** is built are exciting/ positive/ boring. The suspense; event; story; characters; details; and dramatic changes are balanced/ appealing. 10. (I) The **game is fun & enjoyable**. Some parts are/need to be fun. The element of play is

Phases & Categories	Heuristics & its description
	presented in the game and it is engaging and immersive.
	11. (I) The **game surprises** the players when they play. The **game story** has surprises. The rules of the game give players ways to surprise each other and themselves.
	12. (I) Games can **transform players for better/ worse.** The game is **worth playing**/ the time.
	13. (I) **Risks; choice and chance; punishment; competition**; reward is built up. A way to turn loosing state to a winning state.
	14. (I) **Constant feedback, clear progress** display (scores and levels) and response time.
	15. (I) **Players** are able to **socialise/ express themselves.** Some/ all are playing with friends.
	16. (I) **Simplicity/ complexity** is/ should be balanced.
	17. (I) They are **puzzles/quizzes** in the game.
	18. (I) **Tutorial** & **documentation** is clear and comprehensible.
	19. (I) Online Equipment Payments- Upgrading system.
	20. (I) Clear outcomes of the game.
II. Game Design & Development (Game Mechanics, Aesthetic & Technology)	1. (II) **Animation and sound effects work in harmony.**
	2. (II) **Reward and feedback** increase **players' curiosity and engagement.**
	3. (II) **Game instructional, visual and technical** design: venue, objects, attributes, dimensions 2D), novelty, uniqueness;
	imagination, strategy, constraints/ limitation, effects are distinctive.
	4. (II) **Storyline** is easy to understand, clear with **engaging** outcomes/vision.
	5. (II) **Game designs with its different elements** are in **harmony**. The game time is short/slow/fast.
	6. (II) **Physical input & output resources are appealing** from aesthetics, mode of change, size, font and colours.
	7. (II) **User interface**, controllers; **feedback**/ reward and spending money, currency/ points all information are obvious and communicated to the user without interfering with the interface.
	8. (II) **Technology and programmes** are **harmoniously integrated.**
	9. (II) **Online payments- Upgrading game levels.**
III. Game Implementation & Evaluation (Game Usability)	1.(III) **Training facilities and outcomes** are distinctive.
	2.(III) **Curriculum and methods** of delivery are clear.
	3.(III) **Progress, feedback, scores & levels are explicable, challenging & balanced** according to levels.
	4.(III) **Points/ reward** is built up.
	5.(III) **Storyline** is suitable for the **level of complexity.**
	6.(III) **Storyline** is **logical with engaging outcomes/ vision.**
	7.(III) **Storyline** is **novel.**
	8.(III) **Storyline** is **well-designed.**
	9.(III) **Intuitive accessible user-friendly interface**; consistency **throughout the game interface**, menus, design, sounds and animation.
	10.(III) **Controllers** do not confuse the players.
	11.(III) **Useful error handling message**, promoting users to **undo their action**.
	12.(III) **Tutorial** & **documentation** is **easy** to read and understand.
	13.(III) **Friendly Online Customer Support**.

Figure 1: GADDIE: The Game Evaluation Heuristics

7. Conclusions

This research paper has highlighted the effects of games on players' gaming experience for educational simulation games using the heuristics framework, the GADDIE model. This encapsulates game design principles, HCI usability guidelines and educational perspectives. These heuristics were designed based on the research findings and game research literature. These heuristics are intended to **aid our ongoing research project** for **game analysis and evaluation** since research findings reveal that game design heuristics **affect** players' **gaming experience** whether it is for entertaining or educational games. Results found that evaluating games for usability present unique challenges and require heuristics that aim to reflect how users should interact with **games in a cyclic iterative way because if users' needs or expectations are unmet, this will lead to frustration/ undesirable behavioural outcomes when assessed.** This subsequently will cause displeasing gaming experience that should have been motivating & enjoyable. **Usability issues** should **encapsulate gameplay** (goals and challenges of the game), **game interface** (visual & physical aspects like screen) and **game mechanics** (internal aspects of the game: animation, coding…etc). **Game usability heuristics** are usability principles, a quick and inexpensive method of

evaluating the usability of the software for two to three hours aimed at enhancing and improving game design and development.

In this empirical study, the contributed heuristics from the professional critic reviews & FGIs (as aforementioned) were collated and compiled to make our **GADDIE model**. These heuristics are regarded as incredibly significant as the findings reveal (Figure 1). We recognize the values of other heuristics such as Game Physics and Artificial Intelligence that were not supported by our case studies but the ones we discovered are originated from our empirical case studies, and what educational simulation game researchers should emphasis more.

For future research, this empirical work could be developed further using, for instance, observation methods such as eye tracking systems or brain scanners (functional magnetic resonance imaging) to monitor brain activity that is responsible for behaviour, attitudes and feelings, excitement or disengagement during gameplay. It can therefore pinpoint reasons that trigger unpleasant gaming experiences (a transformation for the worse) and enable the advancement of effective strategies for dealing with game design issues in order to improve **game quality design that meet users' expectations**. This study offers a new way of designing game evaluation heuristics for better game designs from HCI design, usability and educational perspectives, and this is the **true value of our contributions** because **this paper is part of ongoing research project for analysing and evaluating educational simulation games**. This research paper indicates several game design issues that affect players' gaming experiences and necessitate the design of a new set of heuristics (a check list) for a better game analysis and evaluation for educational simulation games, which was the aim of this research paper.

References

ADDIE Model, (2016) Available at: http://www.learning-theories.com/addie-model.html (Accessed 20/04/2016).

Anderson, S., (2020) Quantitative Analysis. Available at: https://www.investopedia.com/terms/q/quantitativeanalysis.asp (Accessed 20/02/2021).

Applefield, J.M., Huber, R. & Moallem, M. (2000) Constructivism in Theory and Practice: Toward a Better Understanding. The High School Journal, pp.35-53.

Arthur, J., Waring, M. Coe, R. and Hedges, L.V. (2012) 'Research Methods and Methodologies in Education', California: Sage Publications Inc.

Barbosa, T., Lopes, S. P. Leao. C. Soares, F. and Carvalho, V. (2019) Serious Game for Teaching Statistics in Higher Education: Storyboard Design. In: 7th EAI International Conference, Braga, Portugal, on 'Interactivity, Game Creation, Design, Learning, and Innovation' (ed.) Springer, pp. 169–175. https://doi.org/10.1007/978-3-030-06134-0_18.

Bellotti, F., Kapralos, B. Lee, K. Moreno-Ger, P. and Berta, R. (2013) Assessment in and of serious games: an overview. Advances in Human-Computer Interaction, (2013), p.1.

Belluigi, D.Z. (2009) Exploring the Discourses Around 'Creativity' and 'Critical Thinking' in a South African Creative Arts Curriculum. Studies in Higher Education, 34(6), pp.699-717.

Bennedesen, J. and Caspersen, M.E. (2004) 'Programming in Context: A Model-First Approach to CS1'. In Proceedings of the 35th SIGCSE Technical Symposium on the Computer Science Education, pp.477-481. ACM Press.

Bevan, N. (2001) International standards for HCI and usability. International Journal of Human Computer Studies. 55(4), pp.533-552.

Brennan, R. and Vos, L. (2010) Marketing Simulation Games: Student and Lecturer Perspectives. Marketing Intelligence and Planning.

British Education Research Association (BERA), (2011) 'BERA Ethical Guidelines for Educational Research'. Available at: http://www.bera.ac.uk/ (Accessed 15/10/2016).

British Education Research Association (BERA), (2018) 'BERA Ethical Guidelines for Educational Research'. Available at: https://www.bera.ac.uk/wp-content/uploads/2018/06/BERA-Ethical-Guidelines-for-Educational-Research_4thEdn_2018.pdf?noredirect=1 (Accessed 25/03/2019).

Brown. J.S., Collins. A. & Duguid P. (1989) Situated Cognition and The Culture of Learning. Educational researcher, 18(1), 32-42.

Bruner, J. (1973) Going Beyond the Information Given. New York: Norton.

Bryant, A. (2017). Grounded Theory and Grounded Theorizing: Pragmatism in Research Practice. New York, NY: Oxford University Press.

Bryman, A. (2016) 'Social Research Methods', 5th Edition, United States: Oxford University Press.

Burton, R. R., Brown, J. S. and Fischer, G. (1984) 'Skiing as a Model of Instruction'. In B. Rogoff and J. Lave (ed.).

Caillois, R. (1961) 'Man, Play, and Games'. New York: Free Press.

Cardinot, A. and Fairfield, J.A. (2019). Game-Based Learning to Engage Students with Physics and Astronomy Using a Board Game. International Journal of Game-Based Learning (IJGBL), 9(1), pp.42-57.

Charmaz. K. (2014) 'Constructing Grounded Theory', 2nd Edition. London: Sage Publications Ltd.

Cohen, L., Manion, L. and Morrison, K. (2018) 'Research Methods in Education', London: Routledge.

Conlon, C., Carney, G., Timonen, V., & Scharf, T. (2015) Emergent Reconstruction in Grounded Theory: Learning from Team-Based Interview Research. Qualitative Research, 15, pp.39–56. doi:10.1177/1468794113495038

Cook J. (1992) Negotiating the Curriculum: Programming for Learning. Negotiating the Curriculum: Educating for the 21st Century, pp.15-31.

Cooper, P.A. (1993) Paradigm Shifts in Designed Instruction: From Behaviorism to Cognitivism to Constructivism. Educational technology, 33(5), pp.12-19.

Corbin, J., & Strauss, A. (2015). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory (4th ed.). Thousand Oaks, CA: Sage.

Cordova, D. I. and Lepper, M. R. (1996) 'Intrinsic Motivation and the Process of Learning: Beneficial Effects of Contextualization, Personalization, and Choice'. Journal of Educational Psychology, 88, pp.715-730.

Coulthard, G.J. (2009) 'A Review of the Educational Use and Learning Effectiveness of Simulations and Games' [online]. PhD thesis. Purdue University. Available from: http://www.coulthard.com/library/paper - simulation.html (Accessed 15/12/2015).

Crockett, L. (2018) Bogost's War on Gamification: Irony and Play on Grandma's Sofa. In: 12th European Conference on Games Based Learning (ECGBL 2018). Reading: Academic Conferences and Publishing International Ltd.

Cronan, T.P. and Douglas, D.E. (2012) A Student ERP Simulation Game: A Longitudinal Study. Journal of Computer Information Systems, 53(1), pp.3-13.

Dann, W.P., Cooper, S. and Pausch, R. (2008) Learning to Program with Alice. Prentice Hall Press.

Derryberry, A. (2007) 'Serious games: Online games for learning'. White Paper. [Online]. Available at: http://www.adobe.com/resources/elearning/pdfs/serious_games_wp.pdf (Accessed 10/12/2015).

Desurive, H., Caplan, M. and Toth, J. (2004) 'Using Heuristics to Evaluate the Playability of Games'. CHI conference, 32 (1), pp. 97-110. Doi: 10.1177/104687810103200108.

Desurvire, H. and Wiberg, C. (2010) 'User Experience Design for Inexperienced Gamers: GAP – Game Approachability Principles'. In Evaluating User Experience in Games, Regina Bernhaupt (ed.) Springer, pp.131–148. http://doi.org/10.1007/978-1-84882-963-3_1.

Desurvire. H. and Wiberg, C. (2009) 'Game Usability Heuristics (PLAY) for Evaluation and Designing Better Games: The Next Iteration' CHI conference, pp. 557-555.

Dondlinger, J.M. (2007) 'Educational Video Game Design: A Review of the Literature', Journal of Applied Educational Technology,4(1), Spring/Summer, pp.21-31. Available at: http://reserachgate.net/publication/238444705 (Accessed 12/12/2015).

Dwyer, J. and Slyman, S. (2016) 'An Introduction to Quantitative Methods for Business Research'; Algana Publishing; London; 200 pages; ISBN−13: 9781907934094.